

# Analysis of the Influence of Dietary Pattern on the Health Level of Residents in China

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**Abstract.** We used the DEA cross-efficiency method to explore the health effects of provincial differences in dietary patterns in China. The result showed that for the group aged 0-14, Inner Mongolia and Guizhou provinces rank the top, and children in Zhejiang province should add more dairy products and eggs in the diet; For the group aged 15-64, there are fewer differences between provinces, but it generally shows high calorie and high protein intake among them; For the group aged over 64, Shanghai and Tianjin provinces are low-ranking, and old people in Shanghai province should reduce the egg intake while those in Tianjin province should have more vegetable and meat intake.

## Introduction

Dietary pattern is a crucial factor affecting the health status as well as an important indicator to measure the social development of a country and the well-being of residents. At the 2011 High-level Meeting of the UN General Assembly, it's adopted that poor diet was one of the four leading behavioral risk factors for NCDs [1]. In recent centuries, throughout the world, major shifts in dietary patterns are occurring [2]. They have become increasingly diverse and generally tend to higher total saturated fat intake, which, to a large extent, affects the health level of regional residents. Compared with the 1960s, the number of countries with saturated fat intake exceeding the recommended value increased sharply in the early 21st century, and the incidence of obesity and nutrition-related chronic diseases increased significantly, especially in low-income and middle-income people in developing economies [3, 4].

In China, since the reform and opening, the food consumption level of residents has been continuously improved, and the long-term trend is towards higher fat, higher energy density and fewer fibres intake. Although the intake of calories has gradually reached the recommended level and the dietary and nutritional status of residents has been guaranteed, there are still some problems such as irrational consumption of edible oil, meat, beans and milk [5]. The change of dietary pattern has a series of impacts on residents' health. Residents with abnormal blood lipid, high blood sugar and obesity continue to expand. In addition, the incidence of infectious diseases, parasites, malnutrition and other related diseases is decreasing, and respiratory diseases no longer dominate the cause of death, while nutrition-related chronic diseases such as heart disease, cerebrovascular diseases and tumors have gradually become the main causes of death [6].

Previous studies have explored the effects of dietary structure on the physical health of various groups of people from different perspectives, but mainly relied on qualitative analysis or quantitative analysis at the individual level. We try to focus on the macro level and explored from three aspects, including the regional differences of dietary structure, correlation of dietary pattern and residents' health and health efficiency of each province.

## Methods

### Data

The dietary data came from a nationwide survey conducted by the University of Chinese Academy of Sciences in 2017, in which 6264 residents were interviewed. We recorded the types and quantities of food intake by them in three days and some other information including their age, address, occupation was also collected. The health-related data are mainly from ‘China Health and Family Planning Statistics Yearbook 2017’ and ‘Report on Chronic Disease Risk Factor Surveillance in China’. The chronic disease data of the elderly originated from ‘China Health and Retirement Longitudinal Study’ by Peking University, and the obesity and overweight rate data were calculated based on the result of 2015 Chinese General Social Survey.

### Data Envelopment Analysis (DEA)

The Principle of DEA is by keeping the input or output of the decision making units (DMUs) unchanged, use linear programming to determine the relatively effective production frontier, and then projecting each decision making unit to the production frontier to compare the degree of departure of the decision making unit from the DEA frontier, that is, the efficiency of the decision making unit. CCR model is a widely used classical model, which preliminarily distinguish the effective DMUs with relative efficiency equal to 1 from the non-effective DMUs with relative efficiency less than 1, but cannot fully rank the decision making units, and there are also some drawbacks such as exaggerating the advantages of the evaluated units. Therefore, cross efficiency evaluation method is further adopted in which scholars add various secondary objectives to CCR model to solve those problems. In this paper, two kinds of secondary objectives, benevolent cross-evaluation and aggressive cross-evaluation, proposed by Dolye and Green, were selected [8]. According to the average value of the two results, the efficiency of health management in each province was ranked and compared.

In our work, dietary data, the number of health technicians per 1000 population and per capita disposable income were used as input part. On the other hand, residents were divided into three groups by age ranges: 0-14, 15-64, more than 64 years old, and we chose three to four health indicators as the output part for each group, as shown in table1.

Table 1. Selection of health indicators

age	>=65	15-64
health indicators	Prevalence of hypertension (%)	Obesity rate (%)
	Heart disease incidence (%)	Overweight rate (%)
	Prevalence of abnormal blood lipid(%)	Underweight rate (%)
	Incidence of memory-related diseases (%)	Self-assessment of health
age	0-14	all
health indicators	Average height	Mortality (%)
	Moderate to severe malnutrition in under 5 years of age (%)	Life expectancy
	Average height	Self-assessment of health
		Proportion of diabetic population

## Results

The result from DEA cross-efficiency model is shown in table 2. Obviously, there is still much room for the improvement of health management level in China, and different provinces and regions are facing different problems. For instance, the health status of children in Inner Mongolia is good, but it ranked lower in the other two groups. From the perspective of dietary pattern, the intake of dairy products of children in Inner Mongolia is much higher than that of other provinces,

and milk is rich in high-quality protein, fat, minerals, vitamins, lactose and other nutrients, and calcium nutritional status in adolescence plays a decisive role in the peak bone mass of adults. Hubei province has a better health performance in the elderly group, may benefit from its higher intake of aquatic products, as many medical studies have shown that higher intake of high saturated fatty acids can lead to a significant increase in blood lipid levels, and compared with other livestock and poultry meat, such as pork, which is mainly saturated fatty acids, aquatic products rich in unsaturated fatty acids are more popular among longevity elders. In addition, Beijing and Shanghai rank lower in each group, on the one hand, it is due to the deficiencies of dietary structure, on the other hand, high per capita disposable income in the input indicators would result in low computational efficiency.

Table 2. Calculation Results of DEA cross-efficiency model

group	all	0-14	15-64	>=65	group	all	0-14	15-64	>=65
Beijing	0.432	0.544	0.423	0.200	Henan	0.476	0.760	0.491	0.374
Tianjing	0.484	0.791	0.491	0.238	Hubei	0.464	0.755	0.458	0.432
Hebei	0.485	0.801	0.481	0.276	Hunan	0.462	0.717	0.445	0.333
Shanxi	0.472	0.745	0.479	0.350	Guangdong	0.474	0.649	0.478	0.472
Inner Mongolia	0.471	0.938	0.437	0.247	Guangxi	0.479	0.750	0.473	0.433
Liaoning	0.415	0.681	0.421	0.333	Yunnan	0.446	0.772	0.442	0.481
Jilin	0.450	0.863	0.440	0.254	Chongqing	0.486	0.787	0.487	0.475
Heilongjiang	0.433	0.862	0.386	0.264	Sichuan	0.458	0.690	0.440	0.320
Shanghai	0.408	0.656	0.401	0.214	Guizhou	0.489	0.910	0.498	0.425
Jiangsu	0.451	0.678	0.481	0.319	Shaanxi	0.478	0.648	0.480	0.414
Zhejiang	0.432	0.559	0.446	0.317	Gansu	0.480	0.811	0.471	0.481
Anhui	0.493	0.863	0.487	0.335	Xinjiang	-	0.794	-	0.428
Fujian	0.466	0.648	0.477	0.386	Ningxia	0.484	0.667	0.439	-
Jiangxi	0.491	0.743	0.405	0.440	Shandong	0.437	0.683	0.480	0.257
Hainan	-	0.768	-	-	Qinghai	0.467	-	-	-

Note: some provinces lack grouped data and the result is replaced with "-"

The overall health management level of the group aged 0-14 was significantly higher than that of other groups, reflecting the general concern of residents on children's nutrition and health. In this group, the efficiency of Beijing and Zhejiang is relatively poorer. The main manifestation of Zhejiang is that the intake of vegetables and fruits is much higher than the average value, as well as aquatic products, but the intake of eggs and milk is insufficient. And the proportion of moderate to severe malnutrition of children under 5 years old in this province is also slightly larger than the national average. So it is recommended to increase egg and milk intake to supplement protein and calcium. As for Beijing, almost all types of dietary consumption in Beijing are above the provincial averages, but excessive nutrition in children may also lead to obesity and overweight and other health problems. In addition, according to the Dietary Guidelines for School-age Children in China, it is recommended that school-age children consume 3-4 servings of fruit and 2-3 servings of meat, eggs and aquatic products, while according to the survey data, the intake of livestock, poultry, eggs and aquatic products of children in all provinces is higher than that of fruits. In the 15-64-year-old group, the problem of excessive calorie intake is common. Taking Heilongjiang, Shanghai, and Jiangxi as examples, the intake of fruits and dairy products in these provinces is lower than the recommended level of dietary guidelines for residents, and the grains intake is kind of excessive in Heilongjiang while meat account for high proportion of total dietary in Shanghai and Jiangxi. In the elderly group aged 65 and over, compared with Gansu and Yunnan, where the cross-efficiency is higher, the elderly in the Shanghai area are more likely to consume more grains and eggs, while the intake of aquatic products is slightly lower, and aquatic products and dairy products of the elderly in Tianjin both exceed the average level, but the proportion of meat and vegetables is lower. It is worth noting that the results show that the average intake of dairy products and aquatic products is higher in the provinces ranking lower, but the health level of children in the provinces with more dairy products and elderly in the provinces with more aquatic products are better. The possible reason is that the health effects of dairy products and aquatic products are more obvious in children or in old age, and may be offset by other types of food on an overall level. According to the result

of the all age group, higher grains intake tends to resulting a lower level of health. The possible reason is that refined grains gradually exceeds the proportion of whole grains in the dietary, and the main nutrient components of refined cereals is starch, the excessive intake of which is easily converted into fat accumulation, may also destroying the acid-base balance of human body.

## **Conclusion**

The dietary structure of different age groups in different provinces and regions of China is not exactly the same, which causes the difference of health level. Overall, the intake of vegetables, fruits and dairy products is generally low. From the point of view of nutrition, vegetables and fruits are rich in vitamins, carotenes and minerals, which can stimulate human resistance and improve immunity. Dairy products are rich in calcium and easy to absorb, which is the most effective way for human body to absorb calcium. Therefore, it is advisable to advocate that residents eat a little each time but many times, with fruits and dairy products as snacks, and skimmed milk and its products should be preferred among people with lipid problems. In some areas, the proportion of grain intake of the elderly is too large, while the intake of vegetables, fruits and dairy products is less. Many elderly people in longevity townships in the world have similar dietary habits, such as eating more vegetarian food and grains. Therefore, the elderly should be encouraged to reduce staple food intake, eat more vegetables and fruits, and fish, shrimp and shellfish food instead of livestock.

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