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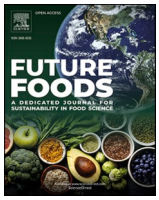

How the popularization of dietary guidelines affects healthy eating behavior: Evidence from the choice of staple food structure in China

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ABSTRACT

Long-term high consumption of refined grains is detrimental to human health. This study aims to assess the effects of dietary guidelines on healthy eating and provide policy insights for dietary pattern transition. The staple food structure considered in this paper consists primarily of a combination of refined grains (rice and white flour mainly) and whole grains and potatoes in various proportions. Using a nationally representative sample of 102,464 adult respondents drawn from the Food Safety and Nutrition Health Survey (FNS), we discovered that awareness of the Chinese Dietary Guidelines (2016), issued by the Chinese Nutrition Society, can help residents choose a healthier staple food structure by substituting refined grains with a higher proportion of whole grains and potatoes. Further analysis reveals that (a) knowing the dietary guidelines moderates the staple food choices of obese, urban-dwelling, and male groups, effectively improving these groups' staple food choices; (b) knowing the dietary guidelines also promotes residents' dietary diversity and vegetable intake; and (c) addressing potential endogeneity due to reverse causality using an instrumental variable approach, our mechanism analysis shows that dietary guidelines primarily promote healthy dietary choices by enhancing nutrition knowledge. This paper examines the health effects of dietary guidelines on residents' staple food choices and demonstrates the significance of dietary guideline popularization and nutrition knowledge based on dietary guidelines.

1. Introduction

Staple foods are an important part of people's daily diets because they are the primary source of energy for the human body. However, widespread consumption of refined grains not only harms human health but also wastes food.[1] For example, a long-term diet of high-carbohydrate refined grains is likely to result in a high glycemic index and glycemic load, which increases the risk of type 2 diabetes, obesity, and other diseases (Gaesser, 2019; Golozar et al., 2017; Raghuram et al., 2021). There is also a correlation between different staple food structures and food waste, with fine grain staple food patterns, such as rice being more likely to result in food waste (Qian et al., 2022).

The crop structure of growing wheat in the north and rice in the south has determined the traditional staple food structure of China to be mainly rice or wheat flour since ancient times. Since emerging from widespread food shortages in the early 1980s, most Chinese residents have developed a persistent preference for refined rice and white flour, driven by cultural familiarity, taste preferences, and historical consumption patterns (Niu and Hou, 2020). China is facing the dilemma of increasing non-communicable diseases (diabetes and obesity) and

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[1] Qian et al. (2022) found that rice-based staple food patterns—mainly consisting of refined white rice—are associated with significantly higher levels of plate waste in Chinese university canteens, compared to wheat-based diets. The underlying mechanisms may include lower satiety, over-serving relative to actual appetite, and lower taste satisfaction compared to wheat-based staple foods.

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micronutrient deficiency.[2] It is primarily related to changes in the dietary structure of Chinese residents since reform and opening up, such as an increase in rice and white flour and a decrease in whole grains and potatoes in the staple food structure (Han et al., 2020). Because staple foods are frequently consumed and have a high proportion of caloric sources in the daily diet, even a minor improvement in staple food structure could have a positive impact on population health (Brinsden et al., 2013). Studies have also shown that a varied staple food pattern is more important for human health than a varied diet of vegetables and meat (Sasaki et al., 2022). However, when compared with other unhealthy side dishes, such as those high in sugar and salt, staple foods are often overlooked. Global progress toward the diversification and healthy transformation of staple food structures has been slow (Brownlee et al., 2018; McGill et al., 2015).

Given that a high-carb staple food structure is more likely to result in health risks, such as type 2 diabetes and obesity, many countries have made limiting the excessive consumption of nutrient-poor but yield-rich high-carb staple foods an important principle in implementing nutrition action plans (Amaral et al., 2017). In 2016, China implemented a "potato staple" policy, proposing the potato as an important source of staple food (Scherer and Huang, 2021). Studies have also shown that potato has good physiological functions and intestinal flora regulation, while reducing resource inputs and greenhouse gas emissions, making it an excellent alternative to traditional staple foods in terms of nutritional health and environmental benefits (Gao et al., 2019; Reddivari et al., 2019; Robertson et al., 2018; Ruan et al., 2021). Additionally, whole grains (such as corn and brown rice) are low in carbohydrates and rich in dietary fiber and trace elements, which have been associated with a reduced risk of coronary heart disease, diabetes, and other chronic diseases (de Mello Fontanelli et al., 2021; Liu et al., 2018; Misra et al., 2009; Shah et al., 2021; Yoshimoto et al., 2020). Handayani et al. (2022) found that a diet rich in whole grains, such as brown rice, improved anthropometric parameters and glycemic control in patients with diabetes. However, on the supply side, a large-scale supply of whole grains and potatoes can be ensured. Because of long-term accumulated dietary habits of residents and other factors, demand for whole grains and potatoes is relatively low, and the food strategy of whole grains and potatoes as the main food is difficult to promote on a large scale (McMackin et al., 2013; Muhihi et al., 2013; Zhang et al., 2017). Therefore, it is crucial to identify effective interventions to promote the acceptance and consumption of high-quality staple foods and to understand the factors influencing the population's staple food choices from the demand side. This is especially true in countries like China, where rice and white flour are staples of the diet and chronic diseases, such as diabetes, are rapidly increasing.

Residents' eating habits are influenced by a variety of factors, such as personal awareness, product characteristics, social norms, and the interaction of different factors. Individual health literacy and nutritional knowledge frequently outperform other factors, so that consumers do not place too much emphasis on food price and taste in the process of dietary consumption and instead focus on food health attributes (Davidson et al., 2021; Zhou et al., 2018). Numerous experimental studies on healthy eating interventions have shown that providing consumers with nutrition knowledge—whether through formal nutrition courses or brief educational interventions—is generally more effective in promoting healthy dietary behaviors than other types of interventions (Cadario and Chandon, 2020; Fahlman et al., 2008; Wang et al., 2015; Whatnall et al., 2018). Because of the general population's low education level and food science literacy, most developing countries, including China, rely on dietary guidelines to acquire and disseminate nutrition knowledge. The Dietary Guidelines for Chinese Residents serve as a fundamental document used by the government for health education and the dissemination of nutrition knowledge.[3] They represent an important measure to promote healthy eating, improve residents' dietary quality, and encourage the adoption of rational dietary behaviors. In terms of staple food structure, the Chinese Dietary Guidelines recommend a balanced diet based on grains and other carbohydrate-rich foods. Daily intake should emphasize whole grains and tubers such as potatoes, with moderate inclusion of legumes like soybeans to improve nutritional diversity.[4]

While health education based on dietary guidelines has become the mainstay of healthy eating interventions, many countries have continued to modify and improve the dietary guidelines' specific dietary recommendations. At the micro level, there is still little research and conflicting findings on the impact of dietary guidelines on individual consumers' healthy dietary decisions. Few studies have focused on developed countries, and no studies on Chinese residents have been found. For example, Mancino et al. (2008) showed that revising dietary guidelines promoted the consumption of healthy foods. However, Srinivasan (2013) concluded that dietary guidelines do not reduce the population's overall calorie intake. Bälter et al. (2012) also concluded that dietary guidelines are ineffective at promoting healthy eating and lowering the risk of diet-related chronic diseases in the general population. The differences in the results of the aforementioned studies could be attributed to different indicators for assessing the effects of dietary guidelines or to sample selection bias.

Based on the above analysis, this paper evaluates the impact of dietary guidelines on residents' healthy eating behavior decisions in terms of their staple food structure choices and possible paths to promote healthy eating transition. The results of the study suggest that knowing the dietary guidelines can help improve the population's choice of staple food. Specifically, the dietary guidelines increased the probability of eating whole grains and potatoes while decreasing the probability of eating rice and white flour. This result is still valid after robustness tests. This paper also found that factors, such as residents' age, gender, and socioeconomic status, influence their choice of staple food structure. Additionally, we investigated the moderating effect of dietary guidelines and found that they are effective in improving the choice of health staple foods in an obese, male, urban-dwelling sample.[5] Dietary guidelines can improve dietary diversity and promote the consumption of healthy foods, such as vegetables and dairy products, in addition to improving residents' choice of staple food structure. The analysis of potential mechanisms found that dietary guidelines promote healthy eating primarily by increasing population knowledge of nutritional diets.

The main marginal contributions of this study are as follows. First,

[2] According to official reports, the incidence of non-communicable diseases—including cardiovascular disease and cancer—has been rising steadily in China, with chronic diseases accounting for over 80% of total deaths among residents (see: https://www.peopleapp.com/column/30046581293-500005751384). In addition, Chinese residents continue to experience insufficient intake of key micronutrients such as calcium, iron, and vitamin A (National Health Commission of China, 2020. Report on Nutrition and Chronic Disease Status of Chinese Residents).

[3] Unlike in some countries where dietary guidelines are primarily developed for healthcare professionals, the Chinese Dietary Guidelines are explicitly intended for both professionals and the general public. The Guidelines serve as a core resource for health education, aiming to improve public nutrition literacy and dietary behavior through accessible recommendations such as the Balanced Diet Pagoda. At the same time, they provide a scientific basis for nutritionists, educators, and public health workers engaged in dietary promotion and intervention.

[4] The Dietary Guidelines for Chinese Residents (2022) recommends adults to consume 200–300 g of cereals per day, which includes 50–150 g of whole grains and mixed legumes; in addition, 50–10 g of potatoes can replace some of the staple foods. Source: http://dg.cnsoc.org/

[5] Urbanicity is defined based on household registration (*hukou*), which is China's official residency system that designates individuals as permanent residents of a specific locality and determines their eligibility for local social benefits.

previous studies on healthy eating and nutritional transition in the literature have primarily focused on the consumption choices and intake of side dishes, such as fresh fruits and vegetables, meat, milk, and eggs or other snacks. Few studies have focused on the composition of the population's staple foods. Even though there are studies that use staple foods as research subjects, they are only at the nutritional fortification level, proposing to improve malnutrition by increasing the micronutrient content of the staple food structure (De-Regil et al., 2014; Teye et al., 2020). The importance of changing the structure of staple foods has been overlooked. This paper investigates the population's healthy eating behavior from the perspective of staple food structure selection; it is a novel perspective that broadens research ideas about healthy eating and nutrition transition.

Second, the focus of this paper's research is China. With rapid economic development and lifestyle changes in recent years, the prevalence of diabetes and obesity has increased significantly in China. As the world's largest developing country, China faces growing public health concerns related to diet and metabolism. While the rise in noncommunicable diseases is multifactorial, research suggests that heavy reliance on refined grains—such as rice and white flour—as staple foods may contribute to the growing burden of obesity and diabetes (Han et al., 2020). Using China as a research object to examine the factors influencing the population's choice of staple food structure has significant practical implications. It also has implications for other countries, particularly developing Asian countries.

Third, although dietary guidelines are widely regarded as the basis for universal nutrition knowledge and health education in many countries, previous research on the specific effects of dietary guidelines is limited and contentious. This paper examines the impact of dietary guidelines on healthy eating in terms of the population's choice of staple food structure, dietary diversity, and intake of healthy foods. It adds to the previous dietary guideline literature while also providing research evidence to further popularize dietary guidelines.

The remainder of the paper is structured as follows. Section 2 introduces the conceptual framework and empirical strategy. Section 3 presents the data and descriptive statistics. Section 4 elaborates and discusses the empirical results. Section 5 contains the conclusion, implication, and limitation.

2. Materials and Methods

2.1. Conceptual framework and empirical specification

We assume that individuals select a specific staple structure from the available options k based on personal characteristics (e.g., gender and age), socioeconomic status (e.g., culture and income), and personal preferences to maximize their expected personal utility. The options presented in this paper include a mixture of rice and white flour, whole grains, and potatoes in various proportions. Assume U_{ik} and U_{im} are the net utilities available when selecting staple structure options k and m and that individuals prefer staple structure option k over m only when $U_{ik} > U_{im}$. However, the net utility associated with each staple structure option could not be directly observed but can be represented by the latent variables U^*_{ik} and U^*_{im}. We assume that the threshold measurement model for all k can be expressed by Equation (1) for any staple food structure type, denoted by 1 when observable and 0 otherwise.

$$\mathrm{U}_{ik} = \begin{cases} 1 \ if \ U^*_{ik} > U^*_{im} \\ 0 \ if \ U^*_{ik} \le U^*_{im} \end{cases}, \ \text{for all } k \neq m \tag{1}$$

Equation (1) can be used to define a probabilistic model for selecting staple food structures, where k and m represent two types of staple food structures. The probability of an individual selecting a specific type of staple food structure k is assumed to be a function of a set of observables X_{ik}. X_{ik} consists of key independent variable I_{ik} and control variable Z_{ik}. The probability function of selecting staple structure k is as follows:

$$Pr_{ik} = Max\left(U^*_{ik}\right) = \alpha_k I_{ik} + \beta_k Z_{ik} + \nu_i. \tag{2}$$

In Equation (2), Pr_{ik} represents the probability of selecting the kth staple structure, where $k = \{1,2,3\}$. $X_{ik} = I_{ik} + Z_{ik}$, α_k, and β_k are unknown parameters. ν_i is an error term that captures other unobserved factors that influence staple structure selection.

According to this paper, the key independent variable I_{ik} in Equation (2) is whether the individual knows the dietary guidelines or not, and knowing is assigned a value of 1; otherwise, it is assigned a value of 0. The control variable Z_{ik} is set with reference to the literature on other dietary behaviors. This paper's control variables included respondents' income, age, gender, marital status, education, family size, having children in the household,[6] BMI, self-rated health, place of residence, presence of chronic diseases, and region (Ren et al., 2019; Zhu et al., 2016). We broaden the equation based on the preceding discussion.

$$Pr_{ik} = Max\left(U^*_{ik}\right) = \gamma_{ik} Dietguide_{ik} + \sum_{r=1}^{r=12} \theta_{ikr} Z_{ikr} + \mu_i \tag{3}$$

In Equation (3), Pr_{ik} represents the previous definition, $Dietguide_{ik}$ represents whether the ith respondent is aware of the dietary guidelines, and Z_{ikr} represents the other control variables ($r = 12$). γ_{ik} and θ_{ikr} are the parameters to be estimated, and μ_i is the random error term.

Discrete choice models include multivariate logit models, ordered logit models, and multinomial logit models. All of the above can be used to calculate Equation (3). The logit model is selected based on the nature of the dependent variable. The individual's selection of staple food structure is the dependent variable in this paper. While the transition in staple food structure—from a focus on rice and white flour to an equal emphasis on rice, white flour, whole grains, and potatoes, and ultimately to a predominance of whole grains and potatoes—may be interpreted as a positive shift in dietary health, this stands in contrast to the actual behavior of individuals when selecting staple foods. As previously stated, each individual selected a staple food structure to maximize expected net utility, and this selection was influenced by other factors, such as socioeconomic status, individual literacy, age, gender, and individual preferences. Because of the ease of obtaining whole grains and potatoes and their own preferences, rural residents and older respondents are more likely to select whole grains and potatoes over rice and white flour. Rice and white flour may be the staple foods of people who are more concerned with taste than with health. It has been demonstrated that there is no better way to rank the three staple food structures. In this paper, individuals select a staple food structure from three mutually exclusive and non-sequential options. Therefore, we estimate the determinants of staple food structure choice using the multinomial logit (MNL) model.

2.2. Data and descriptive

The data used in this paper are from the Food Safety and Nutrition Health Survey (FNS), which was conducted in June 2022 by the Institute of Food Safety Risk Management, Jiangnan University, in collaboration with several organizations across China (excluding Hong Kong, Macau, and Taiwan). The survey was conducted online, with questionnaires distributed to respondents, and had a total sample size of more than 100,000 people. The sample distribution is reported in Table A1. With China's current high Internet and 4G/5G telephone penetration, the representativeness of the online survey sample can be basically ensured, and it does not result in a skewed distribution of sample characteristics.

[6] Children in the household are defined as those under age 12. This definition reflects the age at which children typically complete primary education and begin junior high school, where boarding is more common. The presence of young children at home may lead families to place greater emphasis on healthy eating practices.

Additionally, when compared with an offline face-to-face survey, online surveys can avoid measurement errors caused by social expectation bias as much as possible, and their accuracy is higher when respondents answer sensitive questions (Kreuter et al., 2008). The FNS data aim to investigate the nutritional knowledge, dietary behavior, lifestyle habits, and food safety status of residents across the country. The FNS questionnaire is divided into three sections: basic individual information, food safety status, and nutritional health. Individual basic condition and nutritional health are the main variables in this paper. After the data were recoded and missing values and outliers were removed, a total of 102,464 samples were obtained.

Figure 1 presents the distribution of respondents across three staple food structure categories, based on their self-reported intake patterns. The majority of respondents' staple food structure is dominated by rice and white flour (71.89%). The sample of respondents who choose "whole grains and potatoes mainly" is the smallest, accounting for only 8.63% of the total. The proportion of respondents who selected "rice and white flour, whole grains, and potatoes are basically equal (both are equal)" as their main food is 19.49%. This reflects that rice and white flour dominate the majority of Chinese residents' current staple food structure, with whole grains and potatoes accounting for a small proportion of Chinese residents' staple food structure.

Table 1 reports definitions and basic descriptive statistics for all variables. The sample is well represented in terms of sociological demographic indicators, such as respondents' age and education. Table 1 shows that less than half (44%) of the sample is aware of the dietary guidelines, reflecting the reality of dietary guidelines' low popularity in China. The proportion of respondents with chronic diseases in the sample reached 65.3%, reflecting the growing burden of non-communicable diseases in China. This increase is likely driven by multiple factors, including aging of the population, lifestyle changes such as reduced physical activity and dietary shifts, and broader environmental and socioeconomic transformations accompanying improvements in living standards.

Table 2 shows the differences in the mean values of the variables among the various staple food structure options. We used *F* statistics to determine whether there were mean differences between the various staple food structure options and the corresponding significance. The data in Table 2 show that all three groups with different staple food structure choices differed significantly from each other at the 1% level. The group whose staple food structure is "whole grains and potatoes mainly" has higher knowledge of dietary guidelines than the other groups, indicating that people who know the dietary guidelines are more likely to choose a staple food structure based on whole grains and potatoes. Furthermore, comparing other demographic characteristics between the three groups reveals that those with a higher socioeconomic status, women, and those with a lower BMI level tend to consume more whole grains and potatoes. Overall, the results presented in Table 2 suggest that a variety of factors influence the choice of staple food structure, including income, age, and gender at the individual level,

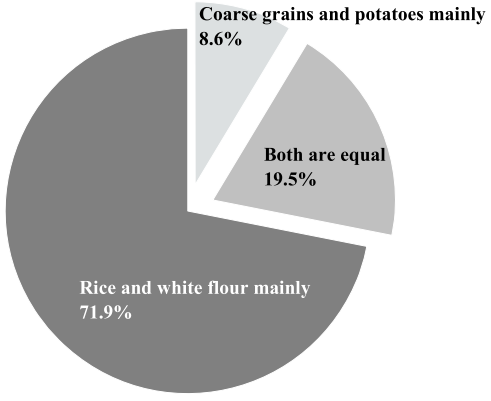

Figure 1. Distribution of respondents by primary staple food structure (% of total sample).
Note: Categories reflect respondents' self-reported staple food choices, based on the relative proportion of refined grains (rice and white flour), coarse grains, and potatoes in their daily diet.

Table 1
Definition of variables and descriptive statistics.

Variables	Definition	Mean	*SD*
Staple food structure	Rice and white flour mainly = 1 Rice and white flour, coarse grains, and potatoes are basically equal (both equal) = 2 Coarse grains and potatoes mainly = 3	1.36	0.63
Dietary guidelines	Do you know the dietary guidelines? Yes = 1, other = 0	0.44	0.49
Income	Personal annual income (RMB): 30,000 and below = 1, between 30,000 and 50,000 = 2, between 50,000 and 100,000 = 3, between 100,000 and 150,000 = 4, between 150,000 and 200,000 = 5, between 200,000 and 500,000 = 6, 500,000 or more = 7	2.51	1.63
Age	18–25 years old = 1, 26–45 years old = 2, 46–60 years old = 3, 61 years old and older = 4	1.84	0.79
Gender	Male = 1, female = 0	0.47	0.50
Marriage	Married = 1, unmarried = 0	0.54	0.49
Education	Receive a high school degree or higher = 1, other = 0	0.85	0.35
Household size	One person = 1, two people = 2, three people = 3, four people = 4, five or more people = 5	3.53	1.05
Children	Children below 12 years old in the family = 1, others = 0	0.35	0.47
BMI	Body mass index: weight (kg)/height (m^2)	22.45	3.51
Health	Self-rated of health: very poor = 1, poor = 2, fair = 3, good = 4, very good = 5	3.51	0.84
Residence	Urban = 1, rural = 0	0.69	0.46
Chronic diseases	With chronic diseases = 1, other = 0	0.65	0.47
Region	Northern region = 1, southern region = 0	0.40	0.49

Note. Chronic diseases include hypertension, hyperglycemia, hyperlipidemia, cardiovascular and cerebrovascular diseases, fatty liver, and obesity. According to the division of the Qinling-Huaihe geographical line, the northern region includes the following 15 provinces: Neimenggu, Beijing, Jilin, Tianjin, Ningxia, Shandong, Shanxi, Xinjiang, Hebei, Henan, Gansu, Liaoning, Shaanxi, Qinghai, and Heilongjiang. Other provinces belong to the southern region.

Table 2
Differences in mean values of variables for various staple food structure choices.

Variables	(1) Rice and white flour mainly	(2) Both equal	(3) Coarse grains and potatoes mainly	(4) *F* statistics
Dietary guidelines	0.42	0.49	0.51	280.24***
Income	1.62	1.62	1.71	76.71***
Age	1.84	1.81	1.84	11.57***
Gender	0.49	0.46	0.39	161.63***
Marriage	0.55	0.53	0.53	17.15***
Education	0.35	0.34	0.31	39.19***
Household size	3.54	3.55	3.40	78.32***
Children	0.35	0.36	0.36	4.34**
BMI	22.53	22.25	22.23	69.10***
Health	3.47	3.63	3.53	296.78***
Residence	0.69	0.66	0.68	43.23***
Chronic diseases	0.64	0.68	0.61	94.91***
Region	0.39	0.43	0.42	39.04***

*10% significance level.
**5% significance level.
***1% significance level.

household size and having children at home at the household level, and urban–rural and southern–northern differences at the regional level.

3. Results

Table 3 summarizes the empirical analysis based on the MNL model. Because the implications of the MNL model coefficient results may not be intuitive, the marginal effects based on the MNL estimation results are reported in Table 3. As a reference, Table A2 shows the coefficients estimated by the MNL model.

3.1. Results from key independent variables

The marginal effect results of MNL estimation are shown in Table 3. The results show that knowledge of dietary guidelines is associated with the choice of staple food structure among various types. Individuals who are aware of the dietary guidelines are more likely to select "whole grains and potatoes mainly" and "both equal," whereas the probability of selecting "rice and white flour mainly" has a significant negative effect. People who are aware of the dietary guidelines have a 2.2 percentage point higher probability of choosing "whole grains and potatoes mainly," and a 3.3 percentage point higher probability of choosing "both equal," compared to those unaware of the guidelines.[7] The results suggest that the dietary guidelines are conducive to improving Chinese residents' staple food structure choices and promoting the inclusion of more whole grains and potatoes in their daily staple foods. Our findings on the relationship between dietary guidelines and the population's choice of staple foods agree with those of Mancino et al. (2008).

Table A2 shows the MNL model estimation results with "rice and white flour mainly" as the reference group. When compared with the reference group, knowing dietary guidelines improves the choice of staple food structure in both other groups. This suggests that the dietary guidelines increase the consumption of whole grains and potatoes in the staple food structure, which is consistent with the marginal effect results in Table 3.

Table 3
Marginal effects of dietary guidelines on the choice of different staple food structures: Results based on MNL estimation.

Variables	(1) Rice and white flour mainly	(2) Both equal	(3) Coarse grains and potatoes mainly
Dietary guidelines	−0.056***	0.033***	0.022***
	(0.002)	(0.002)	(0.001)
Income (Baseline: 30,000 and below)			
Income 2	−0.041***	0.028***	0.012***
	(0.004)	(0.004)	(0.003)
Income 3	−0.041***	0.024***	0.017***
	(0.004)	(0.003)	(0.002)
Income 4	−0.037***	0.019***	0.017***
	(0.005)	(0.004)	(0.003)
Income 5	−0.034***	−0.001	0.035***
	(0.006)	(0.006)	(0.004)
Income 6	−0.064***	0.024***	0.041***
	(0.006)	(0.005)	(0.003)
Age (Baseline: 18–25 years old)			
Age 2	0.003	−0.013***	0.009***
	(0.005)	(0.004)	(0.003)
Age 3	−0.003	−0.011*	0.014***
	(0.006)	(0.005)	(0.004)
Age 4	0.018	0.023**	−0.041***
	(0.011)	(0.009)	(0.008)
Gender	0.041***	−0.005**	−0.034***
	(0.002)	(0.002)	(0.001)
Marriage	0.031***	−0.007	−0.024***
	(0.005)	(0.004)	(0.003)
Education	−0.016***	0.002	0.014***
	(0.004)	(0.003)	(0.002)
Household size	0.007***	0.002*	−0.009***
	(0.001)	(0.001)	(0.001)
Children	−0.023***	0.011***	0.012***
	(0.003)	(0.002)	(0.002)
BMI	0.003***	−0.002***	−0.001***
	(0.000)	(0.000)	(0.000)
Health	−0.034***	0.029***	0.005***
	(0.001)	(0.001)	(0.001)
Residence	0.032***	−0.021***	−0.011***
	(0.003)	(0.002)	(0.002)
Chronic diseases	0.012***	0.008***	−0.021***
	(0.003)	(0.002)	(0.002)
Region	−0.017***	0.016***	0.001
	(0.003)	(0.002)	(0.001)
Observations	102,464		

*10% significance level.
**5% significance level.
***1% significance level.

3.2. Results from control variables

In addition to dietary guidelines, we found in Table 3 that other demographic factors have a significant impact on the population's choice of staple food structure. As income increases, individuals are more likely to choose a staple food structure based on whole grains and potatoes. This is likely due to stronger health awareness and greater willingness to follow dietary recommendations among higher-income groups. With increasing age, individuals were more likely to choose coarse grain–potato staples. However, it is worth noting that rice and white flour are more likely to be staple foods for the sample of people over 60 years of age. One possible explanation is that the elderly group has a psychological preference for rice and white flour, because they grew up eating mostly whole grains and potatoes due to poor economic conditions. Therefore, as living conditions improve, the structure of staple foods will shift toward rice and white flour. Additionally, this paper finds that those with a smaller family size, children in the family, unmarried, and with a higher education level have stronger preference for whole grains and potatoes in the staple food structure. While men with higher BMI prefer rice and white flour, the urban population prefers rice and white flour. People with high BMI prefer rice and white flour as staple foods, which will definitely increase health risks for these groups and should be the focus of health policies. The findings regarding the relationship between individual characteristics and eating behaviors are generally consistent with previous studies (El-Kassas and Ziade, 2016; Roos et al., 1998; Sleboda et al., 2022).

3.3. Robustness check

3.3.1. Replacement regression model

First, we use the Probit model to test the robustness of the previous regression results. Table A3 reports the Probit model estimation results. We discover that dietary guidelines have a significant positive effect on the choice of staple food structure for "whole grains and potatoes mainly" and "both equal," whereas the coefficient for "rice and white flour mainly" is significantly negative. The results are generally consistent with the MNL model estimates. Furthermore, we ranked the three staple food structures in terms of health and performed regression analysis with ordered logit models. The results show that the regression coefficient of the dietary guidelines is significantly positive at the 1% level, confirming the MNL model's estimation results. The marginal effects of the ordered logit model are reported in Table A4.

[7] Marginal effects from the MNL model estimate the change in the predicted probability of each outcome category associated with a one-unit change in the independent variable, holding other covariates constant.

3.3.2. Sample replacement

We excluded individuals with a BMI below 18.5 because this group may include people with disordered or irregular eating patterns (e.g., persistent anorexia, highly limited food intake), which could bias the estimation of staple food structure choices. Excluding this subgroup helps improve model stability and mitigate potential regression error. Table A5 shows the multinomial logit model regression results after excluding the malnourished sample. The sign and significance of the coefficients for the dietary guidelines are generally consistent with the results in Table 3, further validating the baseline regression results' reliability.

3.3.3. Replace the dependent variables

We test the robustness of the baseline results further by replacing the dependent variables. The dependent variables are replaced by the frequency of coarse grain consumption, ranging from "basically not eat" to "eat every day," with values ranging from 1 to 4. An ordered logit model is used for regression analysis. Table A6 shows the results of the ordered logit regression in column (1), and the marginal effects of the dietary guidelines on each choice in columns (2)–(5). The results show that knowing dietary guidelines can help promote the consumption of coarse foods.

3.4. Further analysis

3.4.1. Moderating effects of dietary guidelines

The above analysis demonstrates the health effects of dietary guidelines on the population's staple food structure selection. Additionally, Table 3 shows that the staple food structure of samples with high BMI, men, and those living in urban areas is more rice and white flour based. Next, we further investigate the moderating effect of knowing dietary guidelines to see if they can help improve the choice of staple food structure in these groups.

Table A7 presents that the interaction between dietary guidelines and obesity had a significant positive effect at the 1% level for the staple food choice of "whole grains and potatoes mainly" and a negative effect for the staple food choice of "rice and flour mainly." The results suggest that dietary guidelines play an attenuated moderating role in the positive relationship between obese individuals and rice and white flour choices, implying that knowing dietary guidelines can help obese individuals make better choices about their staple food structure. The study by Lim et al. (2021) found that participants with chronic disease or a family history of chronic disease were willing to sacrifice taste and cost for healthy staple foods because they were concerned about chronic disease and its associated complications.

Table A8 shows how dietary guidelines influence the choice of staple food structure for urban residents. The sign of the coefficient of the interaction between residence and dietary guidelines changes from positive to negative for "rice and white flour mainly," but this is not statistically significant. It is noteworthy that the interaction has a remarkable positive coefficient at the 1% level for "both equal," while it has a significant inhibitory effect on the choice of "whole grains and potatoes mainly." This could be due to the relatively low availability of whole grains and potatoes in urban areas, resulting in a weaker effect of knowing dietary guidelines on improving urban residents' choice of staple food structure.

Table A9 shows how the dietary guidelines influence the choice of staple food structure in the male sample. The sign of the coefficient of "rice and white flour mainly" changes from positive to negative after the interaction between gender and knowledge of dietary guidelines. The coefficients "both equal" and "whole grains and potatoes mainly" change from negative to positive, and the latter coefficient passes the 5% significance level. Dietary guidelines appear to play a moderating role in men's choice of staple food structure, implying that they can promote healthy staple food structure choices in the male sample.

3.4.2. Other health effects of dietary guidelines

The above analysis confirms that dietary guidelines have a health-promoting effect on the choice of staple food structure. Because the dietary guidelines cover a wide range of topics and include recommendations for a variety of healthy foods, this section attempts to dig deeper into the health effects of the dietary guidelines in terms of food diversity and other healthy food intakes. Table 4 shows how dietary guidelines affect food diversity and consumption of vegetables, dark vegetables,[8] dairy products, and soy products. The results show that dietary guidelines are beneficial for increasing dietary diversity and healthy food intake in daily diets. It suggests that, in addition to having a health-promoting effect on the choice of staple food structure, dietary guidelines also have a health effect on dietary diversity and healthy food intake. The definitions and descriptive statistics for all dependent variables in Table 4 are shown in Table A10.[9]

3.4.3. Potential mechanism

This section examines the health effects of dietary guidelines and the potential mechanisms involved. The Chinese Nutrition Society's dietary guidelines for Chinese are a basic document for health education and related health policies. The primary purpose of dietary guidelines is to increase residents' knowledge of nutrition and diet, thus promoting a healthy diet. Numerous studies have shown that increased knowledge of nutritional diets can improve residents' willingness and behaviors toward healthy diet (Chung et al., 2021; De Vriendt et al., 2009; Raby Powers et al., 2005; Xu et al., 2022). Based on the above analysis, we further examine the mechanistic effects of nutrition knowledge in the relationship between dietary guidelines and healthy eating.

The measurement of nutrition knowledge of the samples draws on the study by Ren et al. (2019). Scores on relevant dietary nutrition questions are used to determine it.[10] Columns (1) and (2) in Table 5 show the OLS regression results with nutrition knowledge as the dependent variable. The results show that the dietary guideline coefficient on nutrition knowledge is remarkably positive at the 1% level, indicating that knowing dietary guidelines helps residents improve their nutrition knowledge. We develop an instrumental variable for regression to address the endogeneity problem caused by omitted variables and reverse causality using the concepts of Wang et al. (2015). As the instrumental variable, we use the mean value of knowing dietary guidelines among other samples in the individual's area. The results of

Table 4
Other health effects of dietary guidelines.

Variables	(1) Food diversity	(2) Vegetables	(3) Dark vegetables	(4) Dairy products	(5) Soy products
Dietary guidelines	0.453*** (0.012)	0.398*** (0.011)	0.346*** (0.011)	0.497*** (0.011)	0.465*** (0.012)
Control variables	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.031	0.021	0.011	0.027	0.019
Observations	102,464				

Note. All dependent variables in this table are ordered discrete variables, so we use the Ologit model.
***1% significance level.

[8] In this study, "vegetables" refers to the total quantity of all types of vegetables consumed per day. "Dark vegetables" are defined as those with deep-colored flesh or skins (e.g., spinach, broccoli, carrots, tomatoes), which are typically richer in vitamins, carotenoids, and other micronutrients. The dark vegetable variable measures the proportion of total vegetable intake accounted for by these nutrient-dense varieties.

[9] See Appendix B for the original questionnaire items.

[10] See Appendix C for details on the dietary nutrition questions.

Table 5
Mechanistic effects: Nutrition knowledge.

Variables	Nutrition knowledge			
	OLS		IV-2SLS	
	(1)	(2)	(3)	(4)
Dietary guidelines	0.499***	0.469***	1.908***	1.955***
	(0.009)	(0.009)	(0.129)	(0.141)
Control variables	No	Yes	No	Yes
First-stage instrumental variable	—	—	0.958***	0.898***
			(0.036)	(0.036)
	—	—	—	—
F statistics	—	—	688.07	263.13
Observations	102,464	102,464	102,464	102,464

Note: OLS = Ordinary Least Squares; IV-2SLS = Instrumental Variables – Two-Stage Least Squares.
*** 1% significance level.

the instrumental variable regressions are reported in columns (3) and (4) in Table 5. The first-stage *F* statistics are greater than 10, and the coefficients of the instrumental variables on the dietary guidelines are remarkably positive at the 1% level, satisfying the correlation assumption and rejecting the weak instrumental variables hypothesis. The second-stage regression results show that the coefficient of dietary guidelines on nutrition knowledge is remarkably positive and larger than the regression coefficient of OLS, indicating that the effect of dietary guidelines on nutrition knowledge is underestimated when endogeneity is not considered.

4. Discussion

This paper categorizes the composition of "rice and white flour" and "whole grains and potatoes" in various proportions based on the actual dietary habits of Chinese residents. We investigate the factors that influence residents' choice of staple food structure, with a focus on the role of dietary guidelines. The MNL model estimation results show that knowing dietary guidelines can promote the consumption of whole grain (whole grains and potatoes) staple foods while decreasing reliance on refined grains (rice and white flour). In terms of other influencing factors, we find that respondents with higher socioeconomic status (higher income and education), smaller family size, and children under the age of 12 at home, as well as those who are unmarried, are more likely to choose a staple food structure based on whole grains and potatoes. However, respondents, such as men, high BMI, and urban groups, prefer a staple food structure based on rice and white flour.

Further research in this paper finds that knowing dietary guidelines improves staple food structure choices in obese, male, and urban-dwelling samples by acting as a moderator to promote healthier staple food choices in this group. Furthermore, this paper discovers that dietary guidelines facilitate dietary diversity and vegetable intake, highlighting the role of dietary guidelines in promoting a healthy diet. In the mechanism analysis section of this paper, the important role of dietary guidelines in improving nutrition knowledge is demonstrated. The role of nutrition knowledge in mediating the relationship between dietary guidelines and healthy eating is elucidated.

The findings of this paper have practical implications for obesity prevention and population-wide implementation of healthy dietary interventions. The health effects of dietary guidelines on the population's staple food structure highlight the important role of governmental health education and nutrition knowledge training based on dietary guidelines. Second, as the government works to popularize dietary guidelines, it should tailor healthy eating interventions to individuals. Focus on groups, such as obese, men, low income, younger age groups, and urban residents, as well as other groups with low health awareness, to raise their awareness and recognition of whole grain staples, such as whole grains and potatoes. Additionally, the role of dietary guidelines in promoting healthy eating may work primarily by increasing the population's knowledge of nutritious diets. With the popularity of the Internet and smartphones, policymakers can try to promote healthy eating behaviors among residents by conducting online health education and disseminating nutritional nutrition knowledge via online platforms, in addition to offline channels.

This study has several limitations that warrant consideration. First, respondents' awareness of dietary guidelines was self-reported based on a categorical response (yes/no), which may not fully capture the depth or accuracy of their knowledge. Some individuals may have only heard of the guidelines without understanding their content, potentially leading to misclassification bias. Second, body mass index (BMI) was self-reported, which may introduce measurement error due to under- or over-reporting of weight and height. Third, chronic disease status was coded as a binary variable (presence or absence), which does not distinguish between different types or severity of conditions. Fourth, while our classification of staple food structure captures broad categories, it does not consider differences in food preparation methods, which may influence nutritional outcomes even within the same food group. Finally, the findings reflect population-level patterns and do not account for subgroup-specific determinants, which limits the generalizability of the results to targeted dietary interventions. Future research should employ more refined nutrition knowledge indicators, objective health measures, and richer disaggregation of both dietary intake and health outcomes.

Ethics approval statement

Approval for this study was provided by the ethics review board of Qufu Normal University (Qufu#21-08-004).

CRediT authorship contribution statement

Shijiu Yin: Writing – review & editing, Methodology, Funding acquisition, Data curation. **Huiying Peng:** Writing – review & editing, Supervision, Software, Resources, Investigation. **Yuqiu Qin:** Writing – review & editing. **Zongshuo Yin:** Writing – review & editing, Writing – original draft, Software, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.fufo.2025.100738.

Data availability

Data will be made available on request.

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