Preplanned Studies

Dietary Vitamin Intake Among Chinese Adults — 10 PLADs, China, 2022–2023

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Summary

What is already known about this topic?

Previous surveillance data from 2015–2017 showed that Chinese adults aged 18 to 59 years had mean daily vitamin intakes of 406.8 μg retinol equivalent (RE) for vitamin A, 36.7 mg for vitamin E, 0.8 mg for vitamin B_1, 0.7 mg for vitamin B_2, 13.9 mg for niacin, and 75.5 mg for vitamin C.

What is added by this report?

Recent findings from 10 provincial-level administrative divisions (PLADs) reveal that Chinese adults in 2022–2023 had median daily vitamin intakes of 467.8 μg RE for vitamin A, 27.3 mg for vitamin E, 0.7 mg for vitamin B_1, 0.7 mg for vitamin B_2, 12.9 mg for niacin, and 51.2 mg for vitamin C. The prevalence of insufficient intake was notably high for vitamins B_2 (84.2%), B_1 (78.0%), C (76.4%), and A (52.6%). Notably, only 1.6% of adults met the proposed intakes preventing non-communicable chronic diseases threshold for vitamin C intake.

What are the implications for public health practice?

There is an urgent need for targeted nutrition policies and interventions to address the widespread insufficient intake of vitamins A, B_1, B_2, and C among Chinese adults. Increased consumption of fresh vegetables and fruits is particularly recommended to improve vitamin C intake and reduce non-communicable chronic diseases.

Vitamins are essential micronutrients for maintaining physiological function and overall health. According to the 2015–2017 Chinese Nutrition and Health Surveillance report, Chinese residents generally face risks of insufficient dietary intake of vitamins A, B_1, B_2, and C. With ongoing urbanization, Chinese dietary patterns are transitioning from traditional plant-based diet toward modern western diet. This study analyzed data from 10 provincial-level administrative divisions (PLADs), including Heilongjiang, Liaoning, Shandong, Henan, Hunan, Hubei, Jiangsu, Shaanxi, Guangxi, and Guizhou, during 2022–2023 to characterize current dietary vitamin intakes among Chinese adults. The median daily intakes were 467.8 μg retinol equivalent (RE) for vitamin A, 27.3 mg for vitamin E, 0.7 mg for vitamin B_1, 0.7 mg for vitamin B_2, 12.9 mg for niacin, and 51.2 mg for vitamin C among adults aged 18 years and above. The risk of insufficient intake was particularly concerning for vitamins B_2 (84.2%), B_1 (78.0%), C (76.4%), and A (52.6%), with elevated risks observed among males, rural residents, and older adults. Notably, only 1.6% of adults achieved the proposed intakes for proposed intakes preventing non-communicable chronic diseases (PI-NCD) for vitamin C intake. These findings highlight the urgent need to strengthen dietary guidance for Chinese adults and implement effective nutrition policies and interventions to address vitamin insufficiency, particularly targeting males, elderly individuals, and rural populations.

This study analyzed data from the China Development and Nutrition Health Impact Cohort Survey (2022–2023), which builds upon the China Health and Nutrition Survey (*1*). From an initial sample of 9,860 adults aged ≥18 years with complete dietary data, we excluded pregnant or nursing women (n=49) and individuals with implausible dietary energy intakes [<800 or >5,000 kilocalories (kcal), n=447], yielding a final analytical sample of 9,364 participants. The study protocol received approval from the institutional review board of the National Institute for Nutrition and Health, China CDC (ethics approval code 2022-024). All participants provided written informed consent prior to participation.

Dietary assessment was conducted by trained public health professionals using three consecutive 24-hour dietary recalls (two weekdays, one weekend day) to collect comprehensive food and beverage intake data. Investigators weighed cooking oil and condiment usage during the same three-day period. Nutrient intake

calculations were performed using the "China Food Composition Table" to convert food intake into energy and vitamin contents. Vitamin intake adequacy was evaluated according to the latest Dietary Reference Intakes (DRIs) for China (DRIs, 2023 Edition) (*2*), with intake below the estimated average requirement (EAR) classified as insufficient. Additionally, we assessed the proportion of participants meeting or exceeding the PI-NCD for vitamin C (Supplementary Table S1, available at https://weekly.chinacdc.cn/).

Statistical analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA). Due to non-normal distribution of vitamin intake data, quantitative variables were presented as median (interquartile range), with mean±standard deviation reported for comparison with existing literature. Between-group comparisons of median dietary vitamin intake were conducted using non-parametric Wilcoxon rank sum test and Kruskal-Wallis rank sum test. Chi-square tests were employed to assess differences in insufficiency proportions, while age-related trends were evaluated using Cochran-Armitage trend tests. Statistical significance was set at $P<0.05$.

Among the 9,364 adults surveyed across 10 PLADs, 67.5% resided in rural areas. The median daily dietary vitamin intakes were: vitamin A (467.8 μg RE), vitamin E (27.3 mg), vitamin B_1 (0.7 mg), vitamin B_2 (0.7 mg), niacin (12.9 mg), and vitamin C (51.2 mg) (Table 1). Males exhibited higher dietary vitamin intake than females for all vitamins except vitamin A ($P<0.05$). Significant age-related differences were observed, with vitamin intake generally declining with advancing age ($P<0.05$). Urban-rural disparities were evident for all vitamins except vitamin C ($P<0.05$), with urban residents showing higher intake levels for most vitamins, though vitamin E intake was notably lower in urban areas.

Analysis revealed a concerning pattern of vitamin deficiencies, with the highest insufficiency rates observed for vitamin B_2 (84.2%), followed by vitamin B_1 (78.0%), vitamin C (76.4%), and vitamin A (52.6%) (Figure 1). Males and rural residents demonstrated significantly higher rates of insufficient intake for vitamins A, B_1, and B_2 ($P<0.05$). Age-related trends were observed for vitamins B_1 and B_2, with insufficiency rates increasing with age (P trend<0.05). Notably, only 1.6% of adults achieved the PI-NCD threshold for vitamin C intake.

Table 2 presents the primary food sources of total vitamin A and its two constituent forms. Dark vegetables emerged as the predominant source of both total vitamin A and carotene, contributing 53.5% and 73.4%, respectively. Eggs served as the principal source of dietary retinol, accounting for 47.9% of intake. Among the top five food sources, plant-based foods provided a higher proportion of vitamin A compared to animal-derived sources.

DISCUSSION

Analysis of dietary vitamin intake data from 10 PLADs during 2022–2023 reveals persistently low intake levels among Chinese adults. According to the 2015–2017 Chinese Nutrition and Health Surveillance report, mean vitamin intakes for adults aged 18 to 59 years were 406.8 μg RE/d (vitamin A), 36.7 mg/d (vitamin E), 0.8 mg/d (vitamin B_1), 0.7 mg/d (vitamin B_2), 13.9 mg/d (niacin), and 75.5 mg/d (vitamin C) (*3*). Despite the implementation of major public health initiatives — including the Healthy China 2030 Plan and the National Nutrition Plan 2017–2030 — dietary vitamin intake among Chinese adults has not shown meaningful improvement. With the exception of a slight increase in vitamin A consumption, other vitamin intake levels have either declined or remained stagnant at suboptimal levels.

Our findings demonstrate particularly high deficiency risks for vitamins B_1 and B_2, with insufficiency rates increasing with age. These results align with a previous study (*4*) from the 2015 CHNS, which reported that over 80% of elderly residents were at risk of insufficient dietary vitamin B_1 and B_2 intake. While cereals and their products constitute the primary dietary source of B vitamins for Chinese adults (Supplementary Figure S1, available at https://weekly.chinacdc.cn/), substantial vitamin B losses occur during grain processing. This processing-related nutrient depletion may contribute significantly to the widespread B_1 and B_2 deficiencies observed among Chinese adults, suggesting that increased whole grain consumption could help address these nutritional gaps.

The median daily vitamin C intake among Chinese adults was 51.2 mg, substantially below both the recommended daily intake of 100 mg and the PI-NCD of 200 mg (*2*). A longitudinal analysis of CHNS data from 1989 to 2015 demonstrated a consistent decline in dietary vitamin C intake among adults aged 18–35 years, decreasing from 95.6 mg/d in 1989 to 56.4 mg/d in 2015 (*5*). Our current findings indicate this downward trend in vitamin C intake has persisted. As a crucial antioxidant, vitamin C plays an essential role in immune defense and infection prevention (*6*).

TABLE 1. Dietary vitamin intake among Chinese adults in 10 provincial-level administrative divisions, China, 2022–2023.

Characteristics	*n* (%)	Vitamin A (μg RE/d)		Vitamin E (mg/d)		Vitamin B_1 (mg/d)		Vitamin B_2 (mg/d)		Niacin (mg/d)		Vitamin C (mg/d)	
		Median (IQR)	Mean± SD	Median (IQR)	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	Mean±SD
Gender													
Male	4,369 (46.7)	480.1 (619.1)	739.2±982.9	29.2 (27.8)	36.9±30.4	0.8 (0.5)	0.9±0.5	0.7 (0.4)	0.8±0.5	14.1 (9.3)	15.6±7.9	52.3 (52.9)	64.9±72.3
Female	4,995 (53.3)	460.6 (590.0)	713.6±921.1	26.0 (25.2)	33.5±28.4	0.7 (0.4)	0.8±0.4	0.7 (0.4)	0.7±0.4	12.0 (7.5)	13.3±7.0	50.2 (52.6)	62.6±70.6
P		0.244		<0.001		<0.001		<0.001		<0.001		0.015	
Age (years)													
>18	2,987 (31.9)	484.2 (629.1)	746.9±923.6	25.9 (26.7)	34.2±29.9	0.7 (0.5)	0.8±0.5	0.7 (0.4)	0.8±0.4	13.7 (8.7)	15.2±8.1	50.5 (51.4)	62.6±78.1
>50	3,375 (36.1)	468.5 (601.5)	722.5±909.0	30.1 (27.7)	37.2±29.2	0.8 (0.5)	0.9±0.5	0.7 (0.4)	0.8±0.5	13.3 (8.6)	14.7±7.4	55.2 (53.2)	67.3±74.8
>65	2,110 (22.5)	464.7 (605.5)	717.8±1035.2	26.4 (25.6)	33.9±27.5	0.7 (0.5)	0.8±0.4	0.7 (0.4)	0.7±0.4	12.2 (7.8)	13.4±6.8	50.6 (54.3)	63.5±63.8
>75	892 (9.5)	404.1 (531.6)	683.8±982.8	25.3 (23.8)	32.8±32.1	0.6 (0.4)	0.7±0.5	0.6 (0.4)	0.7±0.4	11.2 (7.3)	12.5±6.6	42.3 (45.3)	54.2±46.7
P		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Area type													
Urban	3,043 (32.5)	504.9 (632.2)	726.3±747.1	26.2 (24.7)	33.8±29.5	0.8 (0.5)	0.9±0.5	0.8 (0.4)	0.8±0.5	13.4 (8.6)	14.9±8.0	51.9 (53.9)	64.4±77.9
Rural	6,321 (67.5)	449.0 (588.8)	725.1±1034.3	27.9 (27.3)	35.7±29.3	0.7 (0.5)	0.8±0.5	0.7 (0.4)	0.8±0.4	12.7 (8.3)	14.1±7.2	50.9 (52.4)	63.4±68.0
P value		<0.001		<0.001		<0.001		<0.001		<0.001		0.794	
Total	9,364 (100.0)	467.8 (604.5)	725.5±950.5	27.3 (26.7)	35.1±29.4	0.7 (0.5)	0.8±0.5	0.7 (0.4)	0.8±0.4	12.9 (8.4)	14.4±7.5	51.2 (52.6)	63.7±71.4

Note: Statistical analyses were performed using Wilcoxon rank sum test for two-group comparisons and Kruskal-Wallis test for multiple group comparisons.
Abbreviation: IQR=interquartile range; SD=standard deviation; RE=retinol equivalent.

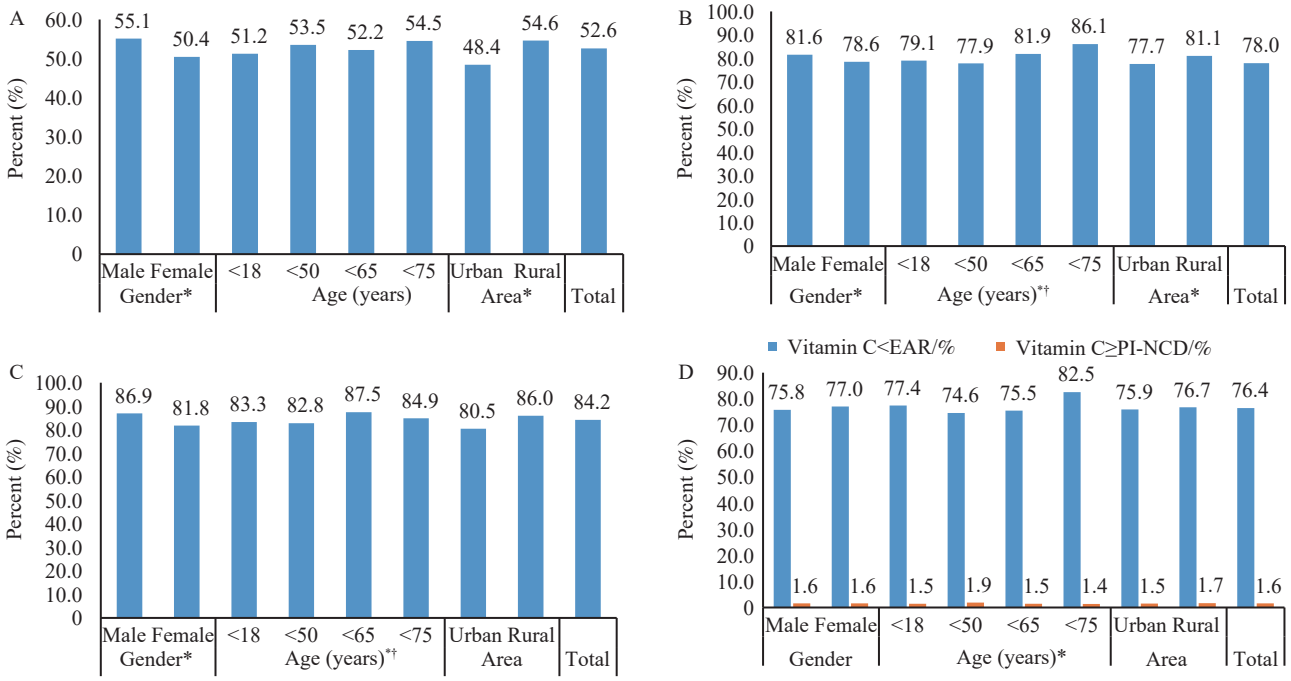

FIGURE 1. Proportion of Chinese adults with dietary vitamin intake below estimated average requirement and meeting or exceeding proposed intakes preventing non-communicable chronic diseases (vitamin C) in 10 provincial-level administrative divisions, China, 2022–2023. (A) vitamin A; (B) vitamin B_1; (C) vitamin B_2; (D) vitamin C.
* Significant differences between groups determined by chi-square test (P<0.001).
† Age-related trends assessed using cochran-armitage trend test (P<0.001).

TABLE 2. Top 5 food sources contributing to dietary vitamin A, carotene, and retinol intake among Chinese adults in 10 provincial-level administrative divisions, China, 2022–2023.

Order*	Vitamin A		Carotene		Retinol	
	Food source	Percent (%)	Food source	Percent (%)	Food source	Percent (%)
1	Dark vegetable	53.5	Dark vegetable	73.4	Egg	47.9
2	Egg	13.2	Light vegetable	10.7	Animal organ	22.5
3	Light vegetable	8.3	Fruit	5.9	Pork	7.4
4	Animal organ	6.2	Tuber	2.2	Poultry	5.4
5	Fruit	4.6	Legumes	1.0	Milk	3.5

* Foods ranked in descending order by vitamin contribution.

Evidence suggests that increasing vitamin C intake by 50–100 mg per day is associated with reduced risks of all-cause mortality, cardiovascular disease (CVD), and various cancers (*7*). However, our study revealed that only 1.6% of adults achieved the PI-NCD threshold for vitamin C intake. This continuous decline in dietary vitamin C consumption may be attributed to the gradual shift from plant-based to animal-based dietary patterns. Given that fresh vegetables and fruits constitute the primary sources of dietary vitamin C (Supplementary Figure S1), we recommend that Chinese adults increase their consumption of these foods while adopting appropriate cooking methods to minimize vitamin C loss.

Notably, the prevalence of insufficient dietary intake for vitamins A, B_1, and B_2 was significantly higher among males and rural residents, with vitamin B_1 and B_2 deficiency rates increasing with age. These findings align with previous studies (*4*,*8*), highlighting the need for targeted dietary interventions for males, rural residents, and elderly populations.

National surveillance data from 2015–2017 revealed that 75.9% of Chinese residents aged 2 years and above had vitamin A intake below the EAR (*9*). Our current analysis of 10 PLADs shows an improved but still concerning rate of 52.6% for vitamin A insufficiency. This represents progress from the 2015 CHNS data, which reported vitamin A deficiency rates

of 66.39% and 63.39% for males and females aged 18–35, respectively (*5*). While vitamin A can be obtained from both plant-derived carotenes and animal-derived retinol, carotenes require biological conversion for utilization. Historical trends indicate that the proportion of retinol in Chinese dietary vitamin A intake has gradually increased, while plant-derived carotene contributions have declined annually (*10*). Our findings demonstrate that plant-based foods remain the primary source of dietary vitamin A among Chinese adults, although observing reduction in vitamin A deficiency rates. However, potential overestimation of carotene conversion efficiency necessitates continued vigilance regarding vitamin A deficiency and its associated health risks.

A notable limitation of this study is the inherent recall bias present in dietary surveys, which remains a universal challenge in nutritional epidemiological research. In addition, vitamin intake in this study only considered food sources, the ignorance of additional intake of nutrient supplements may cause a partial overestimation of the insufficiency rate of vitamin intakes.

In conclusion, our findings demonstrate that vitamin intake among Chinese adults falls substantially below recommended levels, particularly for vitamins B_1, B_2, C, and A. Addressing this nutritional gap requires comprehensive interventions, including enhanced dietary guidance and targeted nutritional education programs. Specific emphasis should be placed on promoting increased consumption of fresh vegetables, fruits, and whole grains, with particular attention to vulnerable populations, including rural residents, males, and elderly individuals. Implementation of evidence-based nutrition and health initiatives is essential to correct suboptimal dietary patterns among Chinese adults.

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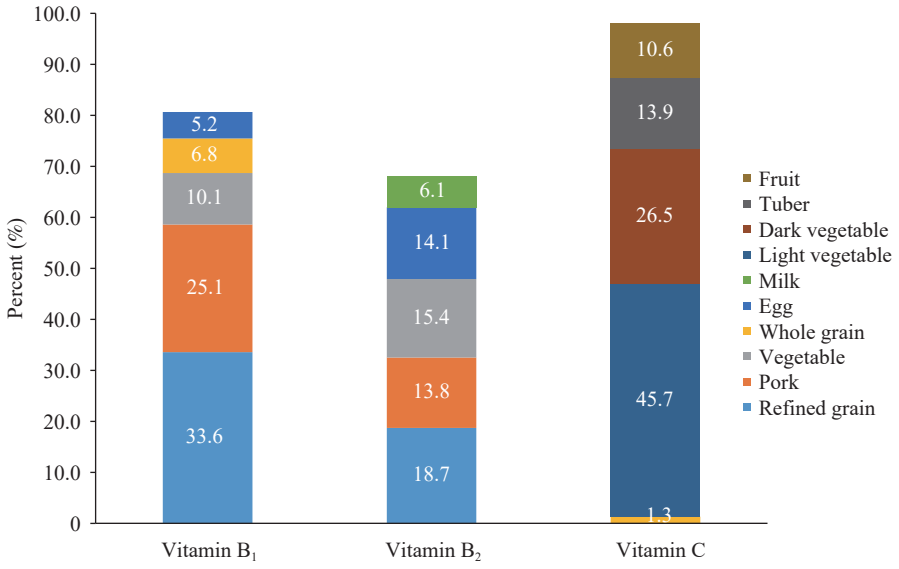
SUPPLEMENTARY MATERIAL

SUPPLEMENTARY TABLE S1. Reference values for Vitamin intake (EAR and PI-NCD) among Chinese adults in 10 provincial-level administrative divisions, China, 2022–2023.

Age group (years)	Vitamin A EAR (μg RAE/d)		Vitamin B_1 EAR (mg/d)		Vitamin B_2 EAR (mg/d)		Vitamin C (mg/d)	
	Male	Female	Male	Female	Male	Female	EAR	PI-NCD
>18	550	470	1.2	1	1.2	1	85	200
>50	540	470	1.2	1	1.2	1	85	200
>65	520	460	1.2	1	1.2	1	85	200
>75	500	430	1.2	1	1.2	1	85	200

Abbreviation: EAR=estimated average requirement; PI-NCD=proposed intakes for preventing non-communicable chronic diseases.



SUPPLEMENTARY FIGURE S1. Top 5 food sources contributing to dietary vitamins B_1, B_2, and C among Chinese adults in 10 provincial-level administrative divisions, China, 2022–2023.