

Preplanned Studies

Macroelements Intake in Chinese Adults — 10 PLADs, China, 2022–2023

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Summary

What is already known about this topic?

The Chinese Nutrition and Health Surveillance in 2015–2017 reported that among adults aged 18–59 years, the average daily intake was 328.3 mg of calcium, 251.8 mg of magnesium, 5,681.4 mg of sodium, and 1,474.1 mg of potassium. For adults aged 60 years and above, the corresponding intakes were 333.2 mg, 242.5 mg, 5,412.1 mg, and 1,392.6 mg per day, respectively.

What is added by this report?

Based on the China Development and Nutrition Health Impact Cohort Survey (2022–2023) across 10 provincial-level administrative divisions (PLADs), the median daily intakes among Chinese adults were calcium (288.3 mg), magnesium (228.9 mg), sodium (4,182.4 mg), and potassium (1,397.6 mg), with a median Na/K ratio of 3.0. The study revealed that 96.1% of adults had calcium intake below the estimated average requirement (EAR), 64.4% had magnesium intake below the EAR, 81.9% had potassium intake below the adequate intake (AI), and 89.4% had sodium intake above the PI-NCD. Urban residents demonstrated generally better macroelement intake patterns compared to rural residents.

What are the implications for public health practice?

There is an urgent need for effective policies and interventions to enhance diet quality through increased consumption of dairy products, fruits, and vegetables, thereby improving calcium, magnesium, and potassium intake while reducing sodium intake and the sodium-to-potassium ratio among Chinese adults. Priority should be given to improving the nutritional status of rural residents and reducing urban-rural disparities.

Calcium, magnesium, sodium, and potassium are essential macroelements for human health. While China has implemented comprehensive policies to enhance nutritional and health status, understanding

current macroelement intake patterns among Chinese adults remains crucial. This study analyzed adults participating in the China Development and Nutrition Health Impact Cohort Survey (2022–2023), which continues the China Health and Nutrition Survey (CHNS). Using consecutive 3-day 24-hour dietary recall combined with household weighing methods, we calculated intake levels of calcium, magnesium, sodium, and potassium. Results revealed median daily intakes of 288.3, 228.9, 4,182.4, and 1,397.6 mg/d for these macroelements, respectively, with a median Na/K ratio of 3.0. Analysis showed that 96.1% of adults had calcium intake below the estimated average requirement (EAR), 64.4% had magnesium intake below the EAR, 81.9% had potassium intake below the adequate intake (AI), and 89.4% exceeded the Prevention of non-communicable diseases intake level (PI-NCD) for sodium. Urban areas consistently demonstrated better macroelement intake patterns compared to rural areas. These findings indicate the need for a comprehensive approach encompassing enhanced nutrition education, promotion of healthy eating habits, strengthened food supply chains, and improved access to nutritious foods to elevate overall nutrition status and reduce urban-rural disparities.

This study utilizes data from the China Development and Nutrition Health Impact Cohort Survey (2022–2023), which builds upon the CHNS, an ongoing large-scale, longitudinal cohort study initiated in 1989 (*1*). The study population comprises Chinese adults from 10 provincial-level administrative divisions (PLADs, including Heilongjiang, Liaoning, Jiangsu, Shandong, Henan, Hubei, Hunan, Guizhou, and Shaanxi provinces; and Guangxi Zhuang Autonomous Region). Exclusion criteria included individuals with implausible energy intake (<600 or >4,000 kcal/d for females, <800 or >5,000 kcal/d for males), implausible macroelements intake (<1% or >99%), and pregnant or lactating women. The study protocol was approved by the institutional review board of the National Institute for Nutrition and

Health, China CDC (ethics approval code 2022-024), with all participants providing written informed consent prior to participation.

Dietary intake data were collected through consecutive 3-day 24-hour dietary recalls (2 workdays and 1 weekend day) using face-to-face interviews at participants' homes. Household weighing methods were employed to measure the consumption of cooking oils and condiments during the corresponding 3-day period. Macroelement intake calculations were based on the *China Food Component Table*. According to the Dietary Reference Intakes for China 2023 (DRIs 2023) (2), population-level nutrient inadequacy was assessed by calculating the proportion of individuals with daily calcium or magnesium intake below the EAR or daily potassium intake below the AI. For sodium, the proportion of individuals exceeding the proposed intakes for preventing non-communicable chronic diseases (PI-NCD) was calculated to assess chronic disease risk. Age-specific EAR, AI, and PI-NCD values are presented in [Supplementary Table S1](#) (available at <https://weekly.chinacdc.cn/>).

Given the non-normal distribution of macroelement intake, statistical analyses employed the Kruskal-Wallis test to evaluate differences in median intake across age groups, while the Wilcoxon rank sum test compared median intake between genders and urban-rural areas. Mean±standard deviation values were reported to facilitate comparison with other studies. The chi-square test was used to compare proportions between different groups. All statistical tests were two-tailed, with significance set at $P<0.05$. Analyses were conducted using R (version 4.4.0, R Foundation for Statistical Computing, Vienna, Austria), and figures were generated using both R and Microsoft Office Excel 2019 MSO (version 2406, Microsoft Corporation, Santa Rosa, California, USA).

This study included 8,912 participants with a mean age of 55.9 years. [Table 1](#) demonstrates that Chinese adults in 2022–2023 had median daily intakes of 288.3 mg calcium, 228.9 mg magnesium, 4,182.4 mg sodium, and 1,397.6 mg potassium, with a median Na/K ratio of 3.0. Urban residents exhibited significantly higher intakes of calcium (311.4 mg/d), magnesium (234.3 mg/d), and potassium (1,467.6 mg/d) compared to rural residents (278.0, 226.2, and 1,359.9 mg/d, respectively). Additionally, urban residents maintained a significantly lower Na/K ratio than their rural counterparts (2.8 *vs.* 3.1).

As shown in [Figure 1](#), the prevalence of inadequate intake was widespread among adults: 96.1% fell below

the EAR for calcium, 64.4% below the EAR for magnesium, and 81.9% below the AI for potassium. Furthermore, 89.4% exceeded the PI-NCD for sodium intake. Urban areas consistently demonstrated better nutritional status, with significantly lower proportions of inadequate intake across all macroelements compared to rural areas ($P<0.001$ for calcium, sodium, and potassium; $P=0.027$ for magnesium).

As shown in [Figure 2](#), analysis of Na/K ratios revealed that only 5.7% of Chinese adults maintained the optimal ratio of ≤ 1 , while 49.8% exhibited ratios >3 . Urban-rural disparities were evident, with urban areas showing a significantly higher proportion of adults achieving the optimal Na/K ratio ≤ 1 (7.8% *vs.* 4.7% in rural areas) and a lower proportion with ratios >3 (45.4% *vs.* 51.9% in rural areas) ($P<0.001$).

DISCUSSION

Our research reveals that the intake of calcium, magnesium, and potassium in Chinese adults remains suboptimal, while sodium intake and the sodium-to-potassium ratio are elevated. The Chinese Nutrition and Health Surveillance (CNHS) in 2015–2017, a nationally representative survey, reported mean intakes of calcium, magnesium, sodium, and potassium of 328.3, 251.8, 5,681.4, and 1,474.1 mg/d for adults aged 18–59 years, and 333.2, 242.5, 5,412.1, and 1,392.6 mg/d for those aged 60 and above, respectively (3). Despite China's implementation of comprehensive policies to enhance nutritional and health status, including the “*National Nutrition Plan 2017–2030*” and the “*Healthy China Initiative 2019–2030: Reasonable Diet Action*”, our findings indicate no substantial improvement in macroelement intake among Chinese adults over this seven-year period.

As illustrated in [Supplementary Figure S1](#) (available at <https://weekly.chinacdc.cn/>), vegetables, cereals, and dried legumes constitute the primary dietary sources of calcium, aligning with findings from the CHNS project in 2015 (4). Notably, milk's contribution to total calcium intake has increased to 9.7% from 6.7% in 2015 (4). However, given the persistently low consumption of dairy products (5), there remains substantial room for improving dairy intake among the population.

Our analysis indicates that 64.4% of Chinese adults exhibit inadequate magnesium intake, consistent with the CHNS project findings from 2015, which reported inadequacy rates between 60.9% and 68.45% (6). Whole grains and dark vegetables, recognized as

TABLE 1. Daily intake of calcium, magnesium, sodium, potassium (mg/d) and sodium/potassium ratio.

Characteristics	n (%)	Ca			Mg			Na			K			Na/K ratio		
		Median (IQR)	Mean±SD		Median (IQR)	Mean±SD		Median (IQR)	Mean±SD		Median (IQR)	Mean±SD		Median (IQR)	Mean±SD	
Age, years																
18–44	2,032 (22.8)	283.7 (198.8)	313.5±155.8		222.3 (122.3)	243.4±102.4		4,010.8 (3,461.1)	5,039.4±3,906.9		1,422.1 (748.6)	1,512.4±612.8		2.9 (2.5)	3.7±3.5	
45–59	3,092 (34.7)	296.3 (192.7)	321.6±153.4		238.8 (126.5)	258.2±102.9		4,399.7 (3,390.4)	5,407.5±4,015.9		1,443 (793.2)	1,551.7±611.5		3.1 (2.6)	3.9±3.3	
60–79	3,430 (38.5)	285.3 (204.3)	319.5±158.2		227.5 (125.7)	249.1±104.1		4,119.9 (3,212.6)	5,048±3,689.9		1,354.4 (760)	1,460.1±598.5		3 (2.6)	3.9±3.3	
≥80	358 (4.0)	273.7 (223.8)	316.5±174.8		197.3 (117.9)	219.2±99		3,671.3 (3,138.5)	4,814±4,430.6		1,153.4 (717.7)	1,288.9±570.6		3.1 (2.6)	4.3±4.9	
P	–	0.019	–		<0.001	–		<0.001	–		<0.001	–		<0.001	–	
Gender																
Male	4,104 (46.1)	303.1 (203.0)	330.7±157.1		245.8 (129.1)	265.2±106.2		4,540.1 (3,489.1)	5,497.7±3,914.9		1,478.7 (800.8)	1,576.6±622.5		3.1 (2.6)	3.9±3.2	
Female	4,808 (53.9)	276.7 (194.8)	308.5±155.7		216.0 (118)	236.6±99.1		3,878.8 (3,095.7)	4,874.4±3,846.1		1,327.7 (730.2)	1,428.9±586.7		2.9 (2.5)	3.9±3.6	
P	–	<0.001	–		<0.001	–		<0.001	–		<0.001	–		0.002	–	
Area type																
Urban	2,899 (32.5)	311.4 (216.1)	338.8±163.4		234.3 (125.8)	254.3±104.2		4,094.7 (3,372.6)	5,121.7±4,045.6		1,467.6 (784.6)	1,565±616		2.8 (2.5)	3.7±3.2	
Rural	6,013 (67.5)	278 (191.0)	309.1±152.5		226.2 (125.3)	247.6±103.0		4,244.8 (3,350.8)	5,180.5±3,813.1		1,359.9 (748.7)	1,464.1±601.3		3.1 (2.6)	4.0±3.5	
P	–	<0.001	–		<0.001	–		0.122	–		<0.001	–		<0.001	–	
Total	8,912 (100.0)	288.3 (199.2)	318.7±156.7		228.9 (125.5)	249.8±103.4		4,182.4 (3,355)	5,161.4±3,890.1		1,397.6 (770.7)	1,496.9±607.9		3.0 (2.6)	3.9±3.4	

Note: Statistical analyses were performed using Wilcoxon rank sum test for two-group comparisons and Kruskal-Wallis test for multiple group comparisons.
-: Not applicable.
Abbreviation: IQR=interquartile range; SD=standard deviation.

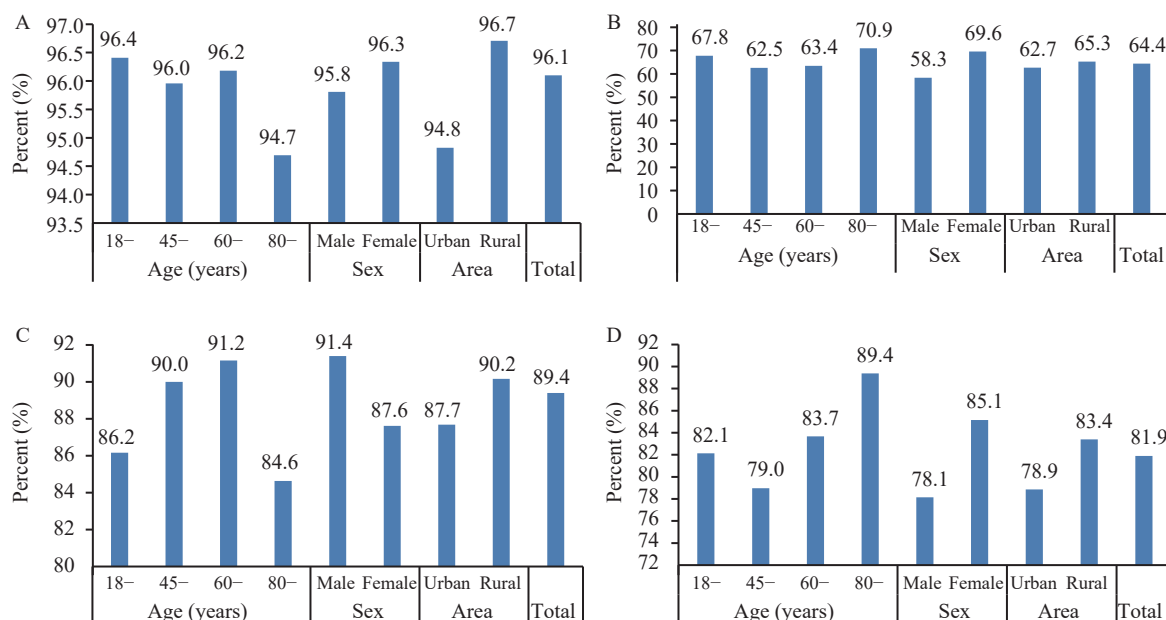


FIGURE 1. Proportions of insufficient intake of calcium, magnesium, and potassium, and excessive intake of sodium. (A) Calcium; (B) Magnesium; (C) Sodium; (D) Potassium.

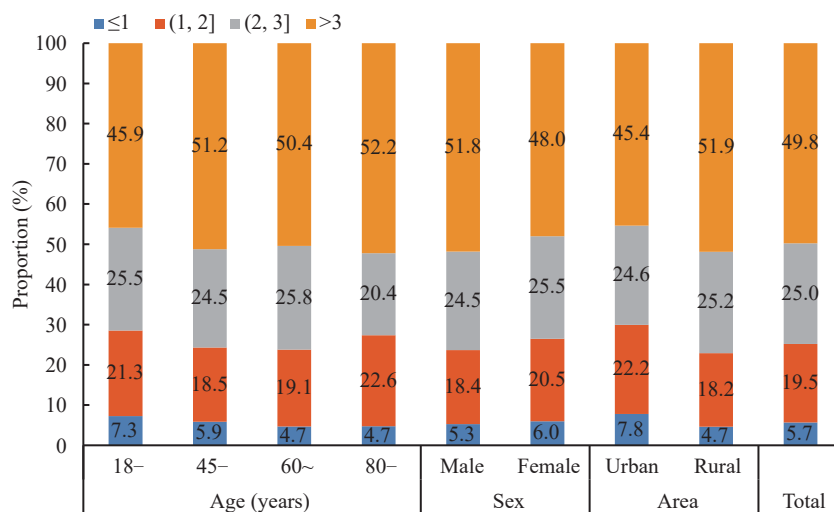


FIGURE 2. Distribution of sodium-to-potassium ratio among Chinese adults in 2022–2023.

superior sources of dietary magnesium, remain the predominant contributors to magnesium intake among Chinese adults in 2022–2023, accounting for 40.4% and 16.2% of total intake, respectively. The observed inadequate magnesium intake may be attributed primarily to the declining consumption patterns of cereals and vegetables (3).

The *Chinese Dietary Guidelines* recommend a daily sodium intake not exceeding 2,000 mg. Our findings from 2022–2023 reveal that Chinese adults' median and mean sodium intakes are 4,182.4 and 5,161.4 mg/d respectively, more than double the recommended maximum. The proportion of individuals exceeding

the PI-NCD for sodium intake has reached 89.4%, compared to 86.7% and 88.2% exceeding 2,000 mg/d in 2018 and 2015, respectively (7–8). Notably, 89.1% of dietary sodium intake derives from cooking salt, as shown in Supplementary Figure S1. While the National *'Healthy Lifestyle Action Plan (2017–2025)'* has implemented six specific action plans — targeting reductions in salt, oil, and sugar, alongside promoting healthy oral health, weight, and bones — and despite a modest downward trend in salt consumption, sodium intake remains persistently elevated (9). Future interventions must continue prioritizing salt reduction strategies to achieve meaningful decreases in salt and

sodium consumption.

Meta-analytic evidence indicates that early dietary modifications targeting a Na/K molar ratio of approximately one unit could significantly contribute to hypertension prevention. Our study reveals a concerning Na/K ratio of 3.0 (mean 3.9). The *Action on Salt China* conducted the largest-scale survey across six PLADs in 2018, employing 24-hour urinary sodium and potassium measurements — the gold standard for intake assessment. Their findings revealed a markedly imbalanced sodium-to-potassium ratio of 5:1 among the Chinese population (10). This substantial imbalance primarily stems from excessive salt consumption coupled with insufficient intake of potassium-rich foods.

A notable urban-rural disparity exists in macroelement intake patterns, with urban areas demonstrating higher intake levels of calcium, magnesium, and potassium. While sodium intake shows no significant urban-rural difference, the lower dietary potassium intake in rural areas results in a higher sodium-to-potassium ratio compared to urban areas. These findings collectively indicate that urban populations maintain generally superior macroelement intake patterns compared to their rural counterparts.

A limitation of this study is that the subjects, drawn from 10 PLADs in China, do not constitute a nationally representative sample. In addition, the macroelement intake in this study only considered food sources. The ignorance of additional intake of nutrient supplements may result in a slight underestimate of calcium or magnesium.

In conclusion, our findings reveal that macroelement intake among Chinese adults remains substantially below recommended targets. To address these nutritional disparities, strict adherence to and implementation of national policies and guidelines — including the *National Nutrition Plan 2017–2030* and the *Healthy China Initiative 2019–2030: Reasonable Diet Action* — is essential for improving overall nutrition status and reducing the urban-rural nutritional gap.

Conflicts of interest: No conflicts of interest.

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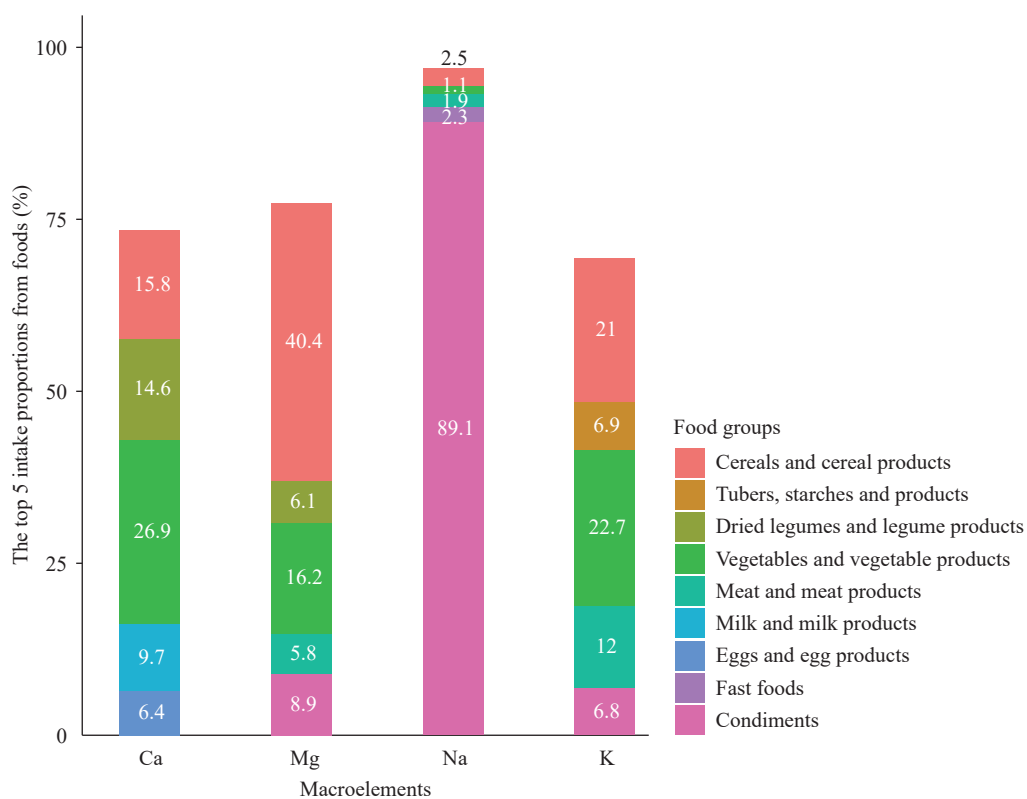
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SUPPLEMENTARY MATERIAL

SUPPLEMENTARY TABLE S1. Age-specific EAR, RNI, AI, and PI-NCD values.

Age group, years	Ca		Mg		Na		K	
	EAR	RNI	EAR	RNI	AI	PI-NCD	AI	PI-NCD
18–29			270	330	1,500	≤2,000		
30–64	650	800		320			2,000	3,600
65–74			260	310	1,400	≤1,900		
≥75			250	300		≤1,800		

Abbreviation: EAR=estimated average requirement; RNI=recommended nutrient intake; AI=adequate intake; PI-NCD=prevention of non-communicable diseases intake level.



SUPPLEMENTARY FIGURE S1. Food sources contributing to the top 5 intake proportions of four macroelements.