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Prevalence of Chronic Kidney Disease in China
Results From the Sixth China Chronic Disease and Risk Factor Surveillance

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IMPORTANCE To our knowledge, there has been no update on the prevalence of chronic kidney disease (CKD) in China since 2012.

OBJECTIVE To provide periodic nationwide data on the prevalence of CKD and the associated behavioral and metabolic risk factors in China.

DESIGN, SETTING, AND PARTICIPANTS This nationally representative cross-sectional study included data from 176 874 adults from all 31 provincial-level administrative divisions in mainland China, as reported in the sixth China Chronic Disease and Risk Factor Surveillance conducted from August 2018 to June 2019. Data analysis was performed in 2021 to 2022.

EXPOSURES Serum creatinine, urinal creatinine, and urine albumin were measured for all participants. Estimated glomerular filtration rate (eGFR) was calculated from serum creatinine using the CKD-EPI equation.

MAIN OUTCOMES AND MEASURES The primary outcome was weighted prevalence of CKD in the overall population and different strata, defined as presence of impaired kidney function (eGFR of <60 mL/min/1.73m^2) or albuminuria (urine albumin-to-creatinine ratio of ≥30 mg/g). Secondary outcomes were awareness of CKD and control of comorbidities. Logistic regression was used to examine the association of sociodemographic characteristics, behavioral and dietary habits, physical activity, and comorbidities with CKD.

RESULTS A total of 184 876 participants contributed data to this study, and of the 176 874 adults 18 years and older with measurements of eGFR and urine albumin-to-creatinine ratio in 2018 to 2019, the mean age was 43.8 years and the weighted proportion of women was 44.6%. The estimated prevalence of CKD, impaired kidney function, and albuminuria were 8.2%, 2.2%, and 6.7%, respectively. A higher prevalence of CKD was observed in the subgroups characterized by older age, female gender, non-Han ethnicity, residency of rural or north and central parts of China, receiving less education or lower income, former smoking, no alcohol drinking, lacking physical activity, and presence of risk factors such as obesity, hypertension, diabetes, dyslipidemia, and self-reported cardiovascular disease. Among the adults with CKD, 73.3%, 25.0%, and 1.8% were at stage 1 to 2, 3, and 4 to 5, respectively, and the awareness of CKD was 10.0%.

CONCLUSIONS AND RELEVANCE This cross-sectional study found a weighted estimated of 82 million adults with CKD in China in 2018 to 2019. The prevalence appears to have decreased by 30% in the past decade. Better environmental protection, integration of CKD into the national public health surveillance program, and control of common CKD comorbidities appear to be associated with reducing the disease burden of CKD.

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Supplemental content

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Chronic kidney disease (CKD) is a highly prevalent condition that contributes to a substantially increased burden of cardiovascular diseases, other morbidities, and mortality. In 2017, 1.2 million people died of CKD globally, and the mortality rate of CKD increased 41.4% between 1999 and 2017.[1] The global prevalence of CKD in 2017 was estimated at 9.1%, though the quality of the data used for prevalence estimation varied greatly with regions.[1]

Estimates of CKD prevalence from large screenings of nationally representative samples were reported in only a few countries, including Australia,[2] the US,[3] Canada,[4] Korea,[5] and China,[6] and ranged from 7.2% to 13.4%. A previous survey of 47 204 participants in China reported a CKD prevalence of 10.8% in 2009.[6] China is experiencing a fast pace of modernization and economic development. During the past decade, changes in socioeconomic status, profiles of the risk factors, health care, and environment may have had an effect on the prevalence of CKD in China. An up-to-date and accurate estimate of CKD prevalence will help the understanding of the disease burden of CKD and improve the prevention and management of CKD.

The China Chronic Disease and Risk Factor Surveillance (CCDRFS) was established in 2004 by the National Center for Chronic and Noncommunicable Diseases Control and Prevention (NCNCD) of the Chinese Center for Disease Control and Prevention with the aim to provide periodic nationwide data on the prevalence of major chronic diseases and related behavioral and metabolic risk factors in the general population in China.[7,8] The sixth CCDRFS was conducted in 2018 to 2019, and for the first time, CKD was added to the disease list of surveillance. In this cross-sectional study, we estimated the prevalence of CKD and examined the associated factors using data from the sixth CCDRFS.

Key Points

Question What is the prevalence of chronic kidney disease (CKD) in China?

Findings In this nationally representative cross-sectional study with 176 874 participants, the estimated prevalence of CKD, impaired kidney function, and albuminuria were 8.2%, 2.2%, and 6.7%, respectively. There were an estimated 82 million adults with CKD in mainland China in 2018 to 2019, though the prevalence appears to have decreased by 30% in the past decade.

Meaning Better environmental protection, integration of CKD into the national public health surveillance program, and control of common CKD comorbidities appear to be associated with reducing the disease burden of CKD.

Method

Survey Design and Populations

The sixth CCDRFS was a large, cross-sectional, nationally representative survey that covered all 31 provincial-level administrative divisions in mainland China and was conducted from August 2018 to June 2019 by the NCNCD. Details of the design, objectives, and survey methods of the CCDRFS are described in the eMethods in Supplement 1 and have been published elsewhere.[7-9] In brief, the sixth CCDRFS used a multistage, stratified, clustered probability sampling to generate a nationally and provincially representative sample. First, 298 chronic disease and risk factor surveillance points covering all 31 provinces were selected (eFigure 1 in Supplement 1). Each surveillance point covered either a rural county or an urban district. Second, 3 townships (rural) or subdistricts (urban) were selected by systematic sampling in each selected surveillance point. Third, within each selected township and subdistrict, 2 villages (rural) or residential areas (urban) were selected by systematic sampling. Last, each selected village or residential area was divided into groups of at least 60 households, and 1 group was selected by simple random sampling. Forty-five households where further selected from 1 group. All eligible adult members of the selected household who met the inclusion criteria were invited to participate in the survey. The eligibility criteria included: (1) age of at least 18 years; (2) having lived in the address for more than 6 months in the past 12 months; (3) not pregnant; and (4) having no serious health condition or illness that would prevent the individual from participating, including intellectual disability or language disorder. A total of 184 876 eligible adults agreed to participate in the survey, with a response rate of 94.9%.

The study protocol was approved by the ethics review committee of the NCNCD. All participants provided written informed consent. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.

Data Collection

Each participant was subject to a comprehensive questionnaire by trained personnel on sociodemographic information, behavioral and dietary habits, physical activity, individual and family history of diseases, and a physical examination including height, weight, waist circumference, blood pressure, and pulse rate. Body weight and height were measured according to a standard protocol, and body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Waist circumference was measured in standing position midway between the lower edge of the costal arch and the upper edge of the iliac crest. Blood pressure was measured at the nondominant arm 3 times consecutively with a 1-minute interval between the measurements in a seated position after 5 minutes of rest using an automated device. Blood pressure readings from the last 2 measurements were averaged and used for subsequent analyses. For participants without self-reported history of diabetes, a 2-hour oral glucose tolerance test (OGTT) with standard 75-g glucose solution was also performed. Blood samples after an overnight fast of at least 10 hours and morning urine samples were collected from all participants.

Laboratory Assays

eTable 1 in Supplement 1 summarizes the methods used for laboratory assays. Serum and urinal creatinine were measured by an enzymatic assay that was traceable to isotope dilution mass spectrometry. Urine albumin was measured by an immune turbidimetric test. Glycosylated hemoglobin A_{1c} (HbA_{1c}) was directly measured from venous blood samples using quantitative

high-performance liquid chromatography and the boronated affinity method on a hemoglobin analyzer (D-10 [Bio-Rad]). Plasma glucose, serum lipids, and uric acid were measured using commercial kits on automatic analyzers. Assay for fasting blood glucose and 2-hour OGTT was completed within 24 hours of the testing in 298 local laboratories that had passed a technical appraisal.[10] All other assays were completed in 3 central laboratories that had completed a standardization and certification program. Estimated glomerular filtration rate (eGFR) was calculated from serum creatinine using the CKD-EPI formula.[11] To make temporal comparison with the previous study, we also calculated eGFR using the modified MDRD (Modification of Diet in Renal Disease)[6] formula.

Assessment Criteria

Impaired kidney function was defined as an eGFR of less than 60 mL/min/1.73 m^2. Albuminuria was defined as a urine albumin-to-creatinine ratio (UACR) of 30 mg/g or higher and further classified into A2 and A3 categories by a UACR of 30 to 299 mg/g and 300 mg/g or higher, respectively. Chronic kidney disease was defined as presence of impaired kidney function or albuminuria. Newly detected hypertension was defined as a blood pressure of 140/90 mm Hg or higher at the time of physical examination and without self-reported history of physician-diagnosed hypertension. Previously diagnosed hypertension was defined as self-reported diagnosis of hypertension in hospitals at the township (community) level and if the patient had been taking antihypertensive medicine in the past 2 weeks. Blood pressure control of hypertension was defined as a blood pressure lower than 140/90 mm Hg among those with hypertension at survey. Newly detected diabetes was defined as without self-reported history of physician-diagnosed diabetes but meeting the American Diabetes Association 2010 criteria for diabetes,[12] which included a fasting plasma glucose of 126 mg/dL or higher, a 2-hour plasma glucose of 200 mg/dL or higher in OGTT testing (to convert glucose to mmol/L, multiply by 0.0555), or an HbA_{1c} of 6.5% or higher. Prediabetes was defined as a fasting plasma glucose of 100 to 125 mg/dL, a 2-hour plasma glucose of 140 to 199 mg/dL in OGTT testing, or an HbA_{1c} of 5.7% to 6.4%. Glycemic control of diabetes was defined as an HbA_{1c} of less than 7.0% among those with diabetes at survey. Dyslipidemia was defined as total cholesterol of 240 mg/dL or higher, high-density lipoprotein cholesterol of 40 mg/dL or lower, low-density lipoprotein cholesterol of 160 mg/dL or higher (to convert cholesterol to mmol/L, multiply by 0.0259), triglyceride of 200 mg/dL or higher (to convert to mmol/L, multiply by 0.0113), or based on self-reported diagnosis of dyslipidemia in hospitals at the township (community) level or above. Hyperuricemia was defined as serum uric acid of greater than 420 µmol/L. Overweight and obese were defined as a BMI of 25.0 to 29.9 and 30 or higher, respectively. Central obesity was defined as a waist circumference of 90 cm or more in men and 85 cm or more in women.

Statistical Analysis

Among 184 876 participants, 176 874 (95.7%) had nonmissing data on eGFR and urine albumin level and were included for subsequent analyses. The characteristics of the study population, including the sociodemographic characteristics, behavioral and dietary habits, physical activity, comorbidities, and laboratory results were summarized as categorical variables and presented as proportions. Prevalence of CKD, impaired kidney function, and albuminuria in the overall population and different strata were calculated using sample weights that incorporated multistage sampling weight, the nonresponse weight, and the poststratification weight based on the sixth national census (2010) population. The 95% CIs of the prevalence estimates were calculated using Taylor series linearization with finite population correction implemented in the proc surveyfreq procedure in SAS, version 9.4 (SAS Institute Inc). Similarly, weighted multivariable logistic regression models for CKD, impaired kidney function, and albuminuria were analyzed with relevant sociodemographic characteristics, behavioral and dietary habits, physical activity, comorbidities, and laboratory results as the independent variables. The prevalence of hypertension, diabetes, and dyslipidemia, as well as the corresponding rates of awareness, treatment, and control among the treated patients, were also calculated. All data cleaning and analyses were performed using SAS, version 9.4, and $P < .05$ was considered statistically significant.

Results

Study Population

A total of 184 876 adults participated in the national surveillance program, with an overall response rate of 94.9%. Of the participants, 176 874 had measurements of eGFR and UACR and constituted the sample population of the current study (eFigure 2 in Supplement 1). In 2018 to 2019, the mean age of Chinese adults was 43.8 years, and among them, 44.6% were female, 17.3% were 60 years or older, 48.1% were from rural areas, and 91.1% were of Han ethnicity (**Table 1**). Risk factors for kidney diseases were very common in Chinese adults, with a raw prevalence of 35.4%, 27.6%, 12.4%, 38.4%, and 14.1% for central obesity, hypertension, diabetes, dyslipidemia, and hyperuricemia, respectively. Additionally, 50.0% of the male adults and 2.1% of the female adults were current smokers. About 4.4% of adults had been diagnosed with kidney disease, 2.2% had an eGFR of less than 60 mL/min/1.73 m^2, and 6.7% had a UACR of 30 mg/g or higher.

Prevalence of CKD

The weighted prevalence of CKD, defined as the presence of impaired kidney function (eGFR of <60 mL/min/1.73m^2) or albuminuria (UACR of ≥30 mg/g), was 8.2% (95% CI, 7.8%-8.6%). The prevalence of impaired kidney function and albuminuria was 2.2% (95% CI, 2.0%-2.4%) and 6.7% (95% CI, 6.4%-7.1%), respectively. The prevalence of CKD by stage of kidney function and albuminuria level is summarized in **Table 2**. Among those with CKD, 73.3%, 25.0%, and 1.8% were at stage 1 to 2, 3, and 4 to 5, respectively. The prevalence of CKD in the rural and urban areas was 8.6% (95% CI, 8.1%-9.1%) and 7.9% (95% CI, 7.3%-8.5%), respectively. The prevalence of CKD based on eGFR calculated by the modified MDRD equation was lower,

Table 1. General Characteristics of the Study Population, 2018-2019

Characteristics	No. (%)[a]		
	Total (n = 176 874)	Male (n = 78 560)	Female (n = 98 314)
Age group, y			
18-29	9104 (24.8)	3971 (24.7)	5133 (24.8)
30-39	17 179 (20.3)	7158 (20.7)	10 021 (19.8)
40-49	31 742 (22.0)	13 390 (22.1)	18 352 (21.9)
50-59	46 706 (15.6)	19 867 (15.6)	26 839 (15.6)
60-69	48 502 (9.8)	22 371 (9.8)	26 131 (9.8)
≥70	23 641 (7.5)	11 803 (7.1)	11 838 (8.0)
Township			
Urban	72 346 (51.9)	30 604 (52.1)	41 742 (51.6)
Rural	104 528 (48.1)	47 956 (47.9)	56 572 (48.4)
Location in China			
South	17 955 (11.5)	7817 (11.8)	10 138 (11.2)
East	45 474 (30.5)	20 460 (30.5)	25 014 (30.6)
Central	22 066 (15.6)	9513 (15.3)	12 553 (15.9)
North	25 382 (12.0)	10 954 (11.7)	14 428 (12.2)
Northeast	16 695 (9.0)	72 24 (9.0)	9471 (9.0)
Southwest	26 610 (14.2)	12 143 (14.4)	14 467 (14.1)
Northwest	22 692 (7.1)	10 449 (7.2)	12 243 (7.0)
Education			
Primary school or lower	87 925 (31.8)	32 752 (25.8)	55 173 (37.8)
Secondary school	53 707 (33.2)	28 053 (36.6)	25 654 (29.7)
High school	23 046 (17.6)	12 082 (20.1)	10 964 (15.0)
College or above	12 196 (17.4)	5673 (17.4)	6523 (17.4)
Ethnicity			
Han	155 460 (91.1)	69 044 (91.4)	86 416 (90.8)
Other[b]	21 414 (8.9)	9516 (8.6)	11 898 (9.2)
Annual income per capita, ¥			
<6000	32 872 (15.4)	15 261 (15.6)	17 611 (15.2)
6000-11 999	30 305 (15.7)	13 861 (15.9)	16 444 (15.6)
12 000-23 999	35 375 (20.7)	15 623 (20.6)	19 752 (20.7)
≥24 000	37 272 (25.0)	16 287 (25.4)	20 985 (24.7)
Refused/do not know	41 050 (23.2)	17 528 (22.5)	23 522 (23.8)
Cigarette smoking			
Never	122 516 (68.9)	27 728 (40.8)	94 788 (97.4)
Former	11 466 (4.8)	10 741 (9.1)	725 (0.5)
Current	42 885 (26.2)	40 087 (50.0)	2798 (2.1)
Alcohol drinking			
Never	117 991 (61.2)	36 435 (42.6)	81 556 (80.1)
Light	43 374 (30.5)	28 061 (42.1)	15 313 (18.7)
Excessive	15 466 (8.3)	14 045 (15.3)	1421 (1.1)
Fruit/vegetable intake <400 g/d	80 957 (44.6)	36 376 (45.5)	44 581 (43.7)
Red meat intake ≥100 g/d	62 211 (42.0)	32 191 (49.4)	30 020 (34.6)
Physical inactivity (<150 min/wk)	34 730 (22.2)	17 244 (24.3)	17 486 (20.1)
BMI group			
<18.5	5182 (4.2)	2265 (3.9)	2917 (4.5)
18.5-24.9	96 420 (55.2)	43 152 (51.9)	53 268 (58.6)
25.0-29.9	61 883 (32.7)	27 729 (35.7)	34 154 (29.7)
≥30.0	12 697 (7.9)	5111 (8.6)	7586 (7.1)
Central obesity	70 512 (35.4)	29 000 (37.3)	41 512 (33.5)

(continued)

Table 1. General Characteristics of the Study Population, 2018-2019 (continued)

Characteristics	No. (%)[a] Total (n = 176 874)	Male (n = 78 560)	Female (n = 98 314)
Hypertension			
No hypertension	103 165 (72.4)	43 992 (69.2)	59 173 (75.7)
Newly detected	38 358 (16.4)	19 266 (19.6)	19 092 (13.1)
Previously diagnosed	34 897 (11.2)	15 089 (11.2)	19 808 (11.2)
Diabetes			
No diabetes	66 016 (47.8)	27 326 (4.39)	38 690 (51.8)
Prediabetes	76 057 (39.8)	35 096 (42.8)	40 961 (36.6)
Newly detected	17 390 (7.9)	8671 (8.9)	8719 (6.8)
Previously diagnosed	12 945 (4.5)	5487 (4.3)	7458 (4.8)
Dyslipidemia	73 021 (38.4)	34 998 (46.3)	38 023 (30.2)
Hyperuricemia	19 270 (14.1)	15 402 (24.4)	3868 (3.6)
Diagnosed kidney diseases	10 204 (4.4)	5094 (4.9)	5110 (3.8)
Diagnosed cardiovascular disease	11 301 (3.5)	5703 (3.9)	5598 (3.0)
Elevated blood pressure[c]	63 419 (24.5)	30 108 (27.7)	33 311 (21.2)
Fasting glucose, mg/dL			
<100	90 853 (59.9)	38 244 (55.0)	52 609 (63.0)
100-124	65 947 (33.1)	30 807 (36.2)	35 140 (29.9)
≥125	19 818 (7.9)	9385 (8.8)	10 433 (7.1)
Glycated hemoglobin A_{1c}, %			
<5.7	128 834 (81.2)	57 247 (80.4)	71 587 (81.9)
5.7-6.4	33 948 (13.4)	15 003 (13.8)	18 945 (12.9)
≥6.5	14 061 (5.5)	6301 (5.8)	7760 (5.2)
2-h OGTT, mg/dL			
<140	119 846 (81.1)	52 959 (80.1)	66 887 (82.2)
140-199	28 244 (14.0)	12 552 (14.3)	15 692 (13.7)
≥200	10 477 (4.8)	5165 (5.6)	5312 (4.1)
eGFR, mL/min/1.73m^2			
≥90	101 834 (74.1)	43 654 (72.5)	58 180 (75.8)
60-89	67 755 (23.7)	31 491 (25.5)	36 264 (21.8)
30-59	6861 (2.1)	3182 (1.9)	3679 (2.2)
15-29	312 (0.1)	169 (0.1)	143 (0.1)
<15	112 (0.0)	64 (0.0)	48 (0.0)
UACR, mg/g			
<30	160 712 (93.3)	71 895 (93.7)	88 817 (92.8)
30-299	14 035 (5.8)	5665 (5.3)	8370 (6.3)
≥300	2127 (0.9)	1000 (1.0)	1127 (0.9)

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); eGFR, estimated glomerular filtration rate; OGTT, oral glucose tolerance test; UACR, urine albumin-to-creatinine ratio.

SI conversion factor: To convert glucose to mmol/L, multiply by 0.0555.

[a] Percentages are weighted.

[b] Other includes all ethnic minorities in mainland China.

[c] Systolic blood pressure 140 mm Hg and higher or diastolic blood pressure 90 mm Hg and higher.

with an estimate of 7.6% (95% CI, 7.3%-8.0%) in the overall population (eTable 2 in Supplement 1).

Factors Associated With the Prevalence of CKD

A higher prevalence of CKD was observed in the subgroups characterized by older age, female gender, non-Han ethnicity, residency of rural or north and central parts of China, receiving less education or lower income, former smoking, no alcohol drinking, lacking physical activity, and presence of the risk factors such as obesity, hypertension, diabetes, dyslipidemia, and self-reported cardiovascular disease (**Table 3**). The rural- and urban-specific prevalence of CKD by stage and albuminuria among the subgroups are summarized in eTables 3 and 4 in Supplement 1, respectively. The prevalence of CKD, especially among those at more advanced stage, increased considerably with age. In the age group of 70 years and older, the prevalence of CKD was high at 29.0%, of which 60.2% had impaired kidney function. Most of the factors associated with the prevalence of CKD had the same trend of association with impaired kidney function, except for geographic location and BMI. While the lowest CKD prevalence was observed in southern China (6.9% vs 7.9%-9.1% in the other regions), the same region had the highest prevalence of impaired kidney function (3.4% vs 1.1%-2.5% in the other regions), as almost half of the observed CKD was at stage 3 or later. Similarly, compared with other BMI groups, the group with BMI 30 or higher had a substantially higher prevalence of CKD (14.5% vs 5.5%-9.6% in other groups) but a slightly lower prevalence of impaired

Table 2. Weighted Prevalence of CKD by Kidney Function and Albuminuria Level in Chinese Adults, 2018-2019

	UACR, mg/g (95% CI)			
eGFR, mL/min/1.73m^2	<30	30-299	≥300	Total
≥90	NA	3.51 (3.28-3.75)	0.41 (0.32-0.51)	3.93 (3.65-4.20)
60-89	NA	1.83 (1.70-1.97)	0.28 (0.24-0.31)	2.11 (1.96-2.26)
30-59	1.48 (1.34-1.62)	0.41 (0.37-0.45)	0.16 (0.14-0.18)	2.06 (1.88-2.23)
15-29	0.02 (0.02-0.03)	0.03 (0.02-0.04)	0.05 (0.03-0.06)	0.10 (0.09-0.12)
<15	0.00 (0.00-0.01)	0.01 (0.00-0.01)	0.03 (0.02-0.04)	0.04 (0.03-0.06)
Total	1.51 (1.37-1.65)	5.80 (5.50-6.10)	0.93 (0.82-1.04)	8.24 (7.84-8.64)

Abbreviation: CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; NA, not applicable; UACR, urine albumin-to-creatinine ratio.

kidney function (2.0% vs 2.0%-2.4% in other groups). The same pattern of association persisted even after adjusting for all of the available covariates in a logistic regression analysis (**Table 4**). The odds of impaired kidney function and albuminuria in northern China were 40% and 147%, respectively, of that in southern China. Compared with the group with BMI of 18.5 to 24.9, a BMI of 30 or higher was associated an 18% lower odds of impaired kidney function and a 55% increased odds of albuminuria. After adjusting for potential confounders, rural area was no longer associated with the risk of albuminuria, and personal income was no longer associated with the risk of CKD, impaired kidney function, and albuminuria.

Awareness and Control of CKD and Comorbidities

The weighted awareness of CKD was 10.0%. Prevalence, awareness, and control of comorbidities, including hypertension, diabetes, dyslipidemia, and hyperuricemia in the individuals with CKD are summarized in **Table 5**. In individuals with CKD, the prevalence of hypertension was the highest at 60.5%, followed by dyslipidemia (50.5%), diabetes (31.3%), and hyperuricemia (21.5%). The awareness rate of dyslipidemia was considerably lower than that of hypertension and diabetes.

Discussion

In this study, we report a prevalence of 8.2%, 2.2%, and 6.7% for CKD, impaired kidney function, and albuminuria, respectively, in adults 18 years or older in mainland China. According to the sixth national population census, we estimate that there are 82 million adults with CKD in China. To our knowledge, this study is the sole national survey on the prevalence of CKD in China during the past decade. The survey relied on the well-established 4-tiered disease control system in China and followed the standardized and the validated protocols.[7] All biochemical measurements were performed at 3 central laboratories with stringent quality control procedures. Together with a response rate of 94.9%, this ensures the accuracy and the population representativeness of the prevalence estimates.

A previous national survey of 47 204 participants during 2009 to 2010 reported a CKD prevalence of 10.8% (95% CI, 10.2%-11.3%) in China.[6] Using the same eGFR calculation equation as in the previous study, we estimated the prevalence in 2018 was 7.6% (95% CI, 7.3%-8.0%), which represents a 30% reduction during the past decade. The downward trend may be due to multiple factors such as improvements in education, health care service, and environment protection in China during the past decade. The control rate of hypertension among treated patients with hypertension was 32.2%, which was considerably higher than 27.4% reported in the previous survey.[13] The glycemic control rate of diabetes among the treated patients was 50.3% in the current survey and not reported in the previous survey. National surveys on diabetes found a statistically significant improvement of glycemic control in diabetes during the period of 2010 to 2017,[14,15] while another study found no statistically significant improvement during the period of 2013 to 2018.[16] Air pollution has been shown to be associated with an increased risk of kidney diseases.[17-21] A recent study in China has shown that an increase of 10 ug/m^3 in particulate matter 2.5 um or less in diameter is associated with a 28% higher risk of CKD.[20] According to the Report on the State of the Ecology and Environment in China, the annual average concentration of particulate matter 2.5 um or less in diameter in China has dropped by 50% from 72 ug/m^3 in 2013 to 36 ug/m^3 in 2019,[22] which may have led to a decrease in the incidence of CKD. Meanwhile, we need to point out that the 2 national surveys differ in the laboratory assays that may also contribute to the observed difference in the estimated CKD prevalence between 2 two surveys.[23] The previous survey used the Jaffe kinetic method for creatinine measurement, and the current survey used more robust enzymatic method.

Age is a substantial risk factor for CKD and had a much higher association with impaired kidney function than with albuminuria. Compared with young adults (18-29 years old), age groups of 30 to 39, 40 to 49, 50 to 59, and 60 to 69 years old had similarly elevated risk of albuminuria (odds ratios ranged from 1.2-1.3), whereas the age group of 70 years and older had the highest risk of albuminuria with an odds ratio of 1.86. In comparison, the association of age was much more prominent with the risk of impaired kidney function, which tripled every 10 years (odds ratio, 3.0; 95% CI, 2.8-3.2). The odds of impaired kidney function in those 70 years and older was 329 times of that in the young adults. The prevalence of CKD and impaired kidney function in those 70 years and older was high at 29.0% and 17.4%, respectively. Impaired kidney function in the oldest age group could be due to either normal aging or pathological causes. The current definition for impaired kidney function and CKD does not consider aging.[24] An age-adapted definition for impaired kidney function and CKD may improve the ability to discriminate normal aging and pathological state among elderly patients.[25]

The prevalence of impaired kidney function and albuminuria varied geographically, and these 2 CKD indicators showed

Table 3. Weighted Prevalence of Chronic Kidney Disease (CKD) by Stage and Distribution of Albuminuria Level in Different Strata Among Chinese Adults, 2018-2019

Characteristic	% (95% CI)[a]								
	CKD stage						Albuminuria, UACR		
	Total	Grade 1, ≥A2	Grade 2, ≥A2	Grade 3	Grade 4, per 10 000	Grade 5, per 10 000	Total	A2	A3
Total	8.2 (7.8-8.6)	3.9 (3.7-4.2)	2.1 (2.0-2.3)	2.1 (1.9-2.2)	10.3 (8.5-12.1)	4.3 (3.1-5.5)	6.7 (6.4-7.1)	5.8 (5.5-6.1)	0.9 (0.8-1.0)
Age group, y									
18-29	3.4 (2.8-4.1)	3.2 (2.5-3.8)	0.2 (0.1-0.4)	0.0 (0.0-0.1)	0.3 (0.0-1.0)	NA	3.4 (2.7-4.1)	2.7 (2.2-3.3)	0.7 (0.3-1.0)
30-39	4.9 (4.4-5.4)	4.0 (3.5-4.5)	0.6 (0.5-0.8)	0.2 (0.1-0.3)	4.2 (0.0-8.8)	2.9 (0.1-5.7)	4.8 (4.3-5.4)	4.1 (3.6-4.6)	0.7 (0.5-0.9)
40-49	6.7 (6.2-7.2)	4.9 (4.4-5.3)	1.3 (1.1-1.5)	0.5 (0.4-0.6)	1.7 (0.5-2.9)	5.7 (2.0-9.4)	6.4 (5.9-6.9)	5.7 (5.2-6.2)	0.7 (0.6-0.8)
50-59	9.1 (8.7-9.6)	4.8 (4.5-5.1)	2.7 (2.4-3.0)	1.4 (1.2-1.6)	14.8 (9.6-20.0)	6.3 (3.6-9.1)	8.2 (7.8-8.7)	7.1 (6.7-7.5)	1.1 (1.0-1.2)
60-69	13.3 (12.6-14.0)	4.1 (3.8-4.5)	4.7 (4.4-5.0)	4.2 (3.8-4.7)	20.7 (15.5-25.8)	5.9 (3.3-8.6)	10.1 (9.6-10.6)	8.8 (8.3-9.3)	1.3 (1.1-1.4)
≥70	29.0 (27.7-30.2)	1.5 (1.2-1.7)	10.1 (9.4-10.8)	16.7 (15.6-17.8)	61.8 (46.1-77.5)	11.8 (3.8-19.8)	16.3 (15.4-17.1)	14.0 (13.3-14.8)	2.3 (2.0-2.5)
Gender									
Female	8.8 (8.3-9.3)	4.1 (3.8-4.5)	2.3 (2.1-2.5)	2.2 (2.0-2.4)	9.2 (7.3-11.1)	3.9 (2.1-5.8)	7.2 (6.7-7.6)	6.3 (5.9-6.7)	0.9 (0.8-1.0)
Male	7.7 (7.2-8.1)	3.7 (3.4-4.0)	1.9 (1.7-2.1)	1.9 (1.7-2.1)	11.4 (8.6-14.2)	4.7 (3.0-6.4)	6.3 (5.9-6.7)	5.3 (5.0-5.7)	1.0 (0.8-1.2)
Township									
Urban	7.9 (7.3-8.5)	3.8 (3.4-4.2)	1.9 (1.7-2.1)	2.1 (1.8-2.3)	9.4 (7.0-11.8)	4.8 (2.8-6.8)	6.4 (5.9-6.9)	5.4 (5.0-5.9)	0.9 (0.7-1.1)
Rural	8.6 (8.1-9.1)	4.1 (3.8-4.4)	2.3 (2.1-2.5)	2.1 (1.8-2.3)	11.3 (8.7-13.8)	3.8 (2.2-5.3)	7.1 (6.7-7.6)	6.2 (5.8-6.6)	0.9 (0.8-1.0)
Location in China									
South	6.9 (5.9-7.9)	1.9 (1.5-2.3)	1.6 (1.3-1.9)	3.2 (2.5-3.9)	12.5 (7.9-17.1)	5.3 (1.6-9.1)	4.3 (3.8-4.8)	3.8 (3.4-4.3)	0.5 (0.4-0.7)
East	8.1 (7.2-8.9)	3.8 (3.2-4.4)	2.1 (1.8-2.5)	2.0 (1.7-2.4)	8.1 (4.6-11.5)	5.0 (2.4-7.6)	6.6 (5.8-7.4)	5.7 (5.0-6.4)	0.9 (0.8-1.0)
Central	9.0 (8.1-10.0)	4.1 (3.5-4.7)	2.4 (2.0-2.8)	2.3 (1.9-2.8)	14.2 (7.9-20.5)	4.7 (2.6-6.8)	7.3 (6.5-8.2)	6.3 (5.6-7.1)	1.0 (0.7-1.3)
North	9.1 (8.2-10.0)	5.7 (4.9-6.5)	2.0 (1.8-2.3)	1.2 (1.0-1.4)	11.3 (7.8-14.8)	1.0 (0.3-1.7)	8.2 (7.2-9.1)	7.1 (6.3-7.9)	1.1 (0.9-1.3)
Northeast	8.5 (6.9-10.1)	4.6 (3.3-5.8)	2.0 (1.7-2.4)	1.7 (1.3-2.2)	9.9 (3.7-16.0)	4.2 (0.0-10.6)	7.3 (5.7-8.8)	5.9 (5.0-6.8)	1.4 (0.6-2.2)
Southwest	8.1 (7.3-8.9)	3.3 (3.0-3.7)	2.3 (1.9-2.7)	2.3 (1.8-2.8)	12.2 (8.3-16.2)	5.3 (2.0-8.5)	6.4 (5.8-7.0)	5.6 (5.1-6.1)	0.8 (0.6-1.0)
Northwest	7.9 (7.0-8.9)	4.8 (4.1-5.6)	2.0 (1.6-2.5)	1.0 (0.8-1.2)	2.7 (0.0-5.3)	2.8 (0.0-5.6)	7.2 (6.2-8.1)	6.2 (5.2-7.3)	1.0 (0.7-1.3)
Education									
Primary school or lower	12.9 (12.2-13.5)	4.4 (4.1-4.8)	3.9 (3.6-4.2)	4.2 (3.9-4.6)	20.1 (16.1-24.1)	8.6 (5.5-11.7)	9.7 (9.2-10.2)	8.4 (7.9-8.9)	1.3 (1.1-1.4)
Secondary school	7.1 (6.6-7.6)	4.1 (3.7-4.5)	1.6 (1.4-1.7)	1.3 (1.1-1.5)	7.3 (4.6-10.0)	3.5 (1.4-5.6)	6.2 (5.7-6.7)	5.2 (4.9-5.6)	1.0 (0.7-1.2)
High school	6.2 (5.6-6.8)	3.7 (3.1-4.3)	1.3 (1.1-1.5)	1.1 (0.9-1.3)	6.7 (1.5-11.8)	1.9 (0.2-3.7)	5.4 (4.8-6.0)	4.6 (4.1-5.1)	0.7 (0.5-1.0)
College or above	4.0 (3.5-4.5)	2.8 (2.4-3.3)	0.7 (0.6-0.9)	0.4 (0.3-0.6)	1.9 (0.0-4.0)	0.4 (0.0-0.8)	3.7 (3.2-4.2)	3.3 (2.8-3.7)	0.4 (0.3-0.6)
Ethnicity									
Han	8.2 (7.7-8.6)	3.9 (3.6-4.1)	2.1 (2.0-2.3)	2.1 (1.9-2.2)	9.9 (8.1-11.7)	4.6 (3.2-5.9)	6.7 (6.3-7.1)	5.7 (5.4-6.0)	0.9 (0.8-1.1)
Other[b]	8.9 (8.2-9.5)	4.7 (4.2-5.2)	2.0 (1.6-2.4)	2.0 (1.7-2.3)	14.5 (5.7-23.3)	1.8 (0.0-3.6)	7.4 (6.8-7.9)	6.6 (6.1-7.1)	0.8 (0.6-0.9)
Annual income per capita, ¥									
<6000	9.4 (8.7-10.1)	4.5 (4.0-5.0)	2.4 (2.2-2.7)	2.3 (2.0-2.7)	8.4 (5.8-10.9)	4.8 (1.4-8.2)	7.8 (7.2-8.4)	6.7 (6.2-7.2)	1.0 (0.8-1.3)
6000-11 999	8.2 (7.6-8.8)	4.0 (3.5-4.5)	2.1 (1.9-2.4)	1.9 (1.7-2.1)	11.7 (5.3-18.1)	4.2 (1.9-6.5)	6.8 (6.2-7.4)	6.0 (5.4-6.5)	0.8 (0.7-1.0)
12 000-23 999	7.6 (7.0-8.2)	3.5 (3.1-3.9)	1.8 (1.6-2.1)	2.1 (1.8-2.3)	11.4 (8.3-14.5)	3.2 (0.7-5.8)	6.1 (5.5-6.6)	5.3 (4.8-5.7)	0.8 (0.6-0.9)
≥24 000	7.4 (6.8-8.0)	3.7 (3.2-4.2)	1.8 (1.6-2.0)	1.8 (1.5-2.0)	10.2 (6.9-13.6)	4.1 (1.4-6.7)	6.1 (5.5-6.7)	5.3 (4.7-5.8)	0.8 (0.7-1.0)
Refused/do not know	9.0 (8.4-9.6)	4.0 (3.5-4.6)	2.4 (2.2-2.7)	2.3 (2.1-2.6)	9.7 (6.0-13.4)	5.3 (2.1-8.4)	7.3 (6.7-7.8)	6.1 (5.7-6.5)	1.2 (0.8-1.5)

(continued)

Table 3. Weighted Prevalence of Chronic Kidney Disease (CKD) by Stage and Distribution of Albuminuria Level in Different Strata Among Chinese Adults, 2018-2019 (continued)

Characteristic	% (95% CI)[a] CKD stage Total	Grade 1, ≥A2	Grade 2, ≥A2	Grade 3	Grade 4, per 10 000	Grade 5, per 10 000	Albuminuria, UACR Total	A2	A3
Cigarette smoking									
Never	8.2 (7.8-8.6)	3.9 (3.6-4.3)	2.1 (2.0-2.3)	2.0 (1.8-2.2)	9.8 (7.8-11.8)	3.7 (2.3-5.1)	6.7 (6.3-7.1)	5.8 (5.5-6.2)	0.9 (0.8-1.0)
Former	12.1 (11.0-13.3)	3.5 (3.0-4.1)	3.3 (2.8-3.8)	4.8 (4.1-5.5)	25.1 (13.3-36.8)	23.9 (7.9-39.9)	8.7 (7.8-9.6)	6.9 (6.2-7.7)	1.8 (1.4-2.2)
Current	7.6 (7.0-8.2)	4.0 (3.5-4.4)	1.9 (1.7-2.1)	1.6 (1.5-1.8)	8.8 (5.5-12.1)	2.3 (1.1-3.4)	6.4 (5.8-6.9)	5.5 (5.1-5.9)	0.8 (0.6-1.1)
Alcohol drinking									
Never	9.2 (8.7-9.6)	4.0 (3.7-4.3)	2.4 (2.3-2.6)	2.6 (2.3-2.8)	12.6 (10.2-15.0)	5.7 (3.9-7.5)	7.3 (6.9-7.7)	6.2 (5.9-6.6)	1.1 (1.0-1.2)
Light	6.3 (5.8-6.9)	3.5 (3.0-3.9)	1.5 (1.3-1.6)	1.3 (1.1-1.5)	6.7 (3.3-10.2)	2.5 (0.4-4.6)	5.4 (4.9-5.9)	4.7 (4.3-5.1)	0.7 (0.4-0.9)
Excessive	8.5 (7.8-9.2)	5.1 (4.5-5.7)	2.1 (1.9-2.4)	1.2 (1.0-1.4)	6.2 (2.6-9.8)	0.6 (0.0-1.2)	7.5 (6.8-8.2)	6.7 (6.0-7.4)	0.9 (0.7-1.0)
Fruit/vegetable intake <400 g/d									
No	7.7 (7.3-8.2)	3.9 (3.5-4.2)	1.9 (1.8-2.1)	1.8 (1.6-1.9)	9.9 (7.4-12.4)	3.8 (2.4-5.1)	6.5 (6.0-6.9)	5.5 (5.2-5.9)	0.9 (0.8-1.1)
Yes	8.9 (8.4-9.4)	4.0 (3.7-4.3)	2.3 (2.1-2.5)	2.4 (2.2-2.7)	10.6 (8.0-13.1)	5.2 (2.9-7.5)	7.0 (6.6-7.5)	6.1 (5.7-6.5)	0.9 (0.8-1.1)
Red meat intake ≥100 g/d									
No	9.3 (8.8-9.7)	4.3 (4.0-4.6)	2.5 (2.3-2.6)	2.4 (2.2-2.6)	10.7 (8.3-13.1)	4.4 (2.8-6.0)	7.6 (7.2-8.0)	6.5 (6.1-6.8)	1.1 (0.9-1.3)
Yes	6.8 (6.4-7.3)	3.4 (3.1-3.7)	1.6 (1.4-1.8)	1.7 (1.4-1.9)	9.5 (7.0-12.0)	4.4 (2.3-6.6)	5.5 (5.2-5.9)	4.8 (4.5-5.2)	0.7 (0.6-0.8)
Physical inactivity (<150 min/wk)									
No	7.9 (7.5-8.3)	3.9 (3.5-4.2)	2.0 (1.9-2.2)	1.9 (1.7-2.1)	8.5 (6.8-10.1)	4.3 (2.9-5.7)	6.5 (6.1-6.9)	5.6 (5.3-6.0)	0.9 (0.7-1.0)
Yes	9.4 (8.7-10.1)	4.2 (3.7-4.7)	2.4 (2.2-2.7)	2.6 (2.3-2.9)	16.7 (12.1-21.4)	4.5 (1.6-7.4)	7.5 (6.9-8.2)	6.3 (5.8-6.9)	1.2 (1.0-1.4)
BMI group									
<18.5	5.5 (4.6-6.5)	2.0 (1.3-2.8)	1.5 (1.2-1.9)	1.8 (1.4-2.2)	9.7 (0.0-19.7)	5.1 (1.0-9.2)	4.2 (3.4-5.1)	3.6 (2.8-4.4)	0.6 (0.4-0.9)
18.5-24.9	6.7 (6.3-7.1)	2.8 (2.6-3.1)	1.7 (1.6-1.9)	2.0 (1.8-2.2)	9.4 (7.0-11.8)	5.3 (3.4-7.3)	5.2 (4.8-5.5)	4.5 (4.2-4.8)	0.7 (0.6-0.8)
25.0-29.9	9.6 (9.1-10.2)	4.7 (4.2-5.1)	2.6 (2.4-2.8)	2.2 (2.0-2.4)	11.6 (8.2-15.1)	3.4 (1.5-5.2)	8.1 (7.5-8.6)	7.0 (6.5-7.5)	1.1 (0.9-1.2)
≥30.0	14.5 (13.1-15.9)	9.6 (8.3-10.8)	2.9 (2.5-3.3)	1.9 (1.6-2.2)	11.6 (6.4-16.8)	0.8 (0.0-1.8)	13.3 (11.9-14.7)	11.0 (10.0-12.0)	2.3 (1.3-3.2)
Central obesity									
No	6.2 (5.8-6.6)	2.8 (2.5-3.1)	1.6 (1.5-1.7)	1.7 (1.5-1.9)	8.2 (6.1-10.3)	4.6 (2.9-6.3)	4.9 (4.6-5.3)	4.3 (4.0-4.6)	0.6 (0.5-0.7)
Yes	11.9 (11.2-12.5)	6.0 (5.5-6.5)	3.0 (2.8-3.3)	2.7 (2.4-2.9)	14.1 (10.6-17.7)	3.8 (2.0-5.6)	10.0 (9.4-10.6)	8.5 (8.0-9.0)	1.5 (1.2-1.7)
Hypertension									
No hypertension	4.5 (4.2-4.8)	2.7 (2.4-2.9)	0.9 (0.8-0.9)	0.9 (0.8-1.0)	3.2 (1.9-4.4)	0.8 (0.4-1.2)	3.7 (3.4-4.0)	3.3 (3.0-3.6)	0.4 (0.3-0.5)
Newly detected	14.3 (13.5-15.1)	7.2 (6.6-7.8)	3.8 (3.5-4.2)	3.0 (2.7-3.3)	17.7 (11.7-23.7)	6.5 (2.8-10.3)	12.2 (11.5-12.9)	10.6 (9.9-11.2)	1.6 (1.4-1.8)
Previously diagnosed	23.5 (22.3-24.6)	7.1 (6.3-7.9)	7.7 (7.1-8.3)	8.0 (7.3-8.6)	45.7 (35.6-55.8)	24.0 (14.3-33.6)	18.0 (17.0-19.0)	14.8 (14.0-15.6)	3.2 (2.6-3.9)
Diabetes									
No diabetes	4.8 (4.4-5.2)	2.6 (2.3-2.9)	1.0 (0.9-1.1)	1.1 (0.9-1.2)	4.9 (3.0-6.8)	2.1 (0.6-3.5)	4.0 (3.6-4.3)	3.4 (3.1-3.7)	0.5 (0.4-0.7)
Prediabetes	8.4 (7.9-8.9)	3.6 (3.3-4.0)	2.3 (2.1-2.5)	2.3 (2.1-2.6)	8.8 (6.5-11.1)	3.7 (2.2-5.3)	6.6 (6.1-7.0)	5.7 (5.4-6.1)	0.8 (0.6-1.0)
Newly detected	17.9 (16.5-19.2)	9.4 (8.3-10.5)	4.4 (3.8-4.9)	3.8 (3.3-4.3)	25.1 (13.3-36.9)	2.4 (1.0-3.8)	15.3 (14.0-16.6)	13.4 (12.2-14.6)	1.9 (1.6-2.2)
Previously diagnosed	25.4 (23.6-27.3)	10.3 (9.4-11.3)	7.8 (7.0-8.6)	6.5 (5.7-7.3)	58.0 (40.5-75.5)	22.8 (13.1-32.5)	21.6 (20.1-23.1)	17.2 (15.9-18.5)	4.4 (3.8-5.0)

(continued)

Table 3. Weighted Prevalence of Chronic Kidney Disease (CKD) by Stage and Distribution of Albuminuria Level in Different Strata Among Chinese Adults, 2018-2019 (continued)

Characteristic	% (95% CI)[a]								
	CKD stage						Albuminuria, UACR		
	Total	Grade 1, ≥A2	Grade 2, ≥A2	Grade 3	Grade 4, per 10 000	Grade 5, per 10 000	Total	A2	A3
Diagnosed kidney diseases									
No	7.8 (7.4-8.2)	3.8 (3.6-4.1)	2.0 (1.8-2.1)	1.9 (1.7-2.0)	7.2 (5.7-8.6)	1.1 (0.7-1.6)	6.3 (6.0-6.7)	5.5 (5.2-5.8)	0.8 (0.7-0.9)
Yes	18.7 (17.2-20.3)	6.0 (5.0-7.0)	4.9 (4.3-5.5)	6.3 (5.5-7.1)	78.4 (52.8-104.0)	73.8 (47.3-100.3)	15.1 (13.8-16.4)	11.6 (10.4-12.8)	3.5 (3.0-4.0)
Diagnosed cardiovascular disease									
No	7.8 (7.4-8.2)	3.9 (3.6-4.1)	2.0 (1.8-2.1)	1.9 (1.7-2.0)	8.8 (7.1-10.5)	4.2 (2.9-5.4)	6.4 (6.1-6.7)	5.6 (5.3-5.9)	0.8 (0.7-0.9)
Yes	20.6 (18.5-22.6)	5.9 (4.1-7.6)	6.5 (5.8-7.2)	7.6 (6.6-8.5)	51.9 (30.8-73.0)	8.8 (3.0-14.6)	15.6 (13.7-17.6)	11.9 (10.9-12.9)	3.7 (2.0-5.5)
Elevated blood pressure[c]									
No	5.0 (4.7-5.4)	2.7 (2.5-3.0)	1.0 (0.9-1.1)	1.2 (1.1-1.4)	4.7 (3.4-6.1)	1.0 (0.6-1.5)	4.0 (3.7-4.3)	3.6 (3.3-3.8)	0.5 (0.4-0.5)
Yes	18.0 (17.2-18.8)	7.5 (7.0-8.1)	5.4 (5.1-5.8)	4.6 (4.2-4.9)	27.5 (21.8-33.1)	14.3 (9.4-19.2)	14.9 (14.2-15.7)	12.6 (12.0-13.2)	2.4 (2.0-2.7)
Fasting glucose, mg/dL									
<100	5.9 (5.5-6.3)	2.9 (2.6-3.2)	1.4 (1.2-1.5)	1.5 (1.3-1.7)	7.8 (5.9-9.6)	4.6 (2.9-6.4)	4.7 (4.4-5.1)	4.1 (3.8-4.4)	0.6 (0.5-0.7)
100-124	9.1 (8.5-9.7)	3.9 (3.5-4.3)	2.5 (2.3-2.7)	2.5 (2.2-2.7)	9.6 (7.1-12.2)	3.7 (2.0-5.4)	7.2 (6.7-7.7)	6.3 (5.8-6.7)	0.9 (0.7-1.2)
≥125	22.0 (20.7-23.4)	11.5 (10.5-12.4)	5.9 (5.3-6.5)	4.3 (3.8-4.8)	32.1 (18.6-45.5)	4.4 (1.2-7.5)	19.5 (18.2-20.8)	16.2 (15.1-17.4)	3.3 (2.9-3.7)
Glycated hemoglobin A_{1c}, %									
<5.7	6.2 (5.8-6.5)	3.1 (2.8-3.3)	1.5 (1.4-1.6)	1.5 (1.4-1.6)	6.7 (5.2-8.2)	4.0 (2.6-5.4)	5.0 (4.7-5.3)	4.3 (4.0-4.6)	0.7 (0.6-0.8)
5.7-6.4	13.6 (12.7-14.5)	5.0 (4.5-5.5)	4.1 (3.6-4.5)	4.3 (3.8-4.8)	16.8 (10.6-23.0)	5.0 (2.5-7.6)	10.4 (9.7-11.1)	9.2 (8.5-9.9)	1.2 (1.0-1.4)
≥6.5	26.1 (24.3-27.8)	14.0 (12.6-15.4)	6.7 (6.0-7.4)	4.8 (4.2-5.5)	48.3 (30.0-66.7)	7.8 (1.9-13.7)	23.2 (21.6-24.9)	19.3 (17.8-20.9)	3.9 (3.4-4.4)
2-h OGTT, mg/dL									
<140	5.8 (5.4-6.1)	2.9 (2.6-3.1)	1.4 (1.3-1.5)	1.4 (1.3-1.5)	6.6 (5.0-8.1)	2.7 (1.5-4.0)	4.7 (4.3-5.0)	4.1 (3.8-4.4)	0.6 (0.5-0.7)
140-199	11.5 (10.6-12.3)	4.8 (4.1-5.5)	3.2 (2.9-3.5)	3.4 (3.0-3.7)	8.7 (5.4-11.9)	3.3 (1.6-5.1)	9.0 (8.2-9.8)	7.8 (7.2-8.3)	1.2 (0.7-1.8)
≥200	19.9 (18.1-21.8)	11.2 (9.6-12.8)	4.5 (3.9-5.2)	4.1 (3.5-4.6)	14.1 (8.7-19.5)	3.7 (1.5-5.9)	17.3 (15.5-19.1)	15.7 (14.0-17.5)	1.6 (1.3-1.8)
Dyslipidemia									
No	6.6 (6.2-7.0)	3.1 (2.8-3.4)	1.7 (1.5-1.9)	1.7 (1.5-1.8)	6.3 (4.9-7.7)	3.9 (2.3-5.4)	5.4 (5.0-5.7)	4.7 (4.4-5.0)	0.6 (0.5-0.8)
Yes	10.9 (10.3-11.4)	5.2 (4.8-5.6)	2.8 (2.6-3.0)	2.7 (2.4-2.9)	16.6 (12.7-20.4)	5.0 (3.0-7.0)	8.9 (8.4-9.4)	7.5 (7.1-7.9)	1.4 (1.1-1.6)
Hyperuricemia (>420 μmol/L)									
No	7.5 (7.1-7.9)	3.9 (3.6-4.2)	2.0 (1.9-2.2)	1.5 (1.4-1.7)	4.2 (3.3-5.1)	3.0 (1.7-4.3)	6.4 (6.0-6.8)	5.6 (5.3-5.9)	0.8 (0.7-0.9)
Yes	12.6 (11.7-13.4)	4.0 (3.4-4.6)	2.7 (2.4-3.0)	5.3 (4.8-5.8)	47.3 (36.8-57.9)	12.1 (7.6-16.6)	8.8 (8.1-9.4)	6.9 (6.3-7.5)	1.8 (1.5-2.1)

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); NA, not applicable; OGTT, oral glucose tolerance test; UACR, urine albumin-to-creatinine ratio.

SI conversion factor: To convert glucose to mmol/L, multiply by 0.0555.

[a] Estimated glomerular filtration rates of 90 or higher, 60 to 89, 30 to 59, 15 to 29, and less than 15 mL/min/1.73m^2 were classified as grades 1 through 5, respectively. Albuminuria levels of less than 30, 30 to 299, and 300 or higher mg/g were classified as categories A1 through A3, respectively.

[b] Other includes all ethnic minorities in mainland China.

[c] Systolic blood pressure 140 mm Hg and higher or diastolic blood pressure 90 mm Hg and higher.

Table 4. Logistic Regression Analyses on Chronic Kidney Disease (CKD), Impaired Kidney Function, and Albuminuria[a]

	CKD		eGFR <60 mL/min/1.73 m^2		Albuminuria	
Characteristic	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age group, y						
18-29	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
30-39	1.31 (1.06-1.62)	.01	5.41 (1.75-16.74)	.004	1.27 (1.02-1.57)	.03
40-49	1.49 (1.19-1.87)	<.001	10.84 (3.78-31.12)	<.001	1.32 (1.05-1.66)	.02
50-59	1.53 (1.21-1.94)	<.001	31.55 (10.68-93.21)	<.001	1.20 (0.94-1.51)	.14
60-69	1.96 (1.56-2.47)	<.001	81.24 (27.40-240.83)	<.001	1.21 (0.96-1.53)	.10
≥70	4.75 (3.78-5.97)	<.001	329.00 (110.92-975.87)	<.001	1.86 (1.47-2.35)	<.001
Gender						
Female	1.40 (1.28-1.52)	<.001	1.43 (1.27-1.62)	<.001	1.34 (1.22-1.47)	<.001
Male	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Township						
Urban	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Rural	0.93 (0.86-1.01)	.09	0.75 (0.67-0.85)	<.001	0.98 (0.90-1.08)	.71
Location in China						
South	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Central	1.27 (1.07-1.52)	.007	0.82 (0.62-1.08)	.16	1.56 (1.32-1.85)	<.001
East	1.07 (0.90-1.28)	.44	0.58 (0.44-0.75)	<.001	1.39 (1.19-1.63)	<.001
North	1.10 (0.92-1.32)	.30	0.40 (0.31-0.52)	<.001	1.47 (1.24-1.74)	<.001
Northeast	1.05 (0.82-1.36)	.69	0.54 (0.43-0.69)	<.001	1.36 (1.05-1.76)	.02
Northwest	1.22 (0.99-1.51)	.06	0.37 (0.28-0.49)	<.001	1.66 (1.37-2.02)	<.001
Southwest	1.10 (0.94-1.28)	.23	0.75 (0.58-0.96)	.02	1.36 (1.19-1.57)	<.001
Education						
Primary school or lower	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Secondary school	0.89 (0.83-0.96)	.002	0.91 (0.80-1.03)	.14	0.90 (0.83-0.97)	.006
High school	0.82 (0.73-0.92)	.001	0.89 (0.76-1.05)	.17	0.82 (0.72-0.94)	.004
College or above	0.70 (0.60-0.82)	<.001	0.74 (0.54-1.00)	.05	0.72 (0.62-0.84)	<.001
Ethnicity						
Han	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Other[b]	1.30 (1.17-1.44)	<.001	1.24 (1.07-1.45)	.006	1.27 (1.14-1.43)	<.001
Annual income per capita, ¥						
<6000	0.98 (0.89-1.09)	.74	0.92 (0.80-1.07)	.30	1.03 (0.92-1.15)	.64
6000-11 999	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
12 000-23 999	0.96 (0.87-1.06)	.39	1.11 (0.96-1.29)	.16	0.92 (0.83-1.03)	.14
≥24 000	0.98 (0.89-1.08)	.70	1.03 (0.89-1.18)	.73	0.98 (0.88-1.10)	.79
Refused/do not know	1.11 (1.01-1.22)	.04	1.09 (0.95-1.26)	.22	1.12 (1.00-1.24)	.047
Cigarette smoking						
Never	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Former	1.05 (0.92-1.19)	.45	1.13 (0.94-1.36)	.18	1.02 (0.90-1.17)	.73
Current	1.15 (1.04-1.26)	.004	1.10 (0.97-1.24)	.13	1.12 (1.02-1.24)	.03
Alcohol drinking						
Never	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Light	0.87 (0.80-0.95)	.03	0.78 (0.69-0.88)	<.001	0.90 (0.82-0.99)	.04
Excessive	0.82 (0.73-0.92)	.001	0.38 (0.33-0.45)	<.001	0.92 (0.81-1.05)	.21
Fruit/vegetable intake <400 g/d						
No	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Yes	1.04 (0.96-1.11)	.35	1.08 (1.00-1.18)	.06	1.01 (0.93-1.10)	.73
Red meat intake ≥100 g/d						
No	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Yes	0.95 (0.88-1.03)	.21	1.01 (0.89-1.14)	.92	0.94 (0.87-1.01)	.10
Physical inactivity (<150 min/wk)						
No	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Yes	1.16 (1.06-1.27)	.001	1.26 (1.16-1.38)	<.001	1.14 (1.03-1.26)	.01

(continued)

Table 4. Logistic Regression Analyses on Chronic Kidney Disease (CKD), Impaired Kidney Function, and Albuminuria[a] (continued)

Characteristic	CKD		eGFR <60 mL/min/1.73 m^2		Albuminuria	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value
BMI group						
<18.5	1.14 (0.95-1.38)	.15	1.21 (0.97-1.51)	.10	1.18 (0.94-1.48)	.14
18.5-24.9	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
25.0-29.9	1.02 (0.94-1.12)	.59	0.87 (0.77-0.98)	.02	1.06 (0.97-1.16)	.21
≥30.0	1.46 (1.29-1.66)	<.001	0.82 (0.67-0.99)	.04	1.55 (1.37-1.77)	<.001
Central obesity						
No	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Yes	1.14 (1.05-1.23)	.001	1.03 (0.93-1.13)	.62	1.15 (1.06-1.25)	.001
Hypertension						
No hypertension	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
New detection	2.28 (2.11-2.47)	<.001	1.33 (1.18-1.49)	<.001	2.60 (2.38-2.85)	<.001
Previously diagnosed	2.87 (2.65-3.12)	<.001	2.06 (1.87-2.28)	<.001	3.11 (2.83-3.43)	<.001
Diabetes						
No diabetes	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Prediabetes	1.17 (1.08-1.26)	<.001	0.87 (0.79-0.96)	.007	1.21 (1.11-1.33)	<.001
New detection	2.07 (1.84-2.32)	<.001	0.95 (0.81-1.11)	.50	2.38 (2.11-2.69)	<.001
Previously diagnosed	2.68 (2.41-2.97)	<.001	1.26 (1.09-1.46)	.02	3.16 (2.83-3.52)	<.001
Diagnosed cardiovascular disease						
No	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Yes	1.07 (0.93-1.23)	.37	1.11 (0.98-1.26)	.09	1.11 (0.95-1.31)	.18
Dyslipidemia						
No	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Yes	1.17 (1.10-1.24)	<.001	1.16 (1.05-1.28)	.003	1.14 (1.07-1.22)	<.001
Hyperuricemia (>420 μmol/L)						
No	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Yes	1.96 (1.77-2.18)	<.001	6.34 (5.54-7.24)	<.001	1.42 (1.27-1.59)	<.001

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); eGFR, estimated glomerular filtration rate; OR, odds ratio.

[a] For each of the traits analyzed, the ORs were estimated from a single logistic model that included all the variables in the Table as covariates.

[b] Other includes all ethnic minorities in mainland China.

different patterns of geographic variation. Moving from north to south, the prevalence of impaired kidney function increased, while the reverse was true for albuminuria. Among the 7 regions of China, southern China had the highest prevalence of impaired kidney function but the lowest prevalence of albuminuria. These geographic differences persisted even after adjusting for all of the available covariates in the regression analysis. The mechanisms for these geographic variations were not fully understood. Southerners are generally smaller in body size compared with northerners. In 2018 to 2019, the average body weight and body surface area were 60.3 kg and 1.63 m^2, respectively, in southerners, compared with 68.1 kg and 1.73 m^2, respectively, in northerners. The eGFR value calculated from the CKD-EPI formula and used for defining CKD was adjusted by the ideal body surface area, which may have led to an underestimation of the real eGFR and an overestimation of the prevalence of impaired kidney function in southerners. On the other hand, air pollution has been shown to be associated with a higher risk of albuminuria.[18,19] South is the least air-polluted region of China, which may partly explain the observed low prevalence of albuminuria in this region.

In the regression analyses, commonly known risk factors, including hypertension, diabetes, dyslipidemia, hyperuricemia, and physical inactivity, were associated with a higher risk of CKD, impaired kidney function, and albuminuria. Compared with the previous national survey, the prevalence of diabetes increased considerably (17.6% vs 7.4%). The prevalence of CKD associated with diabetes increased proportionally (2.6% vs 1.2%) despite the observed decreasing trend of the overall prevalence of CKD.[26] Compared with the nondiabetic group, the prediabetic group was associated with a 13% lower risk of impaired kidney function, probably due to glomerular hyperfiltration at the early stage of diabetes. Obesity, defined as a BMI of 30 or higher, was associated with an increased risk of CKD and albuminuria. However, overweight (BMI ≥25) and obesity were associated with a 13% and 18% lower risk of impaired kidney function, respectively. It has been shown in individuals with obesity that the CKD-EPI equation considerably overestimates the measured GFR adjusted by body surface area,[27] which may lead to underestimating the prevalence of impaired kidney function.

Cigarette smoking has been established as an independent risk factor for CKD in the general adult population.[28,29] Consistently, compared with never smoking in the present study, current smoking was associated with a 15% higher risk of CKD. The risk of CKD in the former smokers was attenuated and not

Table 5. Weighted Prevalence, Awareness, Treatment, and Control of Comorbidities Among Those With CKD, Without CKD, and Total Population, 2018-2019

	% (95% CI)											
	With CKD				Without CKD				Total population			
Comorbidity	Prevalence	Awareness	Treatment	Control in treated patients	Prevalence	Awareness	Treatment	Control in treated patients	Prevalence	Awareness	Treatment	Control in treated patients
Hypertension	60.5 (58.8-62.3)	52.9 (51.3-54.6)	46.3 (44.6-47.9)	24.5 (22.3-26.7)	24.6 (23.8-25.5)	37.9 (36.5-39.3)	31.9 (30.6-33.2)	34.7 (33.1-36.3)	27.6 (26.7-28.4)	40.7 (39.3-42.0)	34.5 (33.3-35.7)	32.2 (30.7-33.8)
Diabetes	31.3 (29.8-32.8)	45.1 (42.7-47.6)	43.6 (41.0-46.2)	42.3 (39.4-45.1)	10.7 (10.2-11.3)	34.4 (32.4-36.4)	31.5 (29.5-33.6)	53.3 (50.2-56.3)	12.4 (11.9-13.0)	36.6 (34.8-38.4)	34.1 (32.2-35.9)	50.3 (47.8-52.8)
Dyslipidemia	50.5 (48.7-52.3)	24.9 (22.8-27.0)	15.5 (13.8-17.3)	31.5 (27.2-35.8)	37.3 (36.2-38.3)	16.6 (15.6-17.6)	9.5 (8.9-10.2)	39.6 (36.9-42.3)	38.4 (37.3-39.4)	17.5 (16.5-18.5)	10.2 (9.5-10.8)	38.2 (35.9-40.6)
Hyperuricemia[a]	21.5 (19.9-23.1)	NA	NA	NA	13.4 (12.6-14.3)	NA	NA	NA	14.1 (13.3-15.0)	NA	NA	NA

Abbreviations: CKD, chronic kidney disease; NA, not applicable.

[a] Awareness, treatment, and control of hyperuricemia were not estimated because self-reported physician-diagnosed hyperuricemia was not ascertained.

statistically significantly different from that in the never smokers, suggesting smoking cessation may reduce or even reverse the adverse kidney outcome associated with smoking. Although alcohol drinking has been shown to be a considerable risk factor for many adverse health outcomes such as mental, liver, and cardiovascular diseases, moderate and excessive drinking were associated with a 13% and 18% reduced risk of CKD, respectively, compared with no consumption in this study. The association with impaired kidney function was substantially stronger than that with albuminuria. A recent systematic review including 14 studies and 211 072 participants also reported a similar inverse association between alcohol drinking and the risk of CKD.[28] The mechanisms underlying this association are unclear.

The awareness of CKD was very low at 10.0%. Presence of risk factors such as hypertension, diabetes, and dyslipidemia in patients with CKD were very common, with prevalence ranging from 60% for hypertension to 31% for diabetes. Moreover, the control rates for hypertension, diabetes, and dyslipidemia were low at 24.5%, 42.3%, and 31.5%, respectively, among the treated patients with CKD. Raising public awareness and the control rate of CKD and its comorbidities is pivotal for reducing the prevalence and disease burden of CKD.

Limitations

This study has limitations. First, we classified CKD status based on a single data time point of serum eGFR and urine albumin level, which may lead to overestimation of the prevalence of CKD.[30] Ideally, confirming the chronicity of the abnormalities by repeated measurements over 3 months would provide a more accurate estimate of the prevalence. Second, we only examined the prevalence of CKD in adults because children were not sampled in the surveillance. Third, we defined CKD by eGFR and albuminuria only. Lack of data on kidney damage markers other than albuminuria may result in underestimation of CKD prevalence. Fourth, the current study did not collected information on kidney replacement therapy, which may result in underestimation of the prevalence of grade 5 CKD. The prevalence of dialysis in China was reported at 419 per million population, or 0.04%.[31] Thus, it would have negligible effect on the estimate of the overall prevalence of CKD. Fifth, the regression analyses result may be subject to confounding by unknow factors. Last, like any cross-sectional studies, we were not able to make causal inferences on the relationship between CKD and the associated factors.

Conclusions

In this cross-sectional study, the prevalence of CKD in Chinese adults was 8.2%. The prevalence appears to have decreased by 30% in the past decade, presumably to some extent due to improved control of risk factors and air qualities in the past decade. However, the awareness and the control rate of CKD and its comorbidities remained unsatisfactorily low. Better environmental protection, integration of CKD into the national public health surveillance program, and control of common CKD comorbidities appear to be associated with reducing the disease burden of CKD.

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