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The association between socioeconomic status and prevalence of chronic kidney disease

A cross-sectional study among rural residents in eastern China

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Abstract

To investigate the prevalence of chronic kidney disease (CKD) among eastern Chinese rural residents and analyze the relationship between socioeconomic conditions and CKD.

A cross-sectional survey of 1713 adults, enrolled from 4 villages in the north-central part of Zhejiang province in eastern China was conducted by collecting data on socioeconomic status, physical examination, and laboratory investigations. CKD was defined as estimated glomerular filtration rate < 60 mL/min per 1.73 m^2 or urinary albumin/creatinine ratio more than 30 mg/g. The crude and adjusted prevalence of CKD was estimated and the association of socioeconomic status was analyzed by logistic regression.

A total of 1654 adults (96.53%) completed the screening, and 1627 (98.37%) of them had complete questionnaire and test information. The standardized prevalence of CKD adjusted by age and sex was 9.21% (95% confidence interval, 7.8–10.63). People with hypertension, hyperglycemia, hyperuricemia, high fasting blood glucose, and high body mass index had higher risk for CKD. Socioeconomic status was found to be partly related to CKD, especially educational level and occupational nature.

A high prevalence of CKD was observed among rural residents in north-central Zhejiang province in eastern China. Socioeconomic statuses were partly related to the prevalence of CKD.

Abbreviations: ACR = creatinine ratio, BMI = body mass index, CI = confidence intervals, CKD = chronic kidney disease, DBP = diastolic blood pressure, eGFR = estimated glomerular filtration rate, FBG = fasting blood glucose, HDL-C = high-density lipoprotein cholesterol, KDIGO = Kidney Disease: Improving Global Outcomes, LDL-C = low-density lipoprotein cholesterol, OR = odds ratios (OR), SBP = systolic blood pressure, Scr = serum creatinine, SES = socioeconomic status, TC = total cholesterol, TG = triglyceride, UA = uric acid.

Keywords: chronic kidney disease, epidemiology, socioeconomic condition

1. Introduction

Chronic kidney disease (CKD) is a worldwide prevalent disease with the prevalence of CKD stages 1 through 5 being around 10% to 16% in different countries.[1–3] Nowadays, CKD is increasingly common with the development of economy. CKD is defined as urinary albumin to creatinine ratio (ACR) equal or >30 mg/g, or estimated glomerular filtration rate (eGFR) lower than 60 mL/min/1.73 m^2 for 3 months.[4] One potential outcome of CKD is end-stage renal disease (ESRD), which needs expensive renal replacement therapy (RRT) such as dialysis and transplantation. A review published in 2013 indicated that there were 1.9 million patients undergoing RRT worldwide, with an annual initiation rate at 73 per a million population.[5] A cross-sectional study indicated that the prevalence of CKD in China was 10.8%, affecting almost 119.5 million patients.[6] Many factors are associated with the prevalence of CKD including gender, diabetes, hypertension, hyperuricemia, the use of traditional medicines,[7] and socioeconomic status (SES).

SES usually represents a person's position in society, which includes occupation, education, income, residential area level, and so on. It has already been demonstrated that low SES is associated with cardiovascular mortality and morbidity.[8] Several studies have investigated the association between socioeconomic status and the prevalence of CKD,[9–12] while few has been reported about this situation in China. Our research aimed at exploring the influence of socioeconomic status on prevalence of CKD among rural residents in north-central Zhejiang Province in eastern China.

2. Methods

2.1. Study design and subjects

This study randomly selected 4 villages (Lujiayuan, Xuqiao, Yongfu, and Gaoer) in north-central Zhejiang province. Adult

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(aged ≥ 18years) residents living for more than 5 years in the locality were included in the cross-sectional survey. The following formula was used to calculate the size of the required sample: $n=(z)^2p\ (1-p)/d^2$, where n=sample size; z=level of confidence according to the standard normal distribution (level of confidence was chosen at 95%, z=1.96), p=estimated proportion of the population; according to the national survey of China, overall prevalence of adult CKD in Zhejiang province was 9.88%,[13] p was chosen as 10%, d=tolerated margin of error, it was chosen as $d=0.15p$, about 1.5%. The calculated sample size is about 1557 people, and taking into account the proportion of lost to follow up or incomplete data (about 10%), the final sample size was determined to be 1713. Using the probability proportional to size the sampling method, 1,654 adult permanent residents (Lujiayuan 274, Xuqiao 447, Yongfu 591, and Gaoer 342) finally completed the screening with a response rate of 96.56%.

The study protocol was approved by Medical Ethics Committee of Zhejiang Provincial People's Hospital (KY2015062). Written informed consents were obtained from all participants who also received counseling and educational pamphlets. People with abnormal findings were notified and advised to have further follow-up measurements.

2.2. Survey method

The survey was conducted from April 1, 2015 to December 31, 2015 by medical graduate students, nurses, and community health workers as investigators. Prior to the survey, all investigators were trained in a unified manner to standardize the investigation process and to ensure on-site quality control. All the respondents were aware of the content and significance of this study. After signing the informed consent form, the investigators conducted sample collection and site survey using a standardized questionnaire at designated community medical service stations. Research Contents: The questionnaire included demographic data (name, age, gender, ethnicity, matital status, occupation, education level, and family average monthly income), relevant medical history (chronic kidney disease, hypertension, diabetes, dyslipidemia, myocardial infarction, stroke, chronic infection, etc.), special medication (antipyretics and analgesics) and lifestyle behaviors (smoking and drinking) and so on. Physical examination including systolic blood pressure (SBP), diastolic blood pressure (DBP), height and weight, which are measured by standard protocols. Body mass index (BMI) is calculated as body weight (kg) divided by height^2 (m)^2, which was categorized into 2 groups: underweight or normal weight (BMI < 24 kg/m^2), and overweight or obesity (BMI ≥24 kg/m^2). Consistent with the US Joint National Committee and Chinese guidelines,[14,15] hypertension was defined as a SBP more than 140 mm Hg or a DBP more than 90 mm Hg, or self-reported use of antihypertensive medication in the past 2 weeks irrespective of blood pressure.

2.3. Laboratory examination

A fasting morning urine sample was collected from all the respondents; urine albumin and urinary creatinine were measured by rate nephelometry using Beckman Coulter IMMAGE 800 System (Beckman Coulter, Brea, CA) and the urinary albumin to creatinine ratio (ACR) was calculated. A fasting peripheral venous blood sample of 5 ml was collected from the respondents, blood laboratory parameters [serum creatinine (Scr), uric acid (UA), fasting blood glucose (FBG), total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C)] were measured by oxidase-based technique using an Olympus AU5400 Chemistry-Immuno Analyzer (Olympus America, Melville, NY) in the Central Biochemistry Laboratory of Zhejiang Provincial People's Hospital.

2.4. Chronic kidney disease

Chronic kidney disease (CKD) was defined as having an estimated glomerular filtration rate (eGFR) < 60 mL/min/1.73 m^2 or the presence of albuminuria. The eGFR level was calculated by the simplified Modification of Diet in Renal Disease equation.[16] Albuminuria was defined as an ACR value higher than 30 mg/g. CKD was classified based on the levels of eGFR and ACR according to Kidney Disease: Improving Global Outcomes (KDIGO) criteria.[4]

2.5. Socio-demographics

The average monthly income of family was calculated as the ratio of the total family income to the number of family members in the household, and was classified into 4 groups: low income group (≤1000 Yuan/month), middle group (1001–3000 Yuan/month), higher middle group (3001–5000 Yuan/month), and high income group (≥5001 Yuan/month).

We divided occupation into 2 groups: farmer (residents who engage in agricultural activities and they earn 50% of their monthly income from agriculture) and non-farmer (other than farmer).

We divided education into 3 levels: primary school and below (including those who never attended school and those whose highest level of education was primary school), junior high school (including those whose highest level of education was junior high school), and senior high/technical secondary school and above (including those whose highest level of education was high school, technical secondary school, or university degree).

3. Statistical analysis

All statistical analyses were performed using SPSS 19.0 software. Binary logistic regression analyses were used to compare the risk factors of chronic kidney disease between different participants' characteristics (gender, age, BMI, family average monthly income, occupation, and educational level). The continuous variables were reported as mean ± standard deviation (SD) and compared using unpaired t-tests or Mann–Whitney U test appropriately. The morbidity prevalence and standardized morbidity prevalence of CKD were calculated. Then the morbidity of CKD (using ACR and/or eGFR) was compared in different socioeconomic status groups. Logistic regression was performed to determine the relationships between the presence of CKD and the demographic, clinical factors and socioeconomic status. Odds ratios (OR) and 95% confidence intervals (CI) were calculated. A P-value of <.05 was considered statistically significant.

4. Results

In the study, a total of 1654 adult permanent residents were enrolled, of which 1627 could provide complete questionnaire and test result which turns out to be a completion rate of 98.37%. The prevalence was gender- and age-adjusted using data from rural area of Zhejiang province in the 6th China national

Table 1

Participants characteristics, $N=1627$.

Characteristics	Value
Age, years	59.47±11.12
Gender, male/female	602/1025
BMI, kg/m^2	23.73±3.10
Monthly income*, ≤1000/1001–3000/3001–5000/>5001	404/382/363/478
Occupation, farmer/non-farmer	1325/302
Educational level, primary school or below/junior high school/senior high school and above	762/558/307
SBP, mm Hg	137.99±21.13
DBP, mm Hg	81.73±12.02
Scr, μmol/L	68.04±25.72
UA, μmol/L	299.46±82.05
FBG, mmol/L	5.90±1.76
TG, mmol/L	1.66±1.18
TC, mmol/L	4.72±0.91
LDL, mmol/L	2.58±0.77
HDL, mmol/L	1.39±0.37

Data presented as mean ± standard deviation or number of individuals.
BMI=body mass index, DBP=diastolic pressure, FBG=fasting blood glucose, HDL=high density lipoprotein-cholesterol, LDL=low density lipoprotein-cholesterol, SBP=systolic pressure, Scr=serum creatinine, TC=total cholesterol, TG=triglyceride, UA=uric acid.
* Family average monthly income (Yuan/month).

population census in 2010. The adjusted prevalence of albuminuria was 7.88% (95% CI, 6.57–9.20) and that of reduced kidney function was 2.37% (95% CI 1.63–3.11). The overall prevalence of CKD was 9.21% (95% CI, 7.8–10.63). The prevalence of CKD was 7.35% in male (95% CI, 5.27–9.46) while 11.02% (95% CI, 9.10–12.96) in female ($P=.009$).

The demographic characteristics of the cohort and mean values of other clinical parameters are presented in Table 1. More than half (63%) of participants were female. Around 1037 participants (63.7%) were 50 to 69 years old, which was the largest age group. It was also observed that 31.4% of participants were overweight or obese; 29.4% of participants had family average monthly income above 5001 Yuan; 81.4% of participants were farmer; and 53.2% of participants attained a junior high school or higher level of education.

Analysis was done to explore the factors associated with CKD in the participants. Population characteristics according to CKD are shown in Table 2. Univariate analysis revealed that the prevalence of CKD differed significantly by gender, age, educational level and occupation (all $P<.05$), but not by family average monthly income ($P=.054$). Compared with males, females were more likely to have CKD (OR=1.533 [1.110, 2.118]). The prevalence of CKD was higher among participants whose age was more than 70 years old (OR=6.876 [3.711, 12.740]), or 50–69 years old (OR=2.785 [1.547, 5.015]) than those whose age was 18 to 49 years old. Participants with overweight or obesity were associated with a higher prevalence of CKD than participants with underweight or normal weight (OR=1.441 [1.062, 1.955]). Nonfarmer participants were less prone to CKD (OR=0.202 [0.106, 0.387]), compared with participants who were farmers. Participants whose highest level of education was primary school were associated with a higher prevalence of CKD than those whose highest level of education was senior high school/technical secondary school (OR=0.178 [0.209, 0.587]).

Though monthly income is a partial indicator of socioeconomic status, the 4 groups of participants did not show statistical difference between them ($P=.054$) based on their monthly income level for prevalence of CKD (Table 2), while defining CKD based on either ACR or decreased eGFR (Table 3).

To further analyze the risk factors for CKD, anthropometric measurements and biochemical indexes were compared in the

Table 2

Univariate analysis of factors associated with chronic kidney disease (CKD), N=1627.

Characteristics	Non-CKD	CKD	*P*-value	OR	95% CI
Gender			.010		
Male	544 (91.21)	58 (8.79)		1.000	
Female	881 (87.68)	144 (12.32)		1.533	1.110–2.118
Age group, years		<0.001			
18–49	282 (95.78)	13 (4.22)		1.000	
50–69	919 (89.78)	118 (10.22)		2.785	1.547–5.015
≥70	224 (80.60)	71 (19.40)		6.876	3.711–12.740
BMI, kg/m^2			.019		
<24	992 (90.00)	124 (10.00)		1.000	
≥24	433 (86.76)	78 (13.24)		1.441	1.062–1.955
Monthly income*		0.054			
≤1000	340 (84.16)	64 (15.84)		1.000	
1001–3000	338 (88.48)	44 (11.52)		0.692	0.458–1.044
3001–5000	329 (90.63)	34 (9.37)		0.549	0.353–0.855
>5001	418 (88.85)	60 (11.15)		0.76	0.521–1.115
Occupation			<.001		
Farmer	1133 (85.51)	192 (14.49)		1.000	
Nonfarmer	292 (96.69)	10 (3.31)		0.202	0.106–0.387
Educational level		<0.001			
Primary school or below	647 (84.91)	115 (15.09)		1.000	
Junior high school	489 (87.63)	69 (12.37)		0.794	0.576–1.094
Senior high school and above	289 (94.14)	18 (5.86)		0.350	0.209–0.587

Data presented as n (%) of participants.
BMI=body mass index, CI=confidence interval, OR=odds ratio.
Binary logistic regression analyses were used.
* Family average monthly income (Yuan/month).

Table 3

Income level and the prevalence of chronic kidney disease (CKD).

Category	Total	ACR	*P*-value	Decreased eGFR	*P*-value	CKD	*P*-value
Monthly income*		n (%)		n (%)		n (%)	
≤1000	404	51 (12.62)		22 (5.45)		64 (15.84)	
1001–3000	382	40 (10.47)	.24	8 (2.09)	.23	44 (11.52)	.14
3001–5000	363	30 (8.26)		9 (2.48)		34 (9.37)	
>5001	478	50 (10.46)		17 (3.56)		60 (12.55)	
Total	1627	171 (10.51)		56 (3.44)		202 (12.42)	

Data presented as n (%) of participants.
ACR = albumin to creatinine ratio, eGFR = estimated glomerular filtration rate.
Mann–Whitney *U* test were used.
* Family average monthly income (Yuan/month).

participants with and without CKD (Table 4). There were significant differences between the 2 groups for the majority of clinical characteristics. CKD prevalence was significantly associated with higher age, BMI, SBP, DBP, Scr, UA, FBG and TG ($P < .05$ for all comparisons). However, there was no significant difference in the mean TC, LDL and HDL between participants with or without CKD.

5. Discussion

This was the first cross-sectional study aimed at exploring the association between socioeconomic status and CKD among rural residents in Zhejiang province in eastern China. Our investigation showed the prevalence of CKD among rural residents in north-central Zhejiang province to be 9.21%, which is higher than the overall prevalence of CKD in east China which is 8.4%[6] as per the first national survey in China. This difference might be attributed to the high sodium intake in these areas which has been demonstrated to be associated with hypertension and CKD[17] or to unmeasured geographical confounders.[18] The incidence of CKD in older people was more than twice higher when compared with respondents under 70-year-old, intelligibly.[12] In these 4 villages investigated, a majority of subjects (81.9%) were over 50 years old, which might also be one reason for the high prevalence of CKD.

In our research, 62.9% of the respondents were female and the standardized prevalence of CKD was 11.02% in these women, which was higher than that in the males (7.35%). This is consistent with the previous studies.[13,19] To explore the reasons of these observations, we found that women and old people in these rural areas stayed back at home in the village while their sons, husbands and fathers went to big cities to earn the family's bread. This gender difference might have caused the aforesaid statistical difference.

Socioeconomic status (SES) usually represents a person's position in society, which generally includes occupation, education, income, residential area level and other variables. It has already been demonstrated that low SES was associated with cardiovascular mortality and morbidity.[8] Several studies have investigated the association between SES and the prevalence of CKD in other countries[11,12,20,21] but few explored that in China. In our study, we mainly assessed a person's SES using family monthly income, educational level and occupation during the survey. Compared to participants without CKD, those with CKD more frequently were farmers and had lower educational level, which is partly consistent with a previous study in Sweden.[22] In rural areas of Zhejiang province, the resident farmers have less access to healthcare facilities with benefits averaging one basic health examination every 2 years. The participants who were not farmers or had high educational levels usually had better medical

Table 4

Clinical characteristics in participants with and without chronic kidney disease (CKD).

Variable	Total (n = 1627)	CKD (n = 202)	Non-CKD (n = 1425)	*P*-value
Age, years	59.47 ± 11.13	65.16 ± 9.87	58.67 ± 11.06	<.001
Height, cm	158.86 ± 8.14	156.62 ± 7.92	159.18 ± 8.12	<.001
Weight, kg	59.99 ± 9.71	59.99 ± 11.17	59.99 ± 9.49	.995
BMI, kg/m^2	23.73 ± 3.10	24.41 ± 3.56	23.63 ± 3.01	.003
SBP, mm Hg	137.99 ± 21.13	147.46 ± 21.64	136.66 ± 20.72	<.001
DBP, mm Hg	81.73 ± 12.02	84.65 ± 13.43	81.33 ± 11.75	.001
Scr, μmol/L	68.04 ± 25.72	83.75 ± 58.68	65.78 ± 14.91	<.001
UA, μmol/L	299.46 ± 82.05	319.87 ± 88.48	296.52 ± 80.69	<.001
FBG, mmol/L	5.90 ± 1.76	6.65 ± 2.64	5.79 ± 1.57	<.001
TG, mmol/L	1.66 ± 1.18	1.86 ± 1.35	1.64 ± 1.15	.028
TC, mmol/L	4.72 ± 0.91	4.78 ± 1.00	4.71 ± 0.89	.311
LDL, mmol/L	2.58 ± 0.77	2.58 ± 0.87	2.58 ± 0.76	.951
HDL, mmol/L	1.39 ± 0.37	1.38 ± 0.37	1.40 ± 0.37	.475

Data presented as mean ± standard deviation.
BMI = body mass index, DBP = diastolic pressure, FBG = fasting blood glucose, HDL = high density lipoprotein-cholesterol, LDL = low density lipoprotein-cholesterol, SBP = systolic pressure, Scr = serum creatinine, TC = total cholesterol, TG = triglyceride, UA = uric acid.
Unpaired t-tests were used.

insurance and paid more attention to their health, which might partly explain their low morbidity of CKD.

Inconsistent with the hypothesis: there was no significant difference in morbidity between groups divided based on monthly income level. Factors associated with higher income group in terms of social and dietary habits might be responsible for the comparable morbidity with the lower income group who in fact have worse healthcare facilities.

This study has certain limitations. All residents of CKD were based on single measurements for eGFR or albuminuria, which made it impossible to confirm whether the kidney damages were persistent, so it may lead to overestimation of the prevalence of CKD. Our study was cross-sectional in design. The interpretation of causal relationships between risk factors and the kidney damage is limited in such a study, and necessitates longitudinal studies to be conducted.

6. Conclusion

Our results show that chronic kidney disease has become an important public health problem in rural areas of north-central region in Zhejiang province of eastern China. Socioeconomic status was partly related to the prevalence of CKD. Compared with nonfarmer or higher education group, people who were farmer or having educational level of primary school and below had a higher risk of CKD. A better access to healthcare and education in the rural population could potentially reduce the prevalence of CKD in the long run.

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