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Comparison of the prevalence of chronic kidney disease among different ethnicities: Beijing CKD survey and American NHANES

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Abstract

Background. It is unclear whether ethnic disparity of the prevalence of chronic kidney disease (CKD) exists among native Chinese and American ethnicities.

Methods. A stratified multistage clustered screening for CKD performed in Beijing in 2006 was compared with data from the National Health and Nutrition Examination Survey (NHANES) between 1999–2006 (participants aged ≥20 years, 13 626 Chinese, 9006 whites, 3447 African Americans, 4626 Hispanics). Serum creatinine from Beijing and NHANES were calibrated at the Cleveland Clinic Laboratory. The re-expressed abbreviated MDRD equation for Americans and its modified form for Chinese were used to estimate glomerular filtration rate (eGFR). Subjects with eGFR <60 mL/min/1.73 m^2 were diagnosed as having chronic renal insufficiency (CRI). Albuminuria was diagnosed if the urine albumin–creatinine ratio was >17 mg/g for males or >25 mg/g for females. CKD was diagnosed if CRI or albuminuria was present.

Results. Compared with American whites, African Americans and Hispanics, Chinese had a lower prevalence of adjusted albuminuria (12.10%, 16.33% and 14.16% versus 9.27%), CRI (9.46%, 5.18% and 3.11% versus 1.38%) and CKD (19.03%, 19.00% and 15.99% versus 10.25%). Moreover, Chinese hold the lowest risk of albuminuria when exposed to diabetes; the risk of CRI among Chinese when exposed to diabetes or hypertension was lower than that among African Americans, but similar to that among whites and Hispanics.

Conclusions. The CKD prevalence was significantly different among native Chinese and American ethnicities.

Keywords: albuminuria; chronic kidney disease; chronic renal insufficiency; ethnicity

Introduction

The prevalence of chronic kidney disease (CKD) is increasing worldwide, and the prevalence has been different among ethnicities. The prevalence of CKD was higher in African Americans [1–13] and Hispanics [3,9,11,14,15] compared with that in whites. Possible reasons for the ethnic disparity of the CKD prevalence include difference in socioeconomic status [4,5,15], prevalence and severity of diabetes and hypertension [6,7] and congenital susceptibility to renal damage [3,12,13].

Through collaboration with Beijing Chronic Disease Center, a strictly designed CKD survey in Beijing, China, was recently accomplished [16]. In this survey, it was found that the prevalence of decreased estimated glomerular filtration rate (eGFR) and albuminuria was 1.7% and 9.2%, respectively, which was much less than that among US ethnicities.

In the current study, the data from CKD survey in Beijing were compared with those from the National Health and Nutrition Examination Survey (NHANES), to confirm the ethnic disparity of the CKD prevalence among native Chinese and American ethnicities and to explore possible reasons for the disparity.

Methods

Study population

NHANES are cross-sectional, stratified, multistage, clustered probability samples of the civilian non-institutionalized US population [17]. Detailed NHANES documentation can be found on the website http://www.cdc.gov/nchs/nhanes.htm. NHANES 1999–2000, 2001–02, 2003–04 and 2005–06 data of American whites, African Americans and Hispanics were collected following National Center for Health Statistics recommendations [18] and then merged with the Beijing CKD survey study that was performed in 2006 with a stratified multistage clustered sample design (for detailed information, refer to our former study [16]).

We limited the study population to persons who were aged 20 years or older: whites (n = 9006), African

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Americans ($n = 3447$), Hispanics ($n = 4626$) and Chinese ($n = 13\,626$). The term 'ethnic' we used in this study involves both common genetic characteristics and shared cultural, religious, behavioural and language traits.

Assessment of kidney damage

Serum creatinine (Scr, mg/dL) of participants of NHANES and Chinese study was measured using a kinetic rate Jaffe method and recalibrated to standardized creatinine measurements obtained at the Cleveland Clinic Research Laboratory (for Americans, standard creatinine $= 0.147 + 1.013 \times$ NHANES 1999–2000 uncalibrated Scr [19], standard creatinine $= -0.016 + 0.978 \times$ NHANES 2005–06 uncalibrated Scr [20], no correction was needed for NHANES 2001–02 [21] and NHANES 2003–04 [22]; for Chinese, standard creatinine $= -0.18 + 1.32 \times$ uncalibrated Scr [23]).

The GFR of participants of NHANES was estimated by using the abbreviated Modification of Diet in Renal Disease (MDRD) study formula re-expressed by Levey *et al*. [24] using standard Scr as follows: GFR (mL/min/1.73 m^2) $= 175 \times$ standard $Scr^{-1.154} \times age^{-0.203} \times 0.742$ (if female) $\times$ 1.212 (if African American). The GFR of Chinese participants was estimated by using the modified MDRD formula for Chinese [23]: GFR (mL/min/1.73 m^2) $= 175 \times$ standard $Scr^{-1.234} \times age^{-0.179} \times 0.79$ (if female). Participants with eGFR >200 mL/min/1.73 m^2 were excluded. Participants with eGFR <15 mL/min/1.73 m^2 were also excluded because many of these individuals were ill or receiving dialysis and would have a low response rate that may induce biased results. Chronic renal insufficiency (CRI) was defined as eGFR <60 mL/min/1.73 m^2.

For NHANES participants, urine albumin was measured by solid phase fluorescence immunoassay and urine creatinine was measured by the modified kinetic Jaffe method using a Synchron AS/Astra analyser (Beckman Coulter, Fullerton, CA, USA). For Chinese participants, urine albumin was measured by immunoturbidimetric assay and urine creatinine was measured by the modified kinetic Jaffe method (ITA, Audit Diagnostics, Cork, Ireland).

The urine albumin–creatinine ratio (UACR) was calculated according to the following equation: UACR (mg/g) = urine albumin concentration (mg/L)/urine creatinine concentration (g/L). Albuminuria was diagnosed if the UACR was 17 mg/g (1.9 mg/mmol) or more for males and 25 mg/g (2.8 mg/mmol) or more for females [25].

To estimate the prevalence of persistent albuminuria, 622 Chinese were randomly selected, and UACR was measured twice 3 months apart. Results showed that 53.0% of those with eGFR ≥90 mL/min/1.73 m^2 and 66.4% of those with eGFR of 60–89 mL/min/1.73 m^2 had persistent albuminuria. Only one-time urine samples were measured in NHANES 1999–2004. However, UACR was measured twice in a sub-sample of NHANES III and revealed that the persistence rate of albuminuria (53.9% of those with eGFR ≥90 mL/min/1.73 m^2 and 72.7% of those with eGFR of 60–89 mL/min/1.73 m^2 still had albuminuria) was similar to that of the Beijing study [26].

Participants with albuminuria or CRI were diagnosed as having CKD [27].

Assessment of demographic and possible risk factors for CKD

Height and weight were used to calculate the body mass index (BMI = weight/height^2, kg/m^2). Overweight was defined as BMI ≥25 kg/m^2 [28].

Blood pressure was measured according to the recommendations of the American Heart Association [29] for Americans and the guidelines presented in the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure [30] for Chinese. Hypertension was defined by any one of the following: systolic BP ≥140 mmHg or diastolic BP ≥90 mmHg; being told at least twice of having hypertension; being administered an antihypertensive medication at the time of the interview.

For both study populations, diabetes was defined by any one of the following: self-report of a physician's diagnosis of diabetes; being administered medication to decrease the blood glucose level at the time of the interview; being administered insulin at the time of interview; having a fasting glucose (FG) level >125 mg/dL.

Hyperlipidaemia for both study participants was defined by any one of the following: total cholesterol (TC) ≥240 mg/dL, triglyceride (TG) ≥200 mg/dL, high-density lipid (HDL) <40 mg/dL, low-density lipid (LDL) ≥160 mg/dL [31]; self-report of a physician's diagnosis of hyperlipidaemia; being administered medication to decrease the blood lipid level at the time of the interview.

Statistical analysis

All analyses were performed on weighted data to produce appropriate statistical estimates for each population from which the studied subjects were sampled. For the NHANES data, an 8-year weight variable was created by assigning 1/2 of the 4-year weight for 1999–2002 if the person was sampled in 1999–2002 or assigning 1/4 of the 2-year weight for 2003–04 and 2005–06 if the person was sampled in 2003–04 or 2005–06 [18]. The sample weight for Beijing CKD survey data was based on population estimates that incorporated the year 2000 census counts [16].

The general characteristics of each ethnicity were provided by descriptive analyses. The differences of these variables among different ethnicities were examined using chi-square statistics for categorical variables and one-way analysis of variance for continuous values.

To assess the ethnic difference in the prevalence of albuminuria, a model of logistic regression was constructed, using albuminuria as the outcome, ethnicities as the predictor and age, gender, diabetes, hypertension, hyperlipidaemia, overweight and smoking as covariates. To test the hypothesis that the susceptibility to risk factors was different among ethnicities, an interaction term between ethnicity and risk factors was included in the model. Five logistic models were constructed to test the interaction between ethnicity and each of diabetes, hypertension, hyperlipidaemia, overweight and smoking respectively. Also, logistic regression models were constructed to test the ethnic difference between the prevalence of CRI and CKD.

Table 1. Characteristics of each ethnic group (weighted)

	Chinese[a] (SE)	Whites (SE)	African Americans (SE)	Hispanics (SE)
Age (years)	40.33 (0.87)	48.10 (0.37)*	43.59 (0.37)*	39.91 (0.56)
Male: female	1.17:1	0.94:1*	0.81:1*	1.00:1*
Height (cm)	164.98 (0.32)	170.03 (0.12)*	169.27 (0.15)*	163.91 (0.18)*
Weight (kg)	66.97 (0.32)	81.50 (0.33)*	86.33 (0.55)*	76.48 (0.44)*
Body mass index (kg/m^2)	24.53 (0.11)	28.10 (0.12)*	30.15 (0.17)*	28.43 (0.16)*
Systolic blood pressure (mmHg)	127.93 (0.84)	122.74 (0.33)*	125.92 (0.50)*	119.48 (0.54)*
Diastolic blood pressure (mmHg)	80.25 (0.37)	70.95 (0.23)*	72.23 (0.37)*	69.78 (0.27)*
Glucose (mg/dL)	97.02 (0.72)	101.34 (0.54)*	103.32 (1.08)*	105.84 (1.44)*
Total cholesterol (mg/dL)	180.59 (1.16)	202.63 (0.39)*	194.51 (0.77)*	199.92 (0.77)*
Triglyceride (mg/dL)	124.00 (2.66)	150.58 (2.67)*	114.26 (2.63)*	154.12 (4.43)*
High-density lipid (mg/dL)	51.34 (0.39)	53.68 (0.38)*	56.40 (0.39)*	50.56 (0.36)
Low-density lipid (mg/dL)	114.72 (1.15)	117.78 (0.76)*	113.58 (1.13)	116.25 (1.25)
Overweight (%)	42.32 (0.01)	64.19 (0.01)*	72.60 (0.01)*	70.41 (0.01)*
Diabetes (%)	11.58 (0.01)	23.00 (0.01)*	27.02 (0.01)*	24.87 (0.02)*
Hypertension (%)	31.89 (0.02)	36.74 (0.01)*	42.48 (0.01)*	23.80 (0.01)*
Hyperlipidaemia (%)	42.37 (0.01)	55.93 (0.01)*	42.72 (0.01)*	52.09 (0.01)*
Smoker (%)	32.82 (0.01)	24.90 (0.01)*	25.73 (0.01)*	21.90 (0.01)*
Urine albumin/creatinine ratio (mg/g)	15.67 (0.89)	22.81 (1.62)*	53.44 (8.60)*	32.89 (3.73)*
Glomerular filtration rate (mL/min/1.73 m^2)	100.60 (1.11)	83.05 (0.40)*	97.65 (0.71)*	99.59 (0.81)*
Albuminuria (%)	9.27 (0.01)	12.10 (0.00)*	16.33 (0.01)*	14.16 (0.01)*
Chronic renal insufficiency (%)	1.38 (0.00)	9.46 (0.00)*	5.18 (0.00)*	3.11 (0.00)*
Chronic kidney disease (%)	10.25 (0.01)	19.03 (0.01)*	19.00 (0.01)*	15.99 (0.01)*

SE, standard error.
*P-value <0.05.
[a]Chinese as reference.

Table 2. OR and aOR for the presence of albuminuria, CRI and CKD (Chinese as reference)

	Whites-to-Chinese		African Americans-to-Chinese		Hispanics-to-Chinese	
	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)
Albuminuria	1.34 (1.06–1.71)*	1.09 (0.90–1.31)	1.83 (1.61–2.08)*	1.30 (1.18–1.44)*	1.53 (1.34–1.75)*	1.21 (1.09–1.33)*
CRI	7.20 (4.17–13.64)*	1.56 (1.35–1.82)*	4.00 (2.99–5.44)*	1.72 (1.40–2.12)*	2.55 (1.86–3.56)*	1.46 (1.17–1.82)*
CKD	2.04 (1.64–2.56)*	1.10 (1.03–1.17)*	1.98 (1.75–2.23)*	1.35 (1.23–1.48)*	1.61 (1.41–1.83)*	1.24 (1.12–1.36)*

Note: Overall odds ratio and multivariate adjusted odds ratio were calculated using the chi-square test and logistic regression analyses, respectively. Results showed that American ethnicities had higher risk for renal damage than Chinese even after adjusting their different proportions of age and sex and different prevalence of risk factors.
CRI, chronic renal insufficiency; CKD, chronic kidney disease; OR, odds ratio; CI, confidence interval; aOR, adjusted-OR (controlling for age, gender, hypertension, diabetes, hyperlipidaemia, overweight and smoking).
*P-value <0.05.

All analyses were performed using STATA version 7 (STATA Corp., College Station, TX, USA).

Results

Assessment of demographic and risk factors for CKD

The selected Beijing population was significantly younger, shorter and thinner than whites and African Americans. Compared with American Hispanics, Chinese were thinner but taller. There were more male and less female smokers in the Beijing population compared with the US population. Chinese had the highest mean systolic blood pressure and mean diastolic blood pressure after age and gender were adjusted. However, Chinese had the lowest prevalence of hypertension. The prevalence of diabetes, hyperlipidaemia and overweight in Chinese was also the lowest among the ethnicities (Table 1).

Ethnic disparity in the prevalence of CKD

Chinese had the highest mean eGFR (100.60 mL/min/1.73 m^2 for Chinese versus 83.05 mL/min/1.73 m^2, 97.65 mL/min/1.73 m^2 and 99.59 mL/min/1.73 m^2 for whites, African Americans and Hispanics). The UACR level of Chinese (15.67 mg/g) was lower than that of whites (22.81 mg/g), African Americans (53.44 mg/g) and Hispanics (32.89 mg/g). Chinese had the lowest prevalence of albuminuria, CRI and CKD (Table 1). After adjusted by gender, age, hypertension, diabetes, hyperlipidaemia, overweight and smoke, Chinese still hold the lowest risk for the presence of albuminuria, CRI and CKD (Table 2).

Different susceptibility to CKD risk factors among ethnicities

It was hypothesized that the effects of each of hypertension, diabetes, overweight, hyperlipidaemia and smoking on the presence of CKD were different. This hypothesis was tested using logistic regression including the interaction term between ethnicity and each of hypertension, diabetes, overweight, hyperlipidaemia and smoking. Results showed that compared with that of non-diabetic subjects, the odds ratio for the presence of albuminuria and CKD in diabetic American ethnicities (diabetic Chinese as reference) increased over 1.5 times. In African Americans, smoking caused the odds ratio for the presence of albuminuria to increase 1.43 times compared with Chinese. However, when allowing for overweight, the odds ratio for the presence of albuminuria and CKD in whites were decreased by ∼30% compared with Chinese. The odds ratio for the presence of CRI in African Americans exposed to diabetes or hypertension, compared with Chinese, increased over two times compared with that of those not exposed, whereas for whites and Hispanics, the odds ratio for the presence of CRI was maintained at the same level no matter whether exposed to risk factors or not. The odds ratio and the deviation of odds ratio (risk factor exposed compared with risk factor not exposed) for each of albuminuria, CRI and CKD among whites, African American and Hispanics compared with Chinese are listed in Table 3A–C.

Discussion

The prevalence of CKD is different among racial and ethnic groups [1–15]. This is the first study to investigate the ethnic disparity in the CKD prevalence and its risk factors among native Chinese and American ethnicities. We found that native Chinese had a lower prevalence of albuminuria, CRI and CKD than American whites, African Americans and Hispanics. It is recognized that CKD is strongly

Table 3. Covariates ethnicities interaction for the presence of albuminuria (A), chronic renal insufficiency (B) and chronic kidney disease (C) in the logistic models (Chinese as reference)

Panel A[a]

Model	Albuminuria	Whites	African Americans	Hispanics
		aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
1	Diabetes	1.59 (1.28–1.98)*	2.73 (2.06–3.60)*	2.55 (1.78–3.65)*
	Non-diabetes	1.03 (0.84–1.25)	1.58 (1.28–1.94)*	1.54 (1.17–2.01)*
	Diabetes ethnicity interaction	1.55 (1.16–2.07)*	1.73 (1.25–2.39)*	1.66 (1.07–2.56)*
2	Hypertension	1.09 (0.92–1.29)	2.00 (1.57–2.54)*	2.03 (1.43–2.88)*
	Non-hypertension	1.23 (0.96–1.57)	1.58 (1.18–2.11)*	1.58 (1.16–2.17)*
	Hypertension ethnicity interaction	0.89 (0.67–1.18)	1.27 (0.86–1.85)	1.28 (0.79–2.09)
3	Hyperlipidaemia	1.19 (0.99–1.44)	2.05 (1.60–2.63)*	1.84 (1.40–2.41)*
	Non-hyperlipidaemia	1.10 (0.86–1.41)	1.63 (1.30–2.05)*	1.70 (1.23–2.33)*
	Hyperlipidaemia ethnicity interaction	1.08 (0.80–1.46)	1.26 (0.92–1.72)	1.08 (0.73–1.61)
4	Overweight	0.97 (0.82–1.16)	1.68 (1.33–2.11)*	1.69 (1.29–2.22)*
	Non-overweight	1.45 (1.13–1.86)*	1.95 (1.43–2.66)*	1.58 (1.19–2.11)*
	Overweight ethnicity interaction	0.67 (0.50–0.90)*	0.86 (0.56–1.31)	1.07 (0.73–1.57)
5	Smoker	1.44 (1.11–1.88)*	2.04 (1.53–2.73)*	1.82 (1.21–2.73)*
	Non-smoker	1.01 (0.84–1.21)	1.72 (1.36–2.17)*	1.68 (1.31–2.15)*
	Smoke ethnicity interaction	0.90 (0.75–1.08)	1.43 (1.04–1.95)*	1.19 (0.81–1.74)

Panel B[b]

Model	Chronic renal insufficiency	Whites	African Americans	Hispanics
		aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
1	Diabetes	5.45 (3.72–740)*	4.19 (2.76–6.35)*	3.47 (1.96–6.15)*
	Non-diabetes	3.16 (1.95–5.11)*	2.08 (1.22–3.56)*	1.76 (0.85–3.66)
	Diabetes ethnicity interaction	1.72 (0.98–3.03)	2.01 (1.08–3.74)*	1.97 (0.78–4.98)
2	Hypertension	4.27 (3.16–5.77)*	3.43 (2.42–4.85)*	2.84 (1.72–4.67)*
	Non-hypertension	2.80 (1.42–5.51)*	1.06 (0.38–2.97)	1.34 (0.52–3.48)
	Hypertension ethnicity interaction	1.53 (0.84–2.77)	3.24 (1.21–8.70)*	2.11 (0.77–5.76)
3	Hyperlipidaemia	3.70 (2.71–5.04)*	2.49 (1.71–3.63)*	1.90 (1.11–3.23)*
	Non-hyperlipidaemia	3.61 (1.83–7.12)*	2.93 (1.39–6.20)*	2.95 (1.25–6.94)*
	Hyperlipidaemia ethnicity interaction	1.02 (0.56–1.88)	0.85 (0.41–1.75)	0.64 (0.25–1.62)
4	Overweight	4.12 (2.92–5.82)*	2.91 (1.92–4.41)*	2.34 (1.36–4.04)*
	Non-overweight	3.20 (1.82–5.63)*	2.45 (1.33–4.52)*	2.17 (0.94–5.02)
	Overweight ethnicity interaction	1.29 (0.79–2.09)	1.19 (0.65–2.17)	1.08 (0.42–2.76)
5	Smoker	3.04 (1.93–4.79)*	1.70 (0.87–3.34)	1.53 (0.47–4.95)
	Non-smoker	3.96 (2.37–6.61)*	2.99 (1.73–5.17)*	2.45 (1.31–4.61)*
	Smoke ethnicity interaction	0.77 (0.39–1.51)	0.57 (0.24–1.35)	0.62 (0.16–2.49)

Continued

Table 3. *Continued*

Panel C[c]

Model	Chronic kidney disease	Whites	African Americans	Hispanics
		aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
1	Diabetes	2.17 (1.72–2.73)*	2.98 (2.25–3.94)*	2.72 (1.89–3.91)*
	Non-diabetes	1.27 (1.06–1.52)*	1.57 (1.29–1.93)*	1.54 (1.15–2.07)*
	Diabetes ethnicity interaction	1.70 (1.25–2.32)*	1.89 (1.36–2.62)*	1.76 (1.10–2.82)*
2	Hypertension	1.54 (1.30–1.82)*	2.16 (1.71–2.73)*	2.07 (1.47–2.91)*
	Non-hypertension	1.36 (1.08–1.71)*	1.51 (1.12–2.05)*	1.55 (1.12–2.15)*
	Hypertension ethnicity interaction	1.13 (0.85–1.49)	1.43 (0.97–2.09)	1.33 (0.82–2.16)
3	Hyperlipidaemia	1.54 (1.31–1.82)*	1.95 (1.56–2.44)*	1.78 (1.36–2.33)*
	Non-hyperlipidaemia	1.32 (1.04–1.69)*	1.80 (1.43–2.26)*	1.85 (1.33–2.59)*
	Hyperlipidaemia ethnicity interaction	1.16 (0.87–1.56)	1.09 (0.83–1.42)	0.96 (0.65–1.43)
4	Overweight	1.28 (1.09–1.51)*	1.74 (1.39–2.17)*	1.77 (1.37- 2.29)*
	Non-overweight	1.71 (1.35–2.16)*	1.98 (1.47–2.66)*	1.52 (1.11–2.10)*
	Overweight ethnicity interaction	0.75 (0.57–0.99)*	0.88 (0.59–1.30)	1.16 (0.79–1.70)
5	Smoker	1.46 (1.16–1.85)*	1.79 (1.33–2.40)*	1.71 (1.08–2.70)*
	Non-smoker	1.44 (1.21–1.71)*	1.91 (1.51–2.41)*	1.81 (1.41–2.32)*
	Smoke ethnicity interaction	1.02 (0.77–1.34)	0.94 (0.64–1.37)	0.95 (0.58–1.54)

CI, confidence interval; aOR, adjusted odds ratio.

[a]Multivariate logistic models containing the interaction term between ethnicity and risk factors were used to explore different ethnic susceptibility to risk factor, which was calculated from the ratio of the risk factor positive odds ratio to the risk factor negative odds ratio. Results showed that the odds ratio for the presence of albuminuria among diabetic American ethnicities, compared with that among non-diabetic, increased over 1.55–1.73 times. For African Americans, smoke also caused the odds ratio for the presence of albuminuria to increase 1.43 times. When exposed to overweight, the odds ratio for the presence of albuminuria in whites was decreased by ∼30%.

[b]Multivariate logistic models containing the interaction term between ethnicity and risk factors were used to explore different ethnic susceptibility to risk factor, which was calculated from the ratio of the risk factor positive odds ratio to the risk factor negative odds ratio. Results showed that the odds ratio for the presence of CRI among African Americans who exposed to diabetes or hypertension, compared with that of those who not exposed, increased over two times, whereas for whites and Hispanics, the odds ratio for the presence of CRI was maintained at the same level no matter whether exposed to risk factors or not.

[c]Multivariate logistic models containing the interaction term between ethnicity and risk factors were used to explore different ethnic susceptibility to risk factor, which was calculated from the ratio of the risk factor positive odds ratio to the risk factor negative odds ratio. Results showed that the odds ratio for the presence of CKD among diabetic American ethnicities, compared with that among non-diabetic, increased 1.70–1.89 times. When exposed to overweight, the odds ratio for the presence of CKD in whites was decreased by ∼30%.

*P-value <0.05.

associated with metabolic disorders in both developed [32,33] and developing countries [34,35]. Zhang *et al*. reported that subjects with metabolic syndrome had two times higher risk for CKD [35]. Our results showed that Chinese had the lowest prevalence of metabolic disorders such as hypertension, diabetes, hyperlipidaemia and overweight, which might partly explain the lowest prevalence of CKD in this ethnic group.

In addition, our analysis revealed that compared with that of non-diabetic subjects, the odds ratio for the presence of albuminuria and CKD in diabetic American ethnicities was 1.5 times higher than that of Chinese. This possibly partly resulted from the different durations of diabetes (5.8 years for Chinese versus 14.6 years for American). In addition, former studies indicated that the reference value of ACR has racial disparities [36,37]; the second possible explanation could be that the diagnostic criteria of albuminuria originated from the western population, which were applied to the Chinese population, would induce estimation bias of the prevalence of albuminuria in Chinese. However, up to now, there was no study that explored the reference value of ACR for the Chinese population. We also revealed that African Americans are more likely to have CRI than Chinese when exposed to diabetes, which possibly partly resulted from their highest susceptibility to diabetes due to the presence of albuminuria (which is a powerful risk factor for decreasing renal function [38]), and their longest duration of diabetes (18.7 years in African Americans, 14.4 years in whites and 11.0 years in Hispanics).

Former studies revealed that Chinese had a higher body fat proportion compared with whites and African Americans even at the same BMI level [39,40]. Therefore, we performed further analysis after redefining 'overweight' for Chinese (BMI >24) according to Chinese criteria [41], and we found that the overweight prevalence in Chinese increased from 42.32% to 52.84%. However, the difference in the risk of CKD and the susceptibility to CKD risk factors among ethnicities were not significantly changed, e.g. compared to Chinese, when exposed to diabetes, the risk of the presence of albuminuria was changed from 1.550 to 1.553 for whites, from 1.726 to 1.729 for African Americans and from 1.657 to 1.658 for Hispanics.

It is a dilemma to make adjustment for the effect of comorbidities. Controlling for these comorbidities (which is related to both gene background and environment and, therefore, possibly is the causal pathway between ethnicity and CKD) may bias the estimated effect of ethnicity. On the other hand, not controlling these comorbidities may also bias the results, as they are risk factors for CKD regardless of ethnicity. The extent to which these comorbidities are confounders and to which these are intermediates is unknown; however, it is doubtless that the trend of the higher

risk for the presence of CKD in American did not change whether controlling comorbidities or not.

Our study has limitations. Firstly, fluorescent immunoassay in NHANES but immunoturbidimetric assay in Beijing CKD screening was used to detect urine albumin. The difference in the albuminuria method might have caused bias in assessing the ethnic difference of the prevalence of albuminuria. However, Mueller *et al* found that the mean urinary albumin level measured by immunoturbidimetric assay was slightly higher than that measured by fluorescent immunoassay [42]. Therefore, the prevalence of albuminuria among Chinese would become much lower if the urinary albumin level in Chinese were calibrated to the method used in NHANES. Secondly, different levels of active intervention of hypertension and diabetes in different ethnicities could confound our finding. The proportion of patients with hypertension and diabetes who received treatment was significantly lower in Chinese than in Americans (75.6% versus 82.0% for hypertension, 79.1% versus 81.9% for diabetes). Thirdly, GFR was estimated using race-specific regression-based formulas that were developed from two independent studies; therefore, the observed difference in the prevalence of CKD possibly partly resulted from a systematic error caused by the difference in the formula being used. However, when the original abbreviated MDRD equation was applied to Chinese, the calculated prevalence of decreased eGFR was found to be 1.70%, which was still much less than that in the US ethnic groups. Finally, although we did the best we could, the data come from two distinct and differing databases, which in themselves are not completely consistent, such as the difference in the questionnaire requesting information of cardiovascular disease that, therefore, was not included in our analysis.

In summary, Chinese had the lowest prevalence of albuminuria, CRI and CKD compared with US ethnic groups, even after adjusted by metabolic disorders, which were lower in them. Chinese hold the lowest risk of albuminuria when exposed to diabetes. Compared with African Americans but not whites and Hispanics, Chinese were more likely to have CRI when exposed to diabetes or hypertension. A more strictly designed study needs to be conducted to confirm and understand the ethnic disparity.

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Conflict of interest Statement. None declared.

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The clinical features of acute kidney injury in patients with acute paraquat intoxication

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Abstract

Background. Paraquat (PQ) is a non-selective herbicide that generates reactive oxygen species *in vivo*. We hypothesized that acute kidney injury (AKI) in patients with acute PQ poisoning would provide a model for the clinical features of ROS-induced AKI.

Methods. From January 2007 to December 2007, 278 patients with acute PQ intoxication were included in the study. AKI was defined based on the RIFLE classification. The serial changes of creatinine (Cr), the incidence of AKI and the mortality according to the RIFLE classification were analysed.

Results. An initial serum Cr >1.2 mg/dL was a significant predictor of mortality [odds ratio 9.00, 95% C.I. (4.747, 17.061), $P < 0.01$]. The incidence of AKI was 51.4% among the 173 patients who had an initial serum Cr ≤ 1.2 mg/dL. Among them, 34.7% were the failure group and oliguric AKI was observed in 10 patients. The average peak serum Cr level, among the 13 survivors in the failure group, was 4.38 mg/dL at the fifth day, after ingestion, and their Cr level normalized within 3 weeks. None of the 13 survivors had permanent loss of renal function. The estimated amount of PQ ingestion was a predictor of the incidence of AKI. The mortality risk was significantly higher in the failure group than in the group without failure.

Conclusion. The clinical feature was characterized by fully developed AKI at the fifth day after PQ ingestion and normalized within 3 weeks without exception.

Keywords: Acute renal failure; paraquat; reactive oxygen species

Introduction

Acute kidney injury (AKI) is a complex disorder that occurs in a variety of settings with clinical manifestations ranging

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