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BRIEF REPORT

Prevalence of Cardiovascular-Kidney-Metabolic Syndrome Stages Among Middle-Aged and Older Adults in China

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The cardiovascular-kidney-metabolic (CKM) syndrome has been introduced as a novel staging construct,[1] and it reflects systemic disorders characterized by inter-relations among metabolic risk factors, chronic kidney disease (CKD), and the cardiovascular system.[1] Poor CKM health affects nearly all organ systems, and notably increases the risk of cardiovascular diseases (CVDs).[1] The CKM staging construct aims to promote multidisciplinary approaches of prevention, risk stratification, and management of these chronic conditions. Recent studies have reported the widespread CKM syndrome in U.S adults, with prevalence increasing with age and varying among different sex and race/ethnicity groups.[2,3] The prevalence could guide health care design and inform public policy. However, the prevalence of CKM syndrome in China remains unknown. Hence, this study seeks to assess the prevalence of CKM syndrome stages using data from the CHARLS (China Health and Retirement Longitudinal Study).

Data for this study was obtained from the nationally representative CHARLS, which covered 150 counties in 28 provinces across China. All participants gave informed consent; the protocol was approved by the Ethical Review Committee at the Peking University. This study enrolled a total of 14,256 participants aged 45 to 85 years who underwent routine clinical tests at the 2011 and 2015 waves. Demographic information (age, sex, alcohol use, smoking status, education) and chronic disease history (cancer, stroke, heart diseases, diabetes, hypertension, and kidney diseases) were collected via questionnaires.

In this cohort, body mass index (BMI), waist circumstance, and systolic and diastolic blood pressure (BP) were measured. Fasting blood samples were collected for laboratory tests, including total cholesterol, high- and low-density lipoprotein cholesterol, triglyceride, plasma glucose, glycosylated hemoglobin, and creatinine.

According to the guideline, 5 stages of CKM syndrome were assessed: stage 0 (no CKM risk factors), stage 1 (excess and/or dysfunctional adiposity), stage 2 (metabolic risk factors and CKD), stage 3 (subclinical CVD), and stage 4 (clinical CVD).[1] CKM Stage 0 included participants with normal BMI (<23 kg/m^2) and normal WC (<80 cm for women or <90 cm for men). Participants meeting criteria of the elevated stages were diagnosed as higher stages. CKM Stage 1 identified individuals with elevated BMI (≥23 kg/m^2), elevated waist circumstance (≥80 cm for women or ≥90 cm for men), or prediabetes. Prediabetes was diagnosed through fasting blood glucose (100 to <126 mg/dL) or glycated hemoglobin (5.7% to <6.5%). CKM Stage 2 identified participants with metabolic risk factors, moderate-to-high-risk CKD (estimated glomerular filtration rate [eGFR] 45 to <60 mL/min/1.73 m^2), or both. eGFR was calculated using the race-free CKD-EPI 2021 creatinine equation. Metabolic risk factors included elevated fasting serum triglycerides (≥135 mg/dL), hypertension,

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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TABLE 1 Prevalence of CKM Syndrome Stages Among Middle-Aged and Older Adults in China

		CKM Syndrome Stages, Prevalence				
	Sample	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
Population (weighted)	404,284,592	40,158,432	87,186,397	169,951,898	48,736,860	58,251,005
Unweighted	14,256	1,459	3,173	5,906	1,677	2,041
Percentage (%)		9.9 (9.3-10.6)	21.6 (20.7-22.5)	42.0 (40.9-43.1)	12.1 (11.4-12.8)	14.4 (13.6-15.2)
Age group, y						
45-64	10,638 (74.6)	10.9 (10.1-11.7)	24.2 (23.1-25.3)	46.8 (45.5-48.1)	6.0 (5.4-6.7)	12.1 (11.3-12.9)
65-85	3,618 (25.4)	7.3 (6.5-8.2)	14.2 (12.9-15.5)	28.4 (26.5-30.4)	29.1 (27.3-31.0)	21.0 (19.1-23.0)
Sex						
Male	6,799 (47.7)	13.0 (11.9-14.1)	19.0 (17.8-20.3)	40.4 (38.8-42.1)	14.7 (13.8-15.8)	12.8 (11.8-13.9)
Female	7,457 (52.3)	7.2 (6.5-7.8)	23.9 (22.7-25.1)	43.5 (42.1-45.0)	9.6 (8.7-10.6)	15.8 (14.7-17.1)

Values are n, n (%), or % (95% CI).
CKM = cardiovascular-kidney-metabolic syndrome.

diabetes, or metabolic syndrome. The metabolic syndrome was identified by the presence of 3 or more of the following conditions: elevated waist circumstance, low high-density lipoprotein cholesterol levels (<40 mg/dL for men or <50 mg/dL for women), elevated triglyceride levels (≥150 mg/dL), high BP (systolic BP ≥130 mm Hg or diastolic BP ≥80 mm Hg), or prediabetes.[3] CKM Stage 3 was identified based on the presence of very-high-risk CKD stages (eGFR 15 to <45 mL/min/1.73 m^2), or a self-reported CKD, or a high-predicted 10-year CVD risk (≥20%). The 10-year cardiovascular risk was estimated with the American Heart Association Predicting Risk of CVD Events (PREVENT) equations.[4] CKM Stage 4 was identified based on self-reported established CVD (coronary heart disease, angina, heart attack, heart failure, and stroke) among individuals with excess/dysfunctional adiposity, other metabolic risk factors, or CKD. Cross-sectional sample weights were used to account for nonresponse, and the demographics of the CHARLS sample closely resembled those of the overall population. Stratification analysis was conducted considering age and sex groups. All analyses were conducted using R statistical software version 4.2.1 (R Foundation for Statistical Computing).

A total of 14,256 participants aged 45 to 85 years were included from CHARLS (Table 1). Among them, the mean age was 58.7 ± 9.1 years; 7,457 (52.3%) women; 6,799 (47.7%), men; 10,638 (74.6%) aged 45 to 64 years; and 3,618 (25.4%) aged 65 to 85 years. The overall prevalence of CKM syndrome from stages 0 to 4 were 9.9% (95% CI: 9.3%-10.6%), 21.6% (95% CI: 20.7%-22.5%), 42.0% (95% CI: 40.9%-43.1%), 12.1% (95% CI: 11.4%-12.8%), and 14.4% (95% CI: 13.6%-15.2%), respectively. Among individuals aged 45 to 64 years, 10.9% (95% CI: 10.1%-11.7%), 24.2% (95% CI: 23.1%-25.3%), 46.8% (95% CI: 45.5%-48.1%), 6.0% (95% CI: 5.4%-6.7%), and 12.1% (95% CI: 11.3%-12.9%) individuals were categorized into CKM syndrome from stages 0 to 4, respectively. Among individuals aged 65 to 85 years, the prevalence of CKM syndrome from stages 0 to 4 were 7.3% (95% CI: 6.5%-8.2%), 14.2% (95% CI: 12.9%-15.5%), 28.4% (95% CI: 26.5%-30.4%), 29.1% (95% CI: 27.3%-31.0%), and 21.0% (95% CI: 19.1%-23.0%), respectively. In men, the prevalence of CKM syndrome from stages 0 to 4 were 13.0% (95% CI: 11.9%-14.1%), 19.0% (95% CI: 17.8%-20.3%), 40.4% (95% CI: 38.8%-42.1%), 14.7% (95% CI: 13.8%-15.8%), and 12.8% (95% CI: 11.8%-13.9%), respectively. In women, the prevalence of CKM syndrome from stages 0 to 4 were 7.2% (95% CI: 6.5%-7.8%), 23.9% (95% CI: 22.7%-25.1%), 43.5% (95% CI: 42.1%-45.0%), 9.6% (95% CI: 8.7%-10.6%), and 15.8% (95% CI: 14.7%-17.1%), respectively.

This study examined the prevalence of CKM syndrome across stages 0 to 4 in the CHARLS, revealing that approximately 90% of middle-aged and older adults in China were affected. Especially, the prevalence of early (stage 1-2) and advanced (stage 3-4) CKM syndrome reached 63.6% and 26.5%, respectively, highlighting its severe burden in China.

CKM syndrome presented as a newly introduced construct,[1] and its prevalence was examined using data from the U.S National Health and Nutrition Examination Survey.[2] The prevalence of advanced CKM syndrome ranged from about 10% among individuals aged 45 to 64 years to over 50% among those aged 65 years or older.[2] Similarly, our study observed a prevalence of advanced CKM syndrome of 18.1% among individuals aged 45 to 64 years, rising to 50.1% among those aged 65 to 85 years in the CHARLS. This suggested a similar rise in advanced CKM syndrome prevalence in China and the United States, emphasizing the necessity for enhanced attention, including

real-time screening, risk evaluation, and comprehensive care strategies.

The CKM staging construct integrated the progressive pathophysiology of CKM syndrome, highlighting the importance of early detection of CKM-related changes to support preventive efforts. Our study found that the prevalence of early CKM syndrome (stage 1-2) ranged from 42.6% to 71.0% in middle age and older adults. To delay and avert CKM syndrome progression, it underscored the pressing need for preventive action targeting metabolic risk factors, such as lifestyle modifications and pharmacological intervention.[5]

Limitations in this study should be noted. First, the risks and prevalence of CVDs were determined by prediction equations and self-reports, respectively, which may lead to underestimation of stages 3 and 4. Second, our study focused on middle-aged and older adults, warranting further investigation involving younger individuals in China. Third, the urinary albumin creatinine ratio was not obtained, and the diagnosis of CKD was merely based on serum creatinine in this study. So, the diagnosis of CKD may be underestimated. Last, our study relied on data from a single cohort to assess the prevalence of CKM syndrome. Compared to the large population in China, it may introduce certain differences in the assessment of prevalence.

In conclusion, our study revealed the widespread prevalence of CKM syndrome stages among middle-aged and older adults in China. Our findings emphasized the urgent need for public health interventions to early diagnoses and prevent CKM syndrome.

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