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Research on the correlation between different dietary habits and chronic diseases in China

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Abstract. Among all chronic disease risk factors, an unhealthy diet is the first and most widely affected risk factor. Although there have been many studies on eating behavior, there is a lack of quantitative studies on the association between dietary taste differences and chronic diseases in different regions of China. Therefore, this paper utilizes crowd-sourced online recipe data to extract multi-dimensional flavor information from cuisine, combined with geo-tagged restaurant-type interest points data from different regions, to quantitatively analyze the flavor preferences of different groups of people. From the perspective of spatial heterogeneity, we established the association between the 7 flavors and three chronic diseases (hemorrhagic stroke, pancreatic cancer, and upper respiratory infection), and obtained the measure of the explanation ability of dietary flavor on the spatial distribution of chronic diseases. The results show that salty is the primary flavor risk factor for hemorrhagic stroke; sweet to a certain extent is the primary flavor risk factor for pancreatic cancer, and the degree of sweetness is not simply linearly related to the risk of pancreatic cancer; spicy is the primary flavor risk factor for upper respiratory infection, and all three are statistically significant.

Keywords: chronic disease, dietary habits, Food taste, multi-source data.

1. Introduction

Chronic diseases, also known as non-communicable diseases, kill 41 million people each year, equivalent to 71% of global deaths [1]. Chronic diseases have a devastating social, economic and public health impact. The World Health Organization (WHO) has identified four modifiable behavioural risk factors for chronic disease, including unhealthy diet, smoking, alcohol consumption and physical inactivity [1]. In 2017, the Global Burden of Disease (GDB) study showed that 10.9 million deaths worldwide were attributed to unhealthy diets [2]. Dietary factors are the most common factors affecting the occurrence and development of chronic diseases [3-5]. Therefore, conducting a comprehensive estimation and comparison of the disease burden associated with dietary factors is essential for developing specific and effective strategies for disease prevention and control. In many studies on eating behavior, there are few studies related to eating taste, and taste information is mostly based on the subjective qualitative evaluation of subjects, and there is a lack of quantitative research on the relationship between regional taste preference and chronic diseases [6-7]. China has a vast territory, a large population and different customs. The products, climate, history, culture, religion and other factors in different regions have created the unique food culture in each region, and then evolved into Chinese

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food culture with different flavors. This paper aims to explore the correlation between chronic diseases and different dietary habits. Hemorrhagic stroke, pancreatic cancer and upper respiratory tract infection are taken as examples of three chronic diseases to establish the correlation between chronic diseases and dietary taste. The spatial correlation between the two is analyzed by using geographical detector method, and the influence of dietary taste preference on the occurrence of chronic diseases is also explored. In order to provide ideas for the study of the pathogenesis of related diseases in the field of public health and the formulation of dietary risk factor intervention measures for chronic diseases.

2. Methodology

2.1. Data collection

The taste data was obtained from the internet, which divides Chinese cuisine into 20 categories according to the origin of cuisines, including Sichuan cuisine, Northeast cuisine and Guangdong cuisine [8]. This paper uses the information of ingredients and seasonings in each dish recipe (for example, the ingredients and seasonings used in Sichuan cuisine "spicy boiled fish" include salt, sugar, dried red pepper, Sichuan peppercorns, scallions, garlic, etc.) as the main data source for extracting dietary tastes.

Cause-of-death monitoring data in routine testing is one of the sources of chronic disease data. This article uses the disease cause of death monitoring data from the Chinese center for Disease Control and Prevention (http://ncncd.chinacdc.cn/) published in 2013 "Chinese residents disease death main reason atlas (database)"[8]. The cause-specific mortality rate provided by the database, in units of 1 in 100,000, refers to the number of deaths per 100,000 people in a place due to a certain disease, which reflects the degree of harm to the lives of residents from various diseases and injuries. According to the existing research data, the causes of death of hemorrhagic stroke, pancreatic cancer and upper respiratory tract infection were used as three chronic diseases according to the degree of correlation between diseases and taste.

2.2. Research methods

Firstly, the quantified values of taste characteristics in 7 dimensions of different cuisines were obtained from recipe data from multiple sources. The POI data was used to calculate the proportion of various cuisines. Then, the flavor of each provincial unit is combined with the proportion of each provincial unit to obtain the 7-dimensional flavor characteristics. Finally, the association between taste and death attribution data for three chronic diseases was examined (Figure 1).

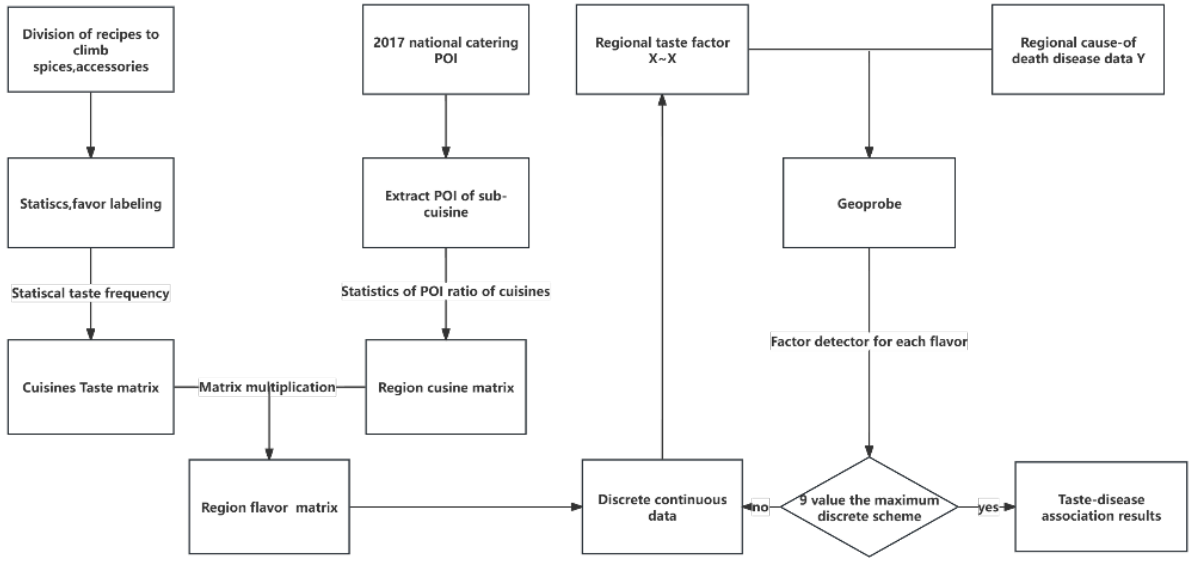

Figure 1. Data processing and research flow

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2.2.1. Cuisines taste extraction

Use web crawlers to get recipe information for 20 cuisines on the Meishij website. Due to the lack of a standardized measurement for ingredient quantities in recipes, this paper aims to assess taste based on the frequency of ingredient usage. Firstly, it is necessary to summarize the "accessories" and "spices" in all recipes, and combine the ingredients with the same name. By consulting the taste information of food ingredients, seven common taste description methods were selected. They are respectively "sour", "sweet", "fresh", "salty", " greasy", "spicy", and "stimulating" (the "stimulating" here refers to the "stimulating" taste of the spices of chili, and the "stimulating" taste refers to various spicy and stimulating tastes outside the source of chili, such as the taste of mustard and garlic), and to establish the "ingredient-taste" comparison table [9]. Next, the flavor labels for each ingredient are labeled, and then the flavors of each dish are labeled. Each ingredient can be labeled with 0 to multiple flavors, such as "seafood soy sauce" labeled as "salty" and "fresh". If a dish uses multiple seasonings that contain a certain flavor, the dish will be labeled with that flavor multiple times. The number of times each dish was marked with various spices was counted, and the frequency of use of 7 spices for each dish was obtained. According to the classification of cuisines, the frequency of use of 7 flavors of each cuisine is obtained. According to the quantity of each cuisine, the flavor frequency of each cuisine is calculated, which is used as the quantitative index of a certain flavor of a certain cuisine, and the quantitative description of 7 flavors of 20 cuisines is obtained

2.2.2. Calculate the flavor characteristics of each region

This paper use the POI corresponding to 16 types of cuisines to extract regional tastes. The proportion of the number of food POI in 16 types of cuisines in 33 provincial units to the total effective food POI was calculated, and the quantified value of 7-dimensional taste characteristics of each provincial unit was calculated according to the taste characteristics of each cuisine. Taking the "spicy" taste of Sichuan province as an example, the proportion of Sichuan food POI in all effective POI in the province was calculated, which was taken as the weight, multiplied by the spicy taste index of Sichuan cuisine, as the contribution value of Sichuan cuisine to the spicy taste of Sichuan province, and so on, the contribution value of 16 cuisines to the spicy taste of Sichuan Province was accumulated, and the quantitative value of Sichuan taste spiciness was obtained.

3. Results

3.1. Taste measurement of cuisines

Comparing the use degree of each flavor in 20 kinds of cuisines, it can be seen that "spicy" flavor is the most frequently used, followed by "salty" flavor, and "spicy" and "sour" flavor seasoning are used less frequently. Comparing the use of 7 flavors in 20 kinds of cuisines, it is found that Hong Kong and Taiwan dishes are heavy on "sweet", Sichuan dishes are heavy on "hot" and Hubei dishes are heavy on "hot". The above results are basically in line with people's general cognition.

3.2. Flavor characteristics of each research unit

In most provincial administrative units, Sichuan cuisine and halal cuisine accounted for a higher proportion of POI. In addition, each type of cuisine has a higher proportion of its own origin region than other regions, for example, Anhui cuisine is the most popular in Anhui province, and Zhejiang cuisine is the most popular in Zhejiang province. In Macau and Hong Kong, except for "sweet", the use of other flavors is weak; in Gansu Province, Ningxia Hui Autonomous Region, Qinghai Province, the overall taste is heavy.

3.3. Results of taste discretization

In relevant studies, three diseases, hemorrhagic stroke, pancreatic cancer and upper respiratory tract infection, were combined with seven flavors respectively to discretize the flavor data. The optimal discretization scheme is shown in table 1.

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Table 1. The optimal discretization scheme

Illness	Taste risk factor	acid	sweet	fresh	salty	greasy	spicy	stimulating
Hemorrhagic apoplexy	acid	0.366						
	sweet	0.792	0.451					
	fresh	0.857	0.855	0.162				
	salty	0.748	0.737	0.921	0.499			
	greasy	0.878	0.851	0.646	0.926	0.363		
	spicy	0.805	0.794	0.969	0.780	0.868	0.523	
	stimulating	0.835	0.881	0.922	0.820	0.905	0.859	0.514
Pancreatic cancer	acid	0.264						
	sweet	0.859	0.628					
	fresh	0.766	0.944	0.122				
	salty	0.860	0.817	0.808	0.426			
	greasy	0.759	0.816	0.654	0.705	0.298		
	spicy	0.763	0.952	0.848	0.886	0.856	0.446	
	stimulating	0.529	0.962	0.798	0.850	0.852	0.838	0.425
upper respiratory tract infection (urti)	acid	0.441						
	sweet	0.800	0.434					
	fresh	0.854	0.816	0.163				
	salty	0.848	0.818	0.971	0.535			
	greasy	0.545	0.786	0.702	0.891	0.440		
	spicy	0.887	0.862	0.966	0.955	0.919	0.505	
	stimulating	0.757	0.819	0.922	0.806	0.724	0.906	0.560

The results of hemorrhagic stroke showed that among the 7 flavors, "salty" was the primary taste risk factor for hemorrhagic stroke. Experimental results of pancreatic cancer show that among the 7 flavors, "sweet" has the strongest ability to explain the spatial distribution of the disease. The experimental results of upper respiratory tract infection showed that among the 7 flavors, "Xin" or “spicy” had the strongest ability to explain the spatial distribution of the disease.

In addition, interactions between flavors can also increase the risk of developing the three diseases targeted in this paper, especially flavors. The interaction between "fresh" and the other six flavors all increased the risk of the target diseases nonlinearly, similar to the effect of the catalyst, but interestingly, as a single flavor factor, "fresh" had the weakest ability to explain the three diseases. The mechanism of this needs to be further studied.

4. Conclusion

As an exploratory attempt to quantitatively mine disease risk factors using data, this paper has achieved statistically significant results, but the uncertainty and applicability of the results still need further discussion and reflection.

On the one hand, restricted by data sources, this paper uses the taste data obtained from food and beverage POI in 2017 to try to explain the data on disease causes of death in 2013. Considering the retardation of the influence of food taste on chronic diseases, the timing of the data design in the experiment fails to achieve optimal logical sequencing and is instead constrained by data accessibility. However, as dietary habits in a region are developed over a long period of time, it is unlikely that there

will be significant changes in dietary taste within a short timeframe. Therefore, the attempt made in this paper holds scientific significance. On the other hand, this experimental conclusion is only applicable to China, and the experiment needs to be adapted to local conditions for different countries or regions.

In this context, it is not difficult to see the statistical significance of data analysis on the correlation between various dietary habits and chronic diseases in China. The theory of dietary taste and chronic disease is not confined to China. If chronic disease data with higher spatial resolution can be obtained, the idea of this experiment can be extended to different scale studies to explore more region-specific chronic disease risk factors, so as to formulate targeted public health policies.

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