

# Prevalence and risk factors of chronic kidney disease and diabetic kidney disease in a central Chinese urban population: a cross-sectional survey

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## Research article

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## Abstract

**Background :** This study was conducted to evaluate and update the current prevalence of and risk factors for chronic kidney disease (CKD) and diabetic kidney disease (DKD) in China. **Methods :** From December 2017 to June 2018, a total of 5231 subjects were randomly recruited from 3 communities in 3 districts of Zhengzhou. CKD was defined as estimated glomerular filtration rate (eGFR) < 60 mL/min/1.73m<sup>2</sup> or urinary albumin to creatinine ratio ≥ 30 mg/g (albuminuria). Diabetic subjects with systolic blood pressure > 140 mmHg, albuminuria or an eGFR less than 60 mL/min/1.73 m<sup>2</sup> were classified as having DKD. Participants completed a questionnaire assessing lifestyle and relevant medical history, and blood and urine specimens were taken. Serum creatinine, uric acid, total cholesterol, triglycerides, low-density lipoprotein, high-density lipoprotein and urinary albumin were assessed. The age- and sex-adjusted prevalences of CKD and DKD were calculated, and risk factors associated with the presence of reduced eGFR, albuminuria, DKD, severity of albuminuria and progression of reduced renal function were analyzed by binary and ordinal logistic regression. **Results :** The overall adjusted prevalence of CKD was 16.8% (15.8 – 17.8%) and that of DKD was 3.5% (3.0 – 4.0%). Decreased renal function was detected in 132 participants (2.9%, 95% confidence interval [CI]: 2.5 – 3.2%), whereas albuminuria was found in 858 participants (14.9%, 95% CI: 13.9 – 15.9%). In all participants with diabetes, the prevalence of reduced eGFR was 6.3% (95% CI = 3.9 – 8.6%) and that of albuminuria was 45.3% (95% CI = 40.4 – 50.1%). The overall prevalence of CKD in participants with diabetes was 48.0% (95% CI = 43.1 – 52.9%). The results of the binary and ordinal logistic regression indicated that the factors independently associated with a higher risk of reduced eGFR and albuminuria were older age, sex, smoking, alcohol consumption, overweight, obesity, diabetes, hypertension, dyslipidemia and hyperuricemia. **Conclusions :** Our study shows the current prevalence of CKD and DKD in residents of Central China. The high prevalence suggests an urgent need to implement interventions to relieve the high burden of CKD and DKD in China.

## Background

Chronic kidney disease (CKD) is a common public health issue with an increasing incidence and prevalence in developing countries, such as China. The burden of CKD is not only restricted to the requirement for renal replacement therapy in end-stage renal disease (ESRD) but is associated with other serious complications, such as cardiovascular events and mortality, that are also substantially influenced by kidney involvement [1, 2].

In the past decade, CKD has been highly prevalent in China. The rapidly increasing prevalence of relevant risk factors, such as diabetes and hypertension, plays an important role [3-6]. In 2010, Yang et al. reported that the prevalences of diabetes and prediabetes were 9.7% and 15.5%, respectively, in China [7]. In the same year, Ho and Hwang et al. demonstrated that diabetic kidney disease (DKD) was responsible for 46.2% and 43.2% of ESRD cases in Hong Kong and Taiwan, respectively [8, 9]. The inadequate awareness and control of diabetes and hypertension has aggravated the health and socioeconomic burden of CKD and DKD in the Chinese population in several aspects, such as lower life expectancy, poor quality of daily life and the high cost of medical care [10-13]. Insufficient contracts with health services, delayed health-seeking behavior and frequent use of Chinese herbal medicines have also contributed to the high incidence and progression of CKD [14, 15].

Previous studies have indicated that over 60% of CKD cases could be detected early by general screening [16-18]. Timely medical care is beneficial for improving the quality of life of CKD patients and reducing the morbidity and mortality caused by ESRD [18]. Nevertheless, studies reporting epidemiological features of CKD and DKD in the Chinese population are still insufficient. Efforts to update the epidemiological data and identify the early risk factors are urgently needed and will be beneficial for developing effective strategies for the prevention of CKD, DKD and ESRD. Therefore, we conducted a cross-sectional study to provide current epidemiological data on CKD and DKD and to identify their risk factors in Central China.

## Methods

### Study subjects

From December 2017 to June 2018, the subjects were recruited from 3 communities in 3 districts of Zhengzhou: the Erqi, Zhongyuan and Jinshui districts. There are 12 administrative districts with a total population of approximately 10 million in Zhengzhou (data available on <http://tjj.zhengzhou.gov.cn/>). A multistage, stratified cluster sampling method was employed to

select participants over 18 years old from the general population. In the first stage, 3 districts were randomly selected from 6 urban districts. In the second stage, one representative community in each district was selected according to the proportion of permanent residents. In the final stage, all permanent residents who satisfied the inclusion criteria and agreed to sign the informed consent were recruited in this study. Altogether, a total of 6000 subjects aged 18 years or older were selected from 3 communities, and 5231 subjects completed the survey and examination, corresponding to a response rate of 87.2%. Two hundred and thirty three subjects were dropped because they didn't respond and 536 subjects were dropped because they didn't complete the questionnaire.

## Measurements and definitions

Data were collected by face-to-face interviews in examination centers at community health stations. All subjects completed a questionnaire that collected information about their sociodemographic status (e.g., age, gender, ethnicity, education, etc.), personal and family health history (e.g., diabetes, hypertension, hepatitis, etc.), lifestyle behaviors (e.g., smoking, alcohol consumption, physical activity, etc.) and awareness and control of chronic noncommunicable disease (e.g., diabetes, hypertension, dyslipidemia, etc.) with assistance of trained practitioners, doctors and nurses. Anthropometric measurements, such as height, weight and blood pressure (BP), were obtained. Height and weight were measured while the participants were in light clothing without shoes, and body mass index (BMI, kg/m<sup>2</sup>) was subsequently calculated. According to the Chinese "Criteria of weight for adults (No. WS/T 428-2013)" (available on <http://www.nhfpc.gov.cn>), BMI was divided into four levels: underweight (< 18.5), healthy weight (18.5 – 23.9), overweight (24 – 27.9) and obesity ( $\geq$  28). BP was measured using an electronic sphygmomanometer (Omron HEM-7071A, Japan) three times in one-minute intervals. The mean value of the three BP readings was used for statistical analysis unless the difference between the readings was higher than 10 mm Hg, in which case the mean value of the other two closest results was calculated. In addition to participants' self-reported use of antihypertension medications in the past 2 weeks, hypertension was defined as participants with an average systolic BP (SBP)  $\geq$  140 mm Hg and/or an average diastolic BP (DBP)  $\geq$  90 mm Hg [19]. Subjects with hypertension were considered to have controlled BP if SBP < 140 mm Hg and DBP < 90 mm Hg.

After at least 8 hours of overnight fasting, venous blood specimens were collected in vacuum tubes without an anticoagulant. Serum concentrations of creatinine, uric acid, total cholesterol, triglycerides, high-density lipoprotein and low-density lipoprotein were measured using enzymatic colorimetry on a Cobas C 701 (Roche). The fasting plasma glucose (FPG) level was estimated by the glucose oxidative method (GOD-PAP). Urinary albumin and creatinine were measured from a fresh morning spot urine sample. Albuminuria was measured with an immune-turbidimetric test. Urinary creatinine was evaluated by Jaffe's kinetic method. The urinary albumin to creatinine ratio (ACR, mg/g) was calculated automatically.

The estimated glomerular filtration rate (eGFR) was calculated by serum creatinine using the 2009 CKD-EPI creatinine equation [20]. According to the 2012 KDIGO classification, eGFR was classified into 5 stages, in which stage 3 was further divided into stages 3a and 3b with an eGFR of 45 mL/min/1.73 m<sup>2</sup> as the cut-off value. ACR was classified as follows: A1, < 30 mg/g; A2, 30 – 300 mg/g; and A3, > 300 mg/g [21]. Albuminuria was defined as an ACR  $\geq$  30 mg/g. Indicators of renal damage were the presence of an eGFR less than 60 mL/min/1.73 m<sup>2</sup> or albuminuria. CKD was defined as the presence of one or two indicators of renal damage.

Diabetes was defined according to the 2009 American Diabetes Association (ADA) guidelines: 1. FPG  $\geq$  7.0 mmol/L; 2. self-reported use of insulin or antidiabetic medications in the past 2 weeks; and 3. self-reported previous diagnosis of diabetes by a physician. Diabetic subjects with systolic blood pressure >140 mmHg, albuminuria or an eGFR less than 60 mL/min/1.73 m<sup>2</sup> were classified as having DKD. Control of diabetes was defined as FPG maintained at less than 7.0 mmol/L for the past 7 days. Dyslipidemia was considered the use of antidyslipidemia medications during the last 2 weeks or the presence of one or more abnormal serum lipid concentrations according to the Chinese guidelines for the prevention and treatment of dyslipidemia in adults: 1. Total cholesterol > 6.22 mmol/L; 2. Triglycerides > 2.26 mmol/L; 3. High-density lipoprotein cholesterol < 1.04 mmol/L; 4. Low-density lipoprotein cholesterol > 4.14 mmol/L [22]. Hyperuricemia was defined as a plasma uric acid concentration > 422  $\mu$ mol/L for men and > 363  $\mu$ mol/L for women.

Education was divided into 3 levels: 1. Primary school or lower; 2. junior middle school; and 3. senior high school or above. Diets rich in fruits and vegetables were considered diets with a daily average consumption of more than 500 g of fruits and vegetables.

A high-fat diet was defined as a diet with a daily average consumption of livestock and poultry of more than 75 g [23]. Physical activity was classified as low, moderate or high according to the international physical activity questionnaire (IPAQ 2001) [24].

## Statistical analysis

Epidata software (version 3.1) was used for data entry and management. All statistical analyses were performed with SAS 9.1 (SAS Institute, Cary, NC, USA) and GraphPad Prism 6 (GraphPad Software, Inc., La Jolla, CA, USA) for Windows. A p-value < 0.05 was considered statistically significant. Data are expressed as the mean  $\pm$  SD, median with range or frequency with percentage, as appropriate. Intergroup comparisons were performed using the Pearson *chi-square* test for categorical variables and Student's t-test, the Mann-Whitney U-test or the Wilcoxon test for continuous variables, as appropriate. The standard population of this study was based on data from the China Population Sampling Census in 2009 (data available on <http://www.stats.gov.cn/>).

The crude and adjusted prevalences of reduced eGFR (eGFR < 60 mL/min/1.73 m<sup>2</sup>), albuminuria, DKD and CKD were reported. Both binary and ordinal logistic regressions were employed to explore the associations between indicators of renal damage and the relevant covariates. In binary logistic regression, crude and multivariable adjusted odds ratios (ORs) with 95% confidential intervals (CIs) were calculated. The covariates involved in our multivariable logistic regression model were age (in 10-year intervals), gender (men versus women), education [ $\leq$  primary school (reference) versus junior high school versus  $\geq$  senior high school], current smoker (yes versus no), alcohol consumption (yes versus no), BMI [healthy weight (reference) versus underweight versus overweight versus obesity], diabetes (yes versus no), hypertension (yes versus no), dyslipidemia (yes versus no), and hyperuricemia (yes versus no). According to the prognosis of CKD by GFR and albuminuria category from the 2012 Kidney Disease: Improving Global Outcomes (KDIGO) guidelines, two models were used to calculate the data in the ordinal logistic regression. In model 1, we analyzed data from subjects with an eGFR > 60 mL/min/1.73 m<sup>2</sup> and different levels of ACR (A1 – A3, n=5099) [21]. In model 2, data from all participants were divided into 4 groups as follows: low risk (no CKD); moderately increased risk; high risk; and very high risk [21]. The results of tests of parallel lines indicated that the two models were statistically executable (both *P* values > 0.05).

## Results

Of the 6000 participants involved in this study, 5231 had a complete data set and were entered into our statistical analysis. Their demographic and clinical characteristics are shown in Table 1. The prevalences of hypertension, dyslipidemia, hyperuricemia and diabetes were 34.6%, 14.6%, 11.5% and 7.6%, respectively. A total of 80.3% of the participants attended senior high school. The prevalences of current smokers and habitual drinkers were similar. The mean eGFR was  $92.6 \pm 21.5$  mL/min/1.73 m<sup>2</sup>, and the median ACR was 14.1, with an interquartile range of 8.8 to 23 mg/g. Generally, participants with reduced eGFR or albuminuria were older, less educated, and had heavy physical activity. They had a lower proportion of high fat diet and higher prevalences of cardiovascular disease, hypertension, dyslipidemia, hyperuricemia and diabetes than did those without indicators of renal damage.

According to the stratification of renal indicators, 132 subjects exhibited an eGFR less than 60 mL/min/1.73 m<sup>2</sup> and 858 individuals exhibited albuminuria (Table 2). In total, 945 participants had CKD, of whom 92 subjects were DKD patients. The adjusted prevalence of an eGFR less than 60 mL/min/1.73 m<sup>2</sup> was 2.8% (95% CI = 2.4 – 3.3%) and that of albuminuria was 14.9% (95% CI = 13.9 – 15.9%). The overall prevalence of CKD and DKD was 16.8% (95% CI = 15.8 – 17.8%) and 1.8% (95% CI = 1.4 – 2.1%), respectively. By disease stage, the prevalence was as follows: stage 1, 6.0%; stage 2, 7.8%; stage 3a, 2.4%; stage 3b, 0.2%; stage 4, 0.3% and stage 5, 0.1%. In subjects with normal eGFR, the numbers with stages A1 – A3 were 4286, 743 and 70, respectively. As shown in figure 1, the prevalence of reduced eGFR was much higher in women over 40 years old than in their male counterparts, and the overall prevalence was higher with older age in both men and women. The prevalence of albuminuria was higher in older participants and in women than men in all age groups except for subjects aged 60 – 69 years old (24.7 versus 26.3%). Overall, the prevalences of CKD and DKD increased with age in both men and women. In addition, subjects with both hypertension and diabetes shows the highest prevalences of reduced eGFR (7.3% 95% CI = 4.0 – 10.5%) and albuminuria (54.8% 95% CI = 48.6 – 61.1%) than whom with either hypertension or diabetes (Figure 2).

In all participants with diabetes (N = 400), compared with those without renal damage, subjects with reduced eGFR tended to be older and were more likely to be women and to have hypertension, dyslipidemia, an insufficient consumption of meat, a lack of

physical activity and poor control of diabetes, while those with albuminuria tended to exhibit poor control of diabetes and were more likely to have dyslipidemia (Table 3). Twenty-five subjects were classified as stage 3 – 5 CKD, and 181 subjects had albuminuria (Table 4). The prevalence of reduced eGFR was 6.3% (95% CI = 3.9 – 8.6%), and that of albuminuria was 45.3% (95% CI = 40.4 – 50.1%). The overall prevalence of CKD in participants with diabetes was 48.0% (95% CI = 43.1 – 52.9%). By disease stage, the prevalence was as follows: stage 1, 15.8%; stage 2, 26.0%; stage 3a, 2.0%; stage 3b, 0.8%; stage 4, 0.5% and stage 5, 0.3%. In subjects with normal eGFR, the numbers with stages A1 – A3 were 209, 139 and 28, respectively.

The prevalence of reduced eGFR was not significantly different among the three tertiles of education and family income, while that of albuminuria was highest in subjects in the lower tertile of education and upper tertile of family income (Table 5). The overall adjusted prevalences of CKD were 33.5% (95% CI = 27.7 – 39.3%) and 26.5% (95% CI = 22.4 – 30.6%), respectively. The prevalences of hypertension and diabetes were lower in subjects with higher education conditions, while they were lowest in subjects in the middle tertile of family income. Poor control of hypertension and diabetes was most prevalent in subjects in the upper tertile of education (6.9% and 29.9%, respectively) and middle tertile of family income (9.3% and 27.4%, respectively).

The results of the binary logistic regression are shown in Table 6. Older age, higher education, and hypertension were all independently associated with a higher risk of reduced eGFR, while male gender showed the opposite association. Factors independently associated with a higher risk of albuminuria were older age, being a current smoker, a diet rich in fruits and vegetables, overweight, obesity, diabetes, hypertension and dyslipidemia. Higher education level and more consumption of meat were associated with lower ORs of developing albuminuria than the other factors. In addition, being male and over 40 years of age, high level physical activity, obesity, dyslipidemia and hyperuricemia were significantly associated with an increased risk of DKD.

In the ordinal logistic regression, the data were analyzed in two models (Table 7). In model one, age, smoking, a diet rich in fruits and vegetables, heavy physical activity, high BMI, diabetes, hypertension, and dyslipidemia were positively associated with increased severities of albuminuria in subjects with normal eGFR values, while a higher education level and a diet rich in meat were associated with reduced severities. Similarly, in model two, a higher education level and a high-fat diet were also negatively correlated with an elevated risk of renal damage, while older age, being a current smoker, a diet rich in fruits and vegetables, obesity, diabetes, hypertension and dyslipidemia showed a positive association.

## Discussion

Henan Province is one of the largest provinces in China, and its population accounts for an estimated 8% of the entire country according to the China Population Census in 2009. The city of Zhengzhou has a population of nearly 10 million people and is one of the representative urban centers in Central China. To the best of our knowledge, the present study was the first study performed with a large representative sample of an urban population in Central China to evaluate the current epidemiological features of both vital indicators of renal damage, eGFR and albuminuria, and DKD. In this study, the prevalence of CKD was 16.8%, and that of DKD was 3.5%, corresponding to over 3 million adults in Henan Province. Generally, older age, sex, education, smoking, unhealthy BMI, diabetes, hypertension, dyslipidemia and hyperuricemia were significantly associated with a higher risk for and elevated severities of reduced renal function. Compared with previous studies, these findings indicated that the prevalence of CKD was higher in the urban population in Central China than in the urban populations in South China (12.1%) and North China (13.0%) and that the prevalence of CKD had increased by 6% since 2009 (10.5%) [11, 25, 26].

In 2012, Zhang et al. conducted a national survey using a multistage stratified sampling method and reported that the prevalence of CKD in Chinese urban residents was 8.9%, with 2.3% of subjects exhibiting a reduced eGFR and 7.0% of subjects exhibiting albuminuria [27]. Our current study indicates that the number of people with CKD has increased in the past six years. Older age was previously shown to be independently associated with a higher risk of reduced renal function, which was further supported by our present study [11, 28-32]. Aging has become a highlighted social problem in China. According to data from the China Population Census in 2009, the proportions of residents aged over 50 and 60 years were 24.0% and 12.7%, respectively, in Henan Province. In this study, the mean age of the subjects without renal damage was 40.3 years, while the mean ages of those with reduced eGFR, albuminuria and DKD were 63.0, 51.5 and 57.9 years, respectively. The age distribution partly contributed to the higher prevalence of CKD in this study population.

Diabetes and hypertension are reported to be significantly related to the high prevalence and incidence of CKD [3, 33-35]. In the past twenty years, a noteworthy increase in the prevalence of diabetes and hypertension in the Chinese population occurred. Xiang et al. conducted a national survey in China and demonstrated that the prevalence of impaired glucose tolerance and diabetes mellitus was 3.2% and 4.8%, respectively [36]. In 2004, the Fourth National Health and Nutrition Examination Survey of China (NHANES) reported that the prevalence of diabetes had increased to 6.4% [37]. Although the growth rate decelerated in the past 10 years, the results from the 2016 Global Burden of Disease study suggested that 6.6% of all-age Chinese individuals had diabetes [5]. In 2002, a national survey by Gu et al. suggested that the overall prevalence of hypertension was 13.6% in residents aged over 15 years [38]. Ten years later, the results of the International Collaborative Study of Cardiovascular Disease in Asia indicated that 27.2% of middle-aged Chinese adults had hypertension [39]. Subsequently, a national hypertension survey conducted from 2012 to 2015 reported that 23.2% of Chinese adults had hypertension [40]. The changing trajectories of the prevalence of diabetes and hypertension were associated with CKD. In our study, we found that the majority of subjects with both hypertension and diabetes had reduced eGFR and albuminuria. The results of the logistic regression also showed that hypertension was independently associated with a higher risk of reduced eGFR, with an OR of 1.81, and both diabetes and hypertension were associated with a higher risk of albuminuria, with ORs of 2.71 and 2.79, respectively. Therefore, the higher prevalence of CKD in our study population could be caused by the high proportions of subjects with diabetes (7.6%) and hypertension (34.6%).

Dyslipidemia tends to develop along with kidney function decline in patients with CKD, even in the early stages. Dyslipidemia is also associated with a higher risk of cardiovascular disease, which is the main cause of death in patients with CKD and ESRD [41]. Ji et al. found that increased serum concentrations of total cholesterol and triglycerides were significantly associated with mildly reduced eGFR [42]. Thompson et al. also indicated that decreased eGFR was independently associated with lower concentrations of high-density lipoprotein and higher concentrations of triglycerides in an Australian population [43]. In a longitudinal study, Tsai et al. found that the level of total cholesterol, both at baseline and over the longitudinal course, was significantly associated with a higher risk of incident ESRD [44]. Similarly, in our current study, the serum concentration of total cholesterol was much higher in subjects with reduced eGFR than in subjects without reduced eGFR, and subjects with DKD had the highest serum concentration of triglycerides. The results of both the binary and ordinal logistic regressions also indicated that dyslipidemia was significantly associated with albuminuria, DKD and severe renal damage.

Hyperuricemia generates renal injury via its crystal-independent mechanisms, such as activating the renin-angiotensin system, thereby inducing endothelial dysfunction and oxidative stress [45]. Previously, Weiner et al. observed that every 1 mg/dL increase in serum uric acid from the baseline level was associated with a 7% higher risk of reduced eGFR in the Atherosclerosis Risks in Communities and the Cardiovascular Health Study [46]. In another prospective cohort study, Zhang et al. demonstrated that the increased level of serum uric acid was associated with both new-onset albuminuria and a decline in the eGFR, defined as a decrease  $\geq 20\%$  [47]. A meta-analysis integrating 13 studies with more than 190 thousand subjects with normal baseline renal function suggested that an elevated serum concentration indicating hyperuricemia was independently associated with a twofold increased risk of new-onset CKD [48]. According to the results of the present study, the prevalence of hyperuricemia was much higher in subjects with reduced eGFR and albuminuria than in subjects without renal damage (16.5% and 15.2%, respectively, versus 10.4%). The results of the logistic regression further supported the idea that hyperuricemia was robustly correlated with a higher risk of albuminuria and DKD, with ORs of 1.70 and 2.15, respectively.

Our present study reports the epidemiologic characteristics and influencing factors of CKD and DKD based on a representative urban population in Central China. Standardized survey tools, training programs and quality-control procedures ensured the reliability of the results. However, several limitations should be addressed. First, the renal indicators were acquired from single measurements, which might partly overestimate the prevalences of CKD and DKD. Second, a cross-sectional study is incapable of demonstrating causal relationships between indicators of renal damage and the relevant influencing factors. Third, for subjects who were taking anti-hypertensive drugs, we did not specifically analyze the association between RAS blockers and DKD.

## Conclusion

The results of the present study demonstrate that the high prevalences of CKD and DKD have become a major public health burden in the Chinese urban population. The rapid increase in the prevalences of hypertension and diabetes will persistently affect the overall prevalence of CKD in the future. Specific strategies aimed at reducing the burden of CKD are urgently needed.

## List Of Abbreviations

CKD: Chronic kidney disease; ESRD: End-stage renal disease; DKD: Diabetic kidney disease; BP: Blood pressure; BMI: Body mass index; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; FPG: Fasting plasma glucose; ACR: Albumin to creatinine ratio; eGFR: estimated glomerular filtration rate; KDIGO: Kidney Disease: Improving Global Outcomes; ADA: American Diabetes Association; IPAQ: International Physical Activity Questionnaire; SD: Standard deviation; OR: Odds ratio; CI: Confidence interval; NHANES: National Health and Nutrition Examination Survey; DM: Diabetes mellitus; HTN: Hypertension.

## Declarations

### Ethics approval and consent to participate

This study was approved by the Ethics Committee of the First Affiliated Hospital of Zhengzhou University (No. KY-2018-LW-66). All participants provided written informed consent before data collection. The present study was performed in accordance with the Declaration of Helsinki.

### Consent for publication

Not applicable.

### Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Competing interests

The authors declare that they have no competing interests.

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### Authors' Contributions

Study design: ZSL, GCD, JYD; data acquisition: SKP, DKJ, ZHZ, LLL, FT; data analysis: YJQ, JYD; statistical analysis: JYD; supervision: CJW, GCD, ZSL; manuscript revision: JYD, YL. Each author contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved. All authors have read and approved the final manuscript.

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## Reference

1. Bello AK, Nwankwo E, El Nahas AM. Prevention of chronic kidney disease: a global challenge. *Kidney Int Suppl.* 2005(98):S11-7.
2. Nugent RA, Fathima SF, Feigl AB, Chyung D. The burden of chronic kidney disease on developing nations: a 21st century challenge in global health. *Nephron Clin Pract.* 2011;118(3):c269-77.
3. Chen J. Epidemiology of hypertension and chronic kidney disease in China. *Curr Opin Nephrol Hypertens.* 2010;19(3):278-82.

4. Chung H-F, Al Mamun A, Huang M-C, Long KZ, Huang Y-F, Shin S-J, et al. Obesity, weight change, and chronic kidney disease in patients with type 2 diabetes mellitus: A longitudinal study in Taiwan. *J Diabetes*. 2017;9(11):983-93.
5. Liu M, Liu SW, Wang LJ, Bai YM, Zeng XY, Guo HB, et al. Burden of diabetes, hyperglycaemia in China from to 2016: Findings from the 1990 to 2016, global burden of disease study. *Diabetes Metab*. 2019 Jun;45(3):286-293..
6. Zhang L, Zuo L, Wang F, Wang M, Wang S, Liu L, et al. Metabolic syndrome and chronic kidney disease in a Chinese population aged 40 years and older. *Mayo Clin Proc*. 2007;82(7):822-7.
7. Yang W, Lu J, Weng J, Jia W, Ji L, Xiao J, et al. Prevalence of diabetes among men and women in China. *N Engl J Med*. 2010;362(12):1090-101.
8. Ho Y-W, Chau K-F, Choy B-Y, Fung K-S, Cheng Y-L, Kwan T-H, et al. Hong Kong Renal Registry Report 2010. *Hong Kong Journal of Nephrology*. 2010;12(2):81-98.
9. Hwang SJ, Tsai JC, Chen HC. Epidemiology, impact and preventive care of chronic kidney disease in Taiwan. *Nephrology (Carlton)*. 2010;15 Suppl 2:3-9.
10. Wang J, Zhang L, Wang F, Liu L, Wang H. Prevalence, awareness, treatment, and control of hypertension in China: results from a national survey. *Am J Hypertens*. 2014;27(11):1355-61.
11. Shan Y, Zhang Q, Liu Z, Hu X, Liu D. Prevalence and risk factors associated with chronic kidney disease in adults over 40 years: a population study from Central China. *Nephrology (Carlton)*. 2010;15(3):354-61.
12. Liu X, Li Y, Guo Y, Li L, Yang K, Liu R, et al. The burden, management rates and influencing factors of high blood pressure in a Chinese rural population: the Rural Diabetes, Obesity and Lifestyle (RuralDiab) study. *J Hum Hypertens*. 2018;32(3):236-46.
13. Liu X, Li Y, Li L, Zhang L, Ren Y, Zhou H, et al. Prevalence, awareness, treatment, control of type 2 diabetes mellitus and risk factors in Chinese rural population: the RuralDiab study. *Sci Rep*. 2016;6:31426.
14. Jha V. Herbal medicines and chronic kidney disease. *Nephrology (Carlton)*. 2010;15 Suppl 2:10-7.
15. Yang B, Xie Y, Guo M, Rosner MH, Yang H, Ronco C. Nephrotoxicity and Chinese Herbal Medicine. *Clin J Am Soc Nephrol*. 2018 Oct 8;13(10):1605-1611..
16. Garg AX, Kiberd BA, Clark WF, Haynes RB, Clase CM. Albuminuria and renal insufficiency prevalence guides population screening: Results from the NHANES III. *Kidney Int*. 2002;61(6):2165-75.
17. Ramirez SP, McClellan W, Port FK, Hsu SI. Risk factors for proteinuria in a large, multiracial, southeast Asian population. *J Am Soc Nephrol*. 2002;13(7):1907-17.
18. Chen N, Wang W, Huang Y, Shen P, Pei D, Yu H, et al. Community-based study on CKD subjects and the associated risk factors. *Nephrol Dial Transplant*. 2009;24(7):2117-23.
19. Liu LS. [2010 Chinese guidelines for the management of hypertension]. *Zhonghua Xin Xue Guan Bing Za Zhi*. 2011 Jul;39(7):579-615.
20. Levey AS, Stevens LA, Schmid CH, Zhang YL, Castro AF, 3rd, Feldman HI, et al. A new equation to estimate glomerular filtration rate. *Ann Intern Med*. 2009;150(9):604-12.
21. Chapter 1: Definition and classification of CKD. *Kidney Int Suppl*. 2013;3(1):19-62.
22. [Chinese guidelines on prevention and treatment of dyslipidemia in adults]. *Zhonghua Xin Xue Guan Bing Za Zhi*. 2007 May;35(5):390-419
23. Wang S-S, Lay S, Yu H-N, Shen S-R. Dietary Guidelines for Chinese Residents (2016): comments and comparisons. *J Zhejiang Univ Sci B*. 2016;17(9):649-56.
24. Craig CL, Marshall AL, Sjostrom M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc*. 2003;35(8):1381-95.
25. Zhang L, Zhang P, Wang F, Zuo L, Zhou Y, Shi Y, et al. Prevalence and factors associated with CKD: a population study from Beijing. *Am J Kidney Dis*. 2008;51(3):373-84.
26. Chen W, Chen W, Wang H, Dong X, Liu Q, Mao H, et al. Prevalence and risk factors associated with chronic kidney disease in an adult population from southern China. *Nephrol Dial Transplant*. 2009;24(4):1205-12.
27. Zhang L, Wang F, Wang L, Wang W, Liu B, Liu J, et al. Prevalence of chronic kidney disease in China: a cross-sectional survey. *Lancet*. 2012;379(9818):815-22.

28. Liu ZH. Nephrology in china. *Nat Rev Nephrol.* 2013;9(9):523-8.
29. Chen J, Wildman RP, Gu D, Kusek JW, Spruill M, Reynolds K, et al. Prevalence of decreased kidney function in Chinese adults aged 35 to 74 years. *Kidney Int.* 2005;68(6):2837-45.
30. Zhang L, Zuo L, Xu G, Wang F, Wang M, Wang S, et al. Community-based screening for chronic kidney disease among populations older than 40 years in Beijing. *Nephrol Dial Transplant.* 2007;22(4):1093-9.
31. Xie Y, Chen X. Epidemiology, major outcomes, risk factors, prevention and management of chronic kidney disease in China. *Am J Nephrol.* 2008;28(1):1-7.
32. Chen W, Liu Q, Wang H, Chen W, Johnson RJ, Dong X, et al. Prevalence and risk factors of chronic kidney disease: a population study in the Tibetan population. *Nephrol Dial Transplant.* 2011;26(5):1592-9.
33. Cao Y, Li W, Yang G, Liu Y, Li X. Diabetes and hypertension have become leading causes of CKD in Chinese elderly patients: a comparison between 1990-1991 and 2009-2010. *Int Urol Nephrol.* 2012;44(4):1269-76.
34. Qin X, Wang Y, Li Y, Xie D, Tang G, Wang B, et al. Risk factors for renal function decline in adults with normal kidney function: a 7-year cohort study. *J Epidemiol Community Health.* 2015;69(8):782-8.
35. Levey AS, Bilous R, Shlipak MG. CKD and Diabetes: What Can We Learn From Their Similarities and Differences? *Am J Kidney Dis.* 2016;67(3):360-3.
36. Hongding X, Wei W, Canqun L. A epidemiological study on DM 1995-1996 in China. *Chin J Diab.* 1998;6:131-3.
37. Danaei G, Finucane MM, Lu Y, Singh GM, Cowan MJ, Paciorek CJ, et al. National, regional, and global trends in fasting plasma glucose and diabetes prevalence since 1980: systematic analysis of health examination surveys and epidemiological studies with 370 country-years and 2·7 million participants. *Lancet.* 2011;378(9785):31-40.
38. Tao S, Wu X, Duan X, Fang W, Hao J, Fan D, et al. Hypertension prevalence and status of awareness, treatment and control in China. *Chin Med J (Engl).* 1995;108(7):483-9.
39. Gu D, Reynolds K, Wu X, Chen J, Duan X, Muntner P, et al. Prevalence, awareness, treatment, and control of hypertension in china. *Hypertension.* 2002;40(6):920-7.
40. Wang Z, Chen Z, Zhang L, Wang X, Hao G, Zhang Z, et al. Status of Hypertension in China: Results From the China Hypertension Survey, 2012-2015. *Circulation.* 2018;137(22):2344-56.
41. Hager MR, Narla AD, Tannock LR. Dyslipidemia in patients with chronic kidney disease. *Rev Endocr Metab Disord.* 2017;18(1):29-40.
42. Ji B, Zhang S, Gong L, Wang Z, Ren W, Li Q, et al. The risk factors of mild decline in estimated glomerular filtration rate in a community-based population. *Clin Biochem.* 2013;46(9):750-4.43. Michael Thompson, Udayan Ray, Richard Yu, Andrew Hudspeth, Michael Smillie, Neville Jordan, et al. Kidney function as a determinant of HDL and triglyceride concentrations in the Australian population. *J Clin Med.* 2016;5(3):35
43. Tsai CW, Huang HC, Chiang HY, Chung CW, Chang SN, Chu PL, et al. Longitudinal lipid trends and adverse outcomes in patients with CKD: a 13-year observational cohort study. *J Lipid Res.* 2019;60(3):648-60.
44. Isaka Y, Takabatake Y, Takahashi A, Saitoh T, Yoshimori T. Hyperuricemia-induced inflammasome and kidney diseases. *Nephrol Dial Transplant.* 2016;31(6):890-6.
45. Weiner DE, Tighiouart H, Elsayed EF, Griffith JL, Salem DN, Levey AS. Uric acid and incident kidney disease in the community. *J Am Soc Nephrol.* 2008;19(6):1204-11.
46. Zhang L, Wang F, Wang X, Liu L, Wang H. The association between plasma uric acid and renal function decline in a Chinese population-based cohort. *Nephrol Dial Transplant.* 2012;27(5):1836-9.
47. Li L, Yang C, Zhao Y, Zeng X, Liu F, Fu P. Is hyperuricemia an independent risk factor for new-onset chronic kidney disease?: A systematic review and meta-analysis based on observational cohort studies. *BMC nephrology.* 2014;15:122.

## Tables

**Table 1 General characteristics of participants according to indicators of renal damage**

	Participants with eGFR < 60 mL/min/1.73 m <sup>2</sup> (N=132)	Participants with albuminuria (N=859)	Participants with DKD (N=92)	Participants without renal damage (N=4286)	Total (N=5231)
Age	63.0 (13.8)	51.5 (14.0)	60.8 (11.8)	40.3 (16.2)	42.5 (16.5)
Men	24 (18.2%)	574 (66.8%)	62 (67.4%)	2362 (55.1%)	2945 (56.3%)
Education ≤ Primary school	20 (15.2%)	90 (10.5%)	15 (16.3%)	156 (3.6%)	257 (4.9%)
Junior high school	32 (24.2%)	192 (22.4%)	26 (28.3%)	564 (13.2%)	774 (14.8%)
≥ Senior high school	80 (60.6%)	577 (67.2%)	51 (55.4%)	3566 (83.2%)	4200 (80.3%)
Current smoker	9 (6.8%)	295 (34.3%)	29 (31.5%)	825 (19.2%)	1125 (21.6%)
Habitual drinker	7 (5.3%)	282 (32.8%)	32 (34.8%)	817 (19.1%)	1104 (21.1%)
Dietary pattern Diet rich in fruits and vegetables	78 (59.1%)	419 (48.8%)	38 (41.3%)	1746 (40.7%)	2222 (42.5%)
High fat diet	11 (8.3%)	92 (10.7%)	9 (9.8%)	680 (15.9%)	779 (14.9%)
Physical activity Low	99 (75%)	494 (57.5%)	55 (59.8%)	2911 (67.9%)	3469 (66.3%)
Moderate	33 (25%)	330 (38.4%)	31 (33.7%)	1293 (30.2%)	1645 (31.4%)
High	0 (0%)	35 (4.1%)	6 (6.5%)	83 (1.9%)	117 (2.2%)
Self-reported HBV infection	2 (1.5%)	11 (1.3%)	0 (0.0%)	54 (1.3%)	66 (1.3%)
Cardiovascular disease	37 (28%)	112 (13%)	29 (31.5%)	247 (5.8%)	376 (7.2%)
Hypertension	79 (59.8%)	558 (65%)	NA	1213 (28.3%)	1812 (34.6%)
Dyslipidemia	33 (25%)	248 (28.9%)	37 (40.2%)	496 (11.6%)	765 (14.6%)
Hyperuricemia	20 (15.2%)	142 (16.5%)	12 (13.0%)	447 (10.4%)	599 (11.5%)
Diabetes	25 (18.9%)	181 (21.1%)	NA	208 (4.9%)	400 (7.6%)
<b>Table 1 General characteristics of participants according to indicators of renal damage (Continued)</b>					
Body mass index (kg/m <sup>2</sup> )	24.9 (3.6)	26.1 (3.8)	26.5 (3.2)	23.6 (3.6)	24.1 (3.8)
Waist-hip ratio	0.8 (0.05)	0.9 (0.04)	0.9 (0.03)	0.8 (0.1)	0.8 (0.1)
Total cholesterol (mmol/L)	4.8 (0.9)	4.6 (0.97)	4.7 (0.9)	4.2 (0.9)	4.3 (0.9)
Triglyceride (mmol/L)	1.7 (1.2)	2.0 (1.8)	2.4 (2.0)	1.3 (1.1)	1.4 (1.3)
LDL cholesterol (mmol/L)	2.6 (0.7)	2.5 (0.6)	2.6 (0.6)	2.3 (0.7)	2.3 (0.7)
HDL cholesterol (mmol/L)	1.4 (0.3)	1.3 (0.4)	1.2 (0.3)	1.4 (0.4)	1.3 (0.4)
Fasting blood glucose (mmol/L)	5.4 (2.3)	5.8 (2.2)	9.1 (3.0)	4.9 (1.0)	5.0 (1.3)
Uric acid (μmol/L)	285.5 (94.5)	321.7 (102.1)	302.4 (99.4)	289.7 (95.5)	294.6 (97.3)
Creatinine (μmol/L)	97.8 (92.0 - 106.7)	84.0 (39.5)	82.3 (70.4 - 96.9)	79.6 (15.2)	80.8 (25.1)
eGFR (mL/min/1.73m <sup>2</sup> )	52.4 (10.7)	86.9 (19.4)	79.6 (21.7)	94.5 (21.2)	92.6 (21.5)
ACR (mg/g)	20.1 (10.7 - 44.2)	47.8 (36.6 - 106.3)	73.9 (42.4 - 244.8)	12.3 (8.1 - 17.6)	14.1 (8.8 - 23)

Note: Data were n (%), mean (standard deviation) or median with interquartile range, as appropriate.

Abbreviations: DKD, diabetic kidney disease; HBV, hepatitis B virus; LDL, low density lipoprotein; HDL, high density lipoprotein; eGFR, estimated glomerular filtration rate; ACR, albumin: creatinine ratio; NA, not applicable.

**Table 2 Adjusted prevalence of indicators of renal function and chronic kidney disease, by disease stage**

Stage	Renal indicator						Chronic kidney disease (in 5231 participants)	
	eGFR (mL/min/1.73m <sup>2</sup> )		Albuminuria		Diabetic kidney disease		N	Prevalence (95% CI)
	n	Prevalence (95% CI)	n	Prevalence (95% CI)	n	Prevalence (95% CI)		
1	> 90	2744 52.1 (50.7 - 53.4)	370	11.5 (10.3 - 12.7)	30	1.1 (0.7 - 1.5)	370	6.0 (5.3 - 6.6)
2	60 - 89	2355 42.4 (41.1 - 43.8)	443	18.4 (16.8 - 20.0)	49	2.1 (1.5 - 2.7)	443	7.8 (7.1 - 8.5)
3	30 - 59	124 2.6 (2.2 - 3.1)	40	37.0 (28.8 - 45.1)	10	8.1 (3.2 - 12.9)	124	2.6 (2.2 - 3.1)
3a	45 - 59	115 2.4 (2.0 - 2.8)	33	32.8 (24.5 - 41.1)	9	7.8 (2.8 - 12.8)	115	2.4 (2.0 - 2.8)
3b	30 - 44	9 0.2 (0.1 - 0.4)	7	76.9 (50.4 - 93.4)	1	11.1 (1.45 - 36.7)	9	0.2 (0.1 - 0.4)
4	15 - 29	5 0.2 (0.1 - 0.4)	4	46.2 (14.8 - 77.5)	2	40.0 (2.8 - 70.8)	5	0.2 (0.1 - 0.4)
5	< 15	3 0.1 (0.1 - 0.2)	1	14.3 (9.4 - 29.2)	1	14.3 (9.4 - 29.2)	3	0.1 (0.1 - 0.2)
Total		5231 100	858	14.9 (13.9 - 15.9)	92	1.8 (1.4 - 2.1)	945	16.8 (15.8 - 17.8)

Note: Albuminuria was defined as urinary albumin to creatinine ratio  $\geq$  30mg/g creatinine. CKD was defined as an eGFR less than 60 mL/min/1.73m<sup>2</sup> or presence of albuminuria. All prevalences were adjusted for synthesized weights.

Abbreviations: eGFR, estimated glomerular filtration rate.

**Table 4 Prevalence of indicators of renal damage in participants with diabetes, by disease stage**

Stage	eGFR (mL/min/1.73m <sup>2</sup> )		Albuminuria	
	n	Prevalence (95% CI)	n	Prevalence (95% CI)
1	> 90	143 35.8 (31.0 - 40.5)	63	15.8 (12.2 - 19.3)
2	60 - 89	232 58.0 (53.1 - 62.9)	104	26.0 (21.7 - 30.3)
3	30 - 59	22 5.5 (3.3 - 7.7)	11	2.8 (1.1 - 4.4)
3a	45 - 59	19 4.8 (2.7 - 6.8)	8	2.0 (0.6 - 3.4)
3b	30 - 44	3 0.8 (0.1 - 1.6)	3	0.8 (0.1 - 1.6)
4	15 - 29	2 0.5 (0.1 - 1.2)	2	0.5 (0.1 - 1.2)
5	< 15	1 0.3 (0.1 - 0.7)	1	0.3 (0.1 - 0.7)
Total		400 100	181	45.3 (40.4 - 50.1)

Note: Albuminuria was defined as urinary albumin to creatinine ratio  $\geq$  30mg/g creatinine.

Abbreviations: eGFR, estimated glomerular filtration rate.

**Table 3 General characteristics of participants with diabetes according to indicators of renal damage**

	Participants with eGFR < 60 mL/min/1.73 m <sup>2</sup> (N= 25)	Participants with albuminuria (N= 181)	Participants without renal damage (N= 208)	Total (N= 400)
Age	68.4 (11.3)	57.6 (12.4)	57.2 (10.6)	57.5 (11.5)
Men	5 (20.0%)	132 (72.9%)	123 (59.1%)	255 (63.8%)
Education				
≤ Primary school	2 (8.0%)	26 (14.4%)	21 (10.1%)	48 (12.0%)
Junior high school	9 (36.0%)	51 (28.2%)	67 (32.2%)	121 (30.3%)
≥ Senior high school	14 (56.0%)	104 (57.5%)	120 (57.7%)	231 (57.8%)
Current smoker	1 (4.0%)	66 (36.5%)	55 (26.4%)	121 (30.3%)
Habitual drinker	1 (4.0%)	61 (33.7%)	35 (16.8%)	96 (24.0%)
Dietary pattern				
Diet rich in fruits and vegetables	9 (36.0%)	69 (38.1%)	100 (48.1%)	174 (43.5%)
High fat diet	1 (4.0%)	16 (8.8%)	22 (10.6%)	38 (9.5%)
Physical activity				
Low	19 (76.0%)	101 (55.8%)	131 (63.0%)	242 (60.5%)
Moderate	6 (24.0%)	72 (39.8%)	74 (35.6%)	147 (36.8%)
High	0 (0.0%)	8 (4.4%)	3 (1.4%)	11 (2.8%)
Awareness of diabetes	24 (96.0%)	130 (71.8%)	164 (78.8%)	305 (76.3%)
Control of diabetes	9 (36.0%)	38 (21.0%)	89 (42.8%)	133 (33.3%)
Self-reported HBV infection	0 (0.0%)	3 (1.7%)	11 (5.3%)	14 (3.5%)
Hypertension	18 (72.0%)	136 (75.1%)	106 (51.0%)	248 (62.0%)
Dyslipidemia	13 (52.0%)	67 (37.0%)	40 (19.2%)	113 (28.3%)
Hyperuricemia	3 (12.0%)	21 (11.6%)	19 (9.1%)	40 (10.0%)
Body mass index (kg/m <sup>2</sup> )	26.2 (3.0)	26.7 (3.3)	25.5 (3.4)	26.0 (3.4)
Total cholesterol (mmol/L)	4.7 (0.9)	4.6 (1.0)	4.4 (1.0)	4.5 (1.0)
<b>Table 3 General characteristics of participants with diabetes according to indicators of renal damage (Continued)</b>				
Triglyceride (mmol/L)	2.2 (1.2)	2.6 (2.5)	1.3 (0.9 - 2.0)	2.2 (2.3)
LDL cholesterol (mmol/L)	2.5 (0.6)	2.6 (0.7)	2.4 (0.7)	2.5 (0.7)
HDL cholesterol (mmol/L)	1.2 (0.3)	1.2 (0.3)	1.2 (0.3)	1.2 (0.3)
Fasting plasma glucose (mmol/L)	8.6 (3.7)	9.1 (2.9)	7.6 (2.3)	8.3 (2.7)
Uric acid (μmol/L)	282.0 (203.0 - 347.0)	300.4 (99.1)	272.3 (93.3)	283.6 (97.0)
Creatinine (μmol/L)	97.5 (89.0 - 111.3)	8.4 (71.6 - 96.5)	77.8 (17.2)	82.9 (40.0)
eGFR (mL/min/1.73m <sup>2</sup> )	48.8 (12.9)	82.4 (20.1)	85.6 (16.5)	83.3 (18.6)
ACR (mg/g)	34.6 (12.4 - 172.7)	62.7 (39.4 - 196.7)	16.3 (7.5)	27.8 (14.5 - 53.5)

Note: Data were n (%), mean (standard deviation) or median with interquartile range, as appropriate.

Abbreviations: DKD, diabetic kidney disease; HBV, hepatitis B virus; LDL, low density lipoprotein; HDL, high density lipoprotein; eGFR, estimated glomerular filtration rate; ACR, albumin: creatinine ratio.

**Table 5 Adjusted prevalence of indicators of renal damage, hypertension and diabetes, by education and family income**

	eGFR < 60mL/min/1.73m <sup>2</sup>	Albuminuria	CKD	Hypertension	Control of hypertension	Diabetes	Control of diabetes	DKD
Education								
≤ Primary school, tertile 1	2.3 (0.5 - 4.2)	31.9 (26.2 - 37.6)	33.5 (27.7 - 39.3)	51.8 (45.6 - 57.9)	15.8 (9.5 - 22.1)	18.7 (13.9 - 23.5)	33.3 (19.5 - 47.2)	5.8 (3.0 - 8.7)
Junior high school, tertile 2	2.1 (1.1 - 3.1)	29.6 (26.4 - 32.8)	31.0 (27.7 - 34.3)	47.9 (44.4 - 51.5)	15.6 (11.9 - 19.3)	15.6 (13.1 - 18.2)	39.7 (30.8 - 48.5)	3.4 (2.1 - 4.6)
≥ Senior high school, tertile 3	3.2 (2.7 - 3.7)	16.1 (15.0 - 17.2)	17.9 (16.7 - 19.0)	31.1 (29.7 - 32.5)	6.9 (5.5 - 8.3)	5.5 (4.8 - 6.2)	29.9 (23.9 - 35.8)	1.2 (0.9 - 1.5)
* <i>P</i> trend	0.20	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.18	< 0.001
Family monthly income (RMB)								
≤ 5000, tertile 1	3.7 (2.0 - 5.5)	18.2 (14.6 - 21.7)	20.6 (16.8 - 24.3)	55.1 (50.6 - 59.7)	21.3 (16.3 - 26.4)	19.3 (15.6 - 22.9)	44.3 (33.7 - 54.9)	6.8 (4.5 - 9.1)
5000 -, tertile 2	2.6 (1.9 - 3.3)	18.1 (16.3 - 19.9)	20.0 (18.2 - 21.8)	35.4 (33.2 - 37.6)	9.3 (7.1 - 11.6)	6.7 (5.6 - 7.9)	27.4 (19.5 - 35.4)	1.0 (0.6 - 1.5)
≥ 7000, tertile 3	2.4 (1.0 - 3.9)	25.2 (21.2 - 29.2)	26.5 (22.4 - 30.6)	39.3 (34.8 - 43.8)	12.9 (7.9 - 17.9)	11.9 (8.9 - 14.9)	33.3 (20.3 - 46.3)	2.9 (1.3 - 4.4)
* <i>P</i> trend	0.38	0.002	0.01	< 0.001	< 0.001	< 0.001	0.04	< 0.001

Note: Albuminuria was defined as urinary albumin to creatinine ratio ≥ 30mg/g creatinine. CKD was defined as an eGFR less than 60 mL/min/1.73m<sup>2</sup> or presence of albuminuria. All prevalences were adjusted for synthesized weights.

Abbreviations: eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; DKD, diabetic kidney disease.

\**P*<sub>trend</sub> was calculated by Cochran-Armitage test

**Table 6 Factors associated with indicators of renal damage and diabetic kidney disease**

	eGFR < 60 ml/min/1.73m <sup>2</sup>		Albuminuria		Diabetic kidney disease	
	Crude OR	Adjusted OR	Crude OR	Adjusted OR	Crude OR	Adjusted OR
Age	1.00	1.00	1.00	1.00	1.00	1.00
18-	2.71 (2.34 - 3.13)	2.77 (2.32 - 3.32)	1.61 (1.52 - 1.71)	1.18 (1.08 - 1.28)	2.19 (1.87 - 2.57)	2.26 (1.85 - 2.77)
Age changed by 10 years						
Gender						
Women	1.00	1.00	1.00	1.00	1.00	1.00
Men	0.17 (0.11 - 0.26)	0.16 (0.09 - 0.29)	1.70 (1.46 - 1.98)	1.18 (0.96 - 1.47)	1.62 (1.04 - 2.51)	1.85 (1.04 - 3.28)
Education						
≤ Primary school	1.00	1.00	1.00	1.00	1.00	1.00
Junior high school	0.51 (0.92 - 0.91)	1.23 (0.65 - 2.30)	0.61 (0.45 - 0.83)	0.60 (0.42 - 0.84)	0.56 (0.29 - 1.08)	0.69 (0.34 - 1.37)
≥ Senior high school	0.23 (0.14 - 0.38)	2.59 (1.41 - 4.77)	0.30 (0.23 - 0.39)	0.48 (0.35 - 0.68)	0.20 (0.11 - 0.36)	0.69 (0.35 - 1.39)
Current smoker	3.80 (1.92 - 7.50)	1.21 (0.50 - 2.93)	2.23 (1.90 - 2.62)	1.44 (1.17 - 1.78)	1.54 (1.09 - 2.17)	0.80 (0.53 - 1.22)
Alcohol consumption	4.90 (2.28 - 10.51)	1.81 (0.71 - 4.63)	2.11 (1.80 - 2.48)	1.16 (0.94 - 1.44)	1.88 (1.30 - 2.74)	1.37 (0.86 - 2.18)

Table 6 Factors associated with indicators of renal damage and diabetic kidney disease (*Continued*)

Diet rich in fruits and vegetables	1.99 (1.40 - 2.83)	1.42 (0.96 - 2.10)	1.36 (1.17 - 1.57)	1.27 (1.07 - 1.50)	0.95 (0.63 - 1.45)	0.72 (0.46 - 1.13)
High fat diet	0.51 (0.28 - 0.96)	0.60 (0.30 - 1.18)	0.64 (0.51 - 0.81)	0.75 (0.58 - 0.96)	0.62 (0.31 - 1.23)	1.02 (0.49 - 2.12)
Physical activity						
Low	1.00	1.00	1.00	1.00	1.00	1.00
Moderate	0.70 (0.47 - 1.04)	1.08 (0.69 - 1.68)	1.51 (1.30 - 1.76)	1.06 (0.89 - 1.27)	1.19 (0.77 - 1.86)	1.02 (0.63 - 1.66)
High	NA	NA	2.57 (1.71 - 3.86)	1.47 (0.93 - 2.30)	3.36 (1.42 - 7.96)	2.66 (1.05 - 6.72)
Body mass index						
Healthy weight	1.00	1.00	1.00	1.00	1.00	1.00
Underweight	0.54 (0.17 - 1.73)	1.26 (0.37 - 4.32)	0.61 (0.35 - 1.06)	0.91 (0.51 - 1.62)	0.46 (0.06 - 3.46)	0.95 (0.21 - 7.43)
Overweight	1.19 (0.80 - 1.77)	0.71 (0.45 - 1.11)	2.81 (2.35 - 3.37)	1.54 (1.26 - 1.88)	2.61 (1.53 - 4.46)	1.37 (0.79 - 2.38)
Obesity	1.75 (1.11 - 2.78)	1.05 (0.62 - 1.78)	4.99 (4.06 - 6.13)	2.30 (1.82 - 2.90)	4.90 (2.80 - 8.58)	2.47 (1.37 - 4.45)
Diabetes	2.94 (1.88 - 4.61)	1.13 (0.68 - 1.90)	5.06 (4.09 - 6.26)	2.71 (2.14 - 3.43)	NA	NA
Hypertension	2.90 (2.03 - 4.12)	1.81 (1.20 - 2.73)	4.61 (3.95 - 5.38)	2.79 (2.35 - 3.31)	NA	NA
Dyslipidemia	1.99 (1.33 - 2.97)	1.51 (0.96 - 2.36)	3.03 (2.54 - 3.60)	1.74 (1.43 - 2.12)	4.08 (2.67 - 6.23)	2.88 (1.84 - 4.51)
Hyperuricemia	1.39 (0.86 - 2.26)	1.57 (0.89 - 2.78)	1.70 (1.38 - 2.08)	0.96 (0.76 - 1.21)	1.16 (0.63 - 2.15)	0.65 (0.34 - 1.24)

Note: Data were crude and multivariable-adjusted odds ratio (95% Confidence Interval).

Abbreviation: DKD, diabetic kidney disease; NA, not applicable

Reference level: Gender = Woman; Education = Junior high school; Alcohol consumption = No; Diet rich in fruits and vegetables = No; High fat diet = No; Physical activity = Low; Body mass index = Healthy weight; Diabetes = No; Hypertension = No; Dyslipidemia = No; Hyperuricemia = No.

**Table 7 Results of ordinal logistic regression for two Models**

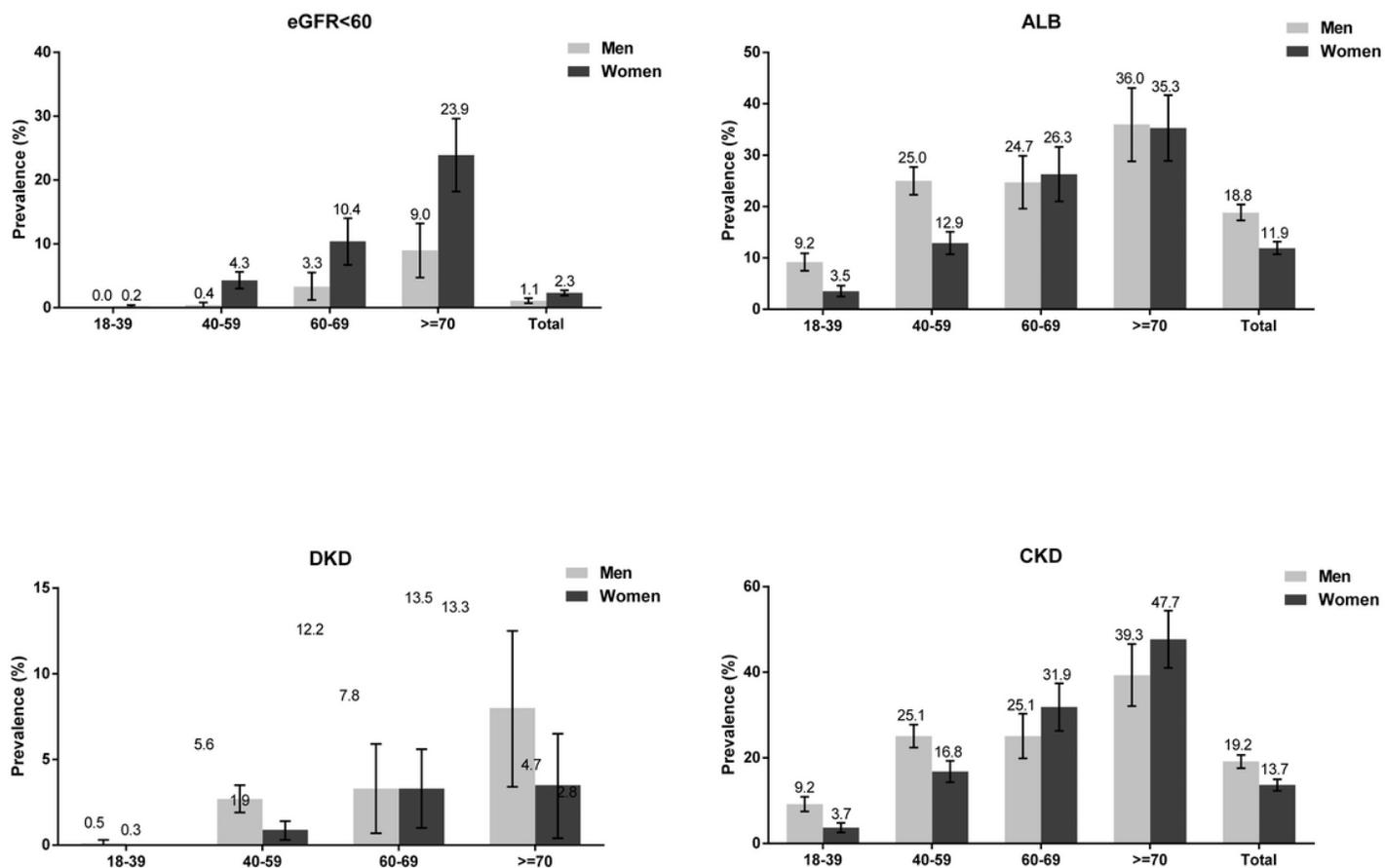
	Model 1 (N=5099)		Model 2 (N=5231)	
	Adjusted OR	P	Adjusted OR	P
Age				
18-	1.00		1.00	
Age changed by 10 years	1.11 (1.02 - 1.21)	0.01	1.32 (1.22 - 1.43)	< 0.001
Gender				
Women	1.00		1.00	
Men	1.18 (0.95 - 1.47)	0.13	0.88 (0.72 - 1.08)	0.23
Education				
≤ Primary school	1.00		1.00	
Junior high school	0.60 (0.42 - 0.85)	0.004	0.68 (0.49 - 0.93)	0.02
≥ Senior high school	0.46 (0.32 - 0.65)	< 0.001	0.61 (0.45 - 0.84)	0.002
Current smoker	1.44 (1.17 - 1.79)	< 0.001	1.41 (1.15 - 1.74)	0.001
Alcohol consumption	1.15 (0.93 - 1.43)	0.20	1.10 (0.89 - 1.36)	0.39
Diet rich in fruits and vegetables	1.30 (1.10 - 1.54)	0.002	1.32 (1.13 - 1.55)	0.001
High fat diet	0.73 (0.56 - 0.95)	0.02	0.73 (0.57 - 0.93)	0.01
Physical activity				
Low	1.00		1.00	
Moderate	1.07 (0.89 - 1.28)	0.49	1.07 (0.90 - 1.27)	0.42
High	1.57 (1.01 - 2.44)	0.05	1.46 (0.94 - 2.27)	0.09
Body mass index				
Underweight	1.00		1.00	
<b>Table 7 Results of ordinal logistic regression for two Models (Continued)</b>				
Healthy weight	1.21 (0.66 - 2.20)	0.54	1.13 (0.66 - 1.95)	0.66
Overweight	1.82 (1.00 - 3.33)	0.05	1.52 (0.88 - 2.64)	0.13
Obesity	2.71 (1.47 - 5.00)	< 0.001	2.34 (1.34 - 4.11)	< 0.001
Diabetes	2.98 (2.35 - 3.77)	< 0.001	2.72 (2.18 - 3.40)	< 0.001
Hypertension	2.80 (2.35 - 3.34)	< 0.001	2.73 (2.32 - 3.22)	< 0.001
Dyslipidemia	1.81 (1.49 - 2.20)	< 0.001	1.79 (1.48 - 2.15)	< 0.001
Hyperuricemia	0.99 (0.78 - 1.25)	0.93	1.09 (0.87 - 1.36)	0.45

Note: Data were multivariable-adjusted odds ratio (95% Confidence Interval) and *P* value for each variable.

Abbreviation: NA, not applicable

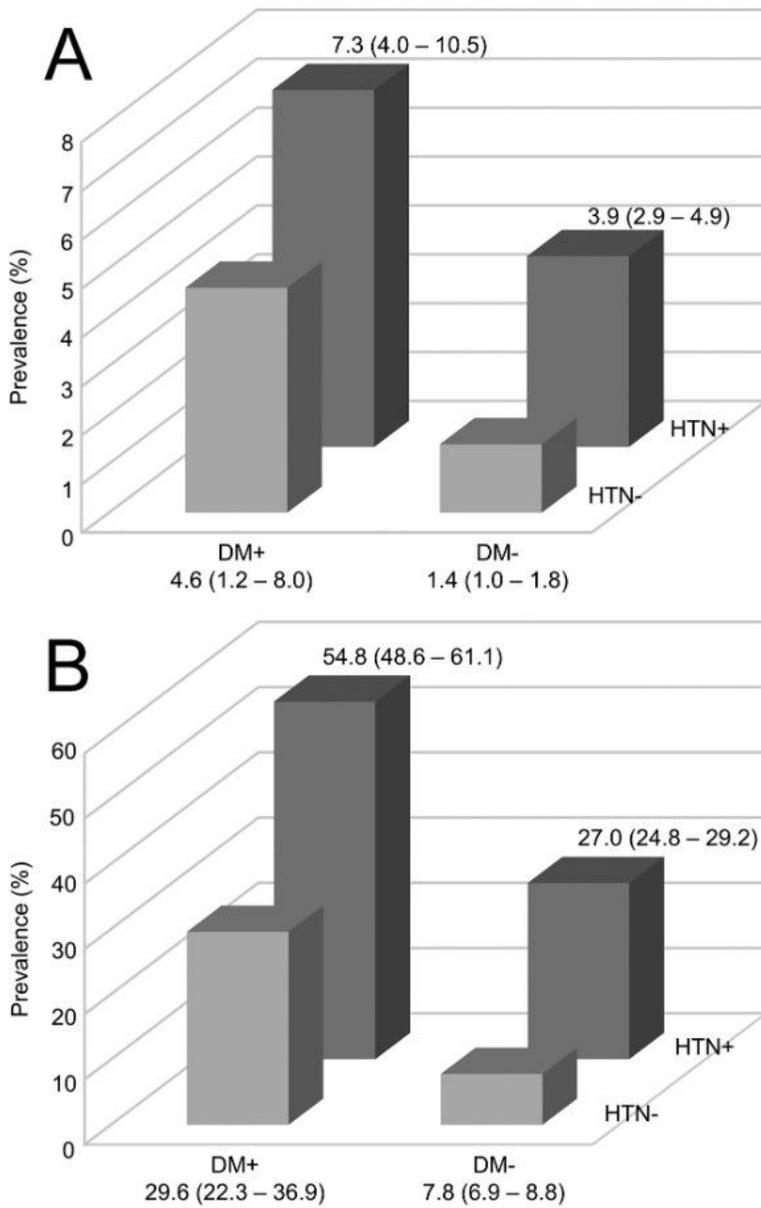
Reference level: Gender = Woman; Education = Primary school; Current smoker = No; Alcohol consumption = No; Diet rich in fruits and vegetables = No; High fat diet = No; Physical activity = Low; Body mass index = Underweight; Diabetes = No; Hypertension = No; Dyslipidemia = No; Hyperuricemia = No.

## Figures



**Figure 1**

Adjusted prevalence of indicators of renal damage, DKD and CKD, stratified by sex and age. Adjusted prevalences of eGFR less than 60 mL/min/1.73 m<sup>2</sup> (eGFR < 60), albuminuria (ALB), diabetic kidney disease (DKD) and chronic kidney disease (CKD). Data are expressed as prevalence, and the bars represent the 95% CIs.



**Figure 2**

Prevalence of indicators of renal damage according to hypertension and diabetes. Prevalences of eGFR less than 60 mL/min/1.73 m<sup>2</sup> (A) and albuminuria (B). Data are expressed as prevalence (95% CI for prevalence). DM refers to diabetes mellitus, and HTN refers to hypertension.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [STROBEchecklistv4crosssectional.pdf](#)