The Mobility of Income-related Inequality in Food Preferences Among Chinese Adults: a Population-based Longitudinal Study

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**The mobility of income-related inequality in food preferences
among Chinese adults: a population-based longitudinal study**

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Abstract

Background:

This study aimed to investigate the income-related inequality of food preference and its mobility in the long run, and to quantify the determinants' contributions of socioeconomic inequality mobility in food preference in China.

Methods:

The data were sourced from the China Health and Nutrition Survey (CHNS) conducted in 2006, 2009, 2011 and 2015, respectively. A study sample of 3940 adults were included for analysis. Five preselected questions were used to construct a summary food preference index. Cross-sectional and longitudinal concentration indices were used to measure the income-related inequality in food preference at a certain time and for a period, respectively. Health-related income mobility index was used to measure the gap between cross-sectional and longitudinal income-related health inequality concentration indices. Decomposition analysis was used to decompose income mobility index into its determinants.

Results:

The mean scores of food preference increased from 17.641 in 2006 to 18.881 in 2015. The richest people had the highest mean scores of food preference compared to other income groups in each year. Age, gender, income, education, and dietary knowledge score were positively associated with healthy food preference. The concentration indices of food preference score on income in each year were all positive, indicating that there was pro-rich inequality in food preference score with the rich having higher preference scores in each period. The income mobility index of food preference was -0.1426 after 4 periods, indicating that the degree of pro-rich inequality in food preference was larger than that at the baseline in the long run. Decomposition analysis showed that being married and living in Western China made healthy food preference more concentrated among the rich in the long run. Whereas increasing age and dietary knowledge contributed to making healthy food preference behavior less concentrated among the rich in the long run.

Conclusions:

The cross-sectional measure of food preference score inequality was underestimated in the long

run. Our study suggests that people with decreased income could be taken as targeted population in future public intervention measures, and narrowing the regional gap between Eastern and Western China could be strengthened in future Chinese policies.

Keywords: Food preference, Income-related inequality, Multi-level model, Health-related income mobility

Background

As an element of human existence and development, health is an eternal human topic for human beings. Health is determined by various factors, such as eating habits, daily living habits, physical exercise, mental state. Among all these factors, developing and maintaining healthy dietary habits are one of the most important determinants that closely related to human health [1]. Good dietary habits can help people to have good intake of nutrients that are essential for the growth, development, and maintenance of body functions. Insufficient nutrient intake that does not meet nutrient requirements can influence the metabolic processes to slow down or even stop [2].

China's expansive economic growth in the past decade has gradually accelerated the pace of life in many cities [3]. These changes have also increased the availability of energy-dense foods and sugar-sweetened beverages in the market. Consequently, due to the taste preference, sensory attributes, cost, availability, convenience, cognitive restraint, and cultural familiarity, many people have developed palate preferences for these types of food. Food preferences are strongly associated with eating habits and diets. [4]. Studies have found that preferences in these foods with extra calories may contribute to the development of overweight and obesity, which are the leading factors for many chronic diseases. Therefore, there are two points that researchers need to pay attention to. The first point is related to what kind of foods and beverages people are willing to consume. This matter should be further studied so that possible interventions to help people to practice healthy eating habits can be promoted. The second point is the distribution of bad food preference between the rich and the poor. Monitoring the distribution is important so that an intervention measure can be targeted on the groups that need it more.

Although several studies have published using one-wave cross-sectional survey with focusing on food preference in children or adolescents, studies on food preference of adults are less reported [5-8]. As children are usually taken care of by their parents, their dietary intake often depends on the family context and their food knowledge. Consequently, their food preferences are more likely to be influenced by their caregivers. To fill in the gaps in the current literature and provide more information, the main interest of this study is to investigate the distribution of food preference and its inequality in adults. This study has three objectives. Firstly, to investigate the distribution of healthy food preference for Chinese adults and to measure income-related inequality over time.

Secondly, to find determinants of food preference; and lastly, to quantify each determinants' contribution to the mobility of food preference inequalities. The study complements existing literature by providing the first longitudinal study on inequality in food preference. Our study will provide evidence-based findings for policy makers and public health workers to develop public health policies and strategies to help people in making a healthy food preference and eliminating inequality between the poor and the rich.

Methods

Study design

A retrospective cohort study was performed to track the change of food preference score and its inequality over time as well as to analyze the contribution of each determinants on this mobility.

Data source

The data were sourced from the China Health and Nutrition Survey (CHNS). CHNS is a multidisciplinary and national panel dataset on nutrition, health status, socioeconomic status, community information and family relations of Chinese. The first wave of CHNS was conducted in 1989 and the following waves of CHNS were conducted every 2-4 years. A multistage, random cluster sample design was used to draw the surveyed samples in 15 provinces and municipal cities that substantially vary in geography, economic development, public resources, and health indicators. CHNS was initially designed to estimate the impact of the health, nutrition, and family planning policies and programs implemented by national and local governments. It was also designed to investigate how the social and economic transformation of Chinese society was affecting the health and nutritional status of the Chinese. Overall, the gross survey sample included 30,000 individuals in 7200 households. Detailed information on procedure of data collection and quality assurance measures could be found in CHNS official website (<https://www.cpc.unc.edu/projects/china>). This

study used the balanced panel data conducted in 2006, 2009, 2011 and 2015, indicating only those participants who were followed up in each survey were included. Since our study focused on adult samples defined as those aged ≥ 18 years old ($n=3978$), respondents whose key information (food preference/income) was missing were further excluded in this analysis, leaving a study sample of 3940 adult respondents.

Variables

Food preference

Five questions on preferences for five kind of food were preselected in the survey: fast foods, salty snack foods, fruit, vegetables, and soft drinks/sugary fruit drinks. A five-point Likert scale (dislike very much, dislike, neutral, like, like very much) was employed to estimate the degree of liking for each question. A score for each category ranging from 1 to 5 was generated to measure the preference degree, with a higher score indicating a healthier preference. A summary of food preference index was created in our study to measure the overall degree of healthy preferences with the sum of scores on five questions. The maximum score for food preference index is 25.

Other variables

Socioeconomic characteristics considered in this study were comprised of age, gender, household size, education (illiterate, elementary, middle school, high school, and university), marital status (unmarried, married, and others), working status and income. Income was measured by net per capita household expenditure. Net per capita household expenditure was calculated by subtracting health expenditure from total household expenditure and dividing by household size. In descriptive analysis, income was equally grouped into 5 categories: poorest, poorer, middle, richer, and richest. Regional characteristics considered in the study were urbanization index and

geographic regions (Western China, Central China, and Eastern China). Urbanization index is a continuous variable to assess the urbanization degree of the communities in China. The construction of this indicator includes the 12 aspects of urbanization, which are population density, economic activity, traditional markets, modern markets, transportation, health infrastructure, sanitation, communication, social services, diversity, education, and housing[9]. Each aspect was given a score from 0 to 10, and then weighted equally in the overall index and added together for an overall maximum possible score of 120. A higher urbanization score indicates greater urbanization. Compared to urban/rural dichotomy measure, urbanization index encompasses the underlying complexity and heterogeneity of the community that would otherwise be missed in binary measure. Detailed construction procedure could be found on official CHNS website (<https://www.cpc.unc.edu/projects/china>). Lastly, since there was a potential association between dietary knowledge and food preference, dietary knowledge was also considered as a covariate in our study [10, 11]. Dietary knowledge score was a summary variable constructed from the 12 questions surveyed in CHNS. Respondents were asked to choose “strongly disagree”, “disagree”, “neutral”, “agree” and “strongly agree” for each question. For each positive question, we assigned a score ranging from 0 to 2, with 2 for strongly agree, 1 for agree, and 0 for other answers, and vice versa. The maximum dietary knowledge score is 24 with a higher score indicates better knowledge.

Statistical analyses

Means and standard deviations (SD) were used to describe the continuous variables of baseline characteristics of respondents, percentages were used to describe the categorical variables of baseline characteristics.

In the past decades, there have been numerous methodological sources on the analysis of longitudinal data [12-14] . Multilevel model was a widely used methodological and statistical source on the longitudinal study which collected the repeated data on the same sample of respondents over time [13]. Multilevel model has better performance in explaining the variability of the dependent variables [15]. In multilevel models for longitudinal data, the lowest level of data which is referred to as “Level-1”, γ_{00} . Each Level-1 measurement is nested within a particular research participant. The respondents constitute Level-2 data. The simplest multilevel models without any independent variables (random intercept) are presented as follows:

Level 1 repeated-measures level model

$$y_{ti} = \beta_{0i} + e_{ti}$$

Where t represents the measurement occasions at time t , i represents the i th participants, y_{ti} is the estimated average score of independent variables for i th individual at time t .

β_{0i} is the estimated average y (over the time period) for the i th individual. e_{ti} is the within-individual random error which captures the differences between the observed average independent variable at time t and predicted dependent variable value of i th individual.

$$\beta_{0i} = \gamma_{00} + U_{0i}$$

where γ_{00} is the grand mean of y , and U_{0i} is the difference between the i th average y and grand mean of y .

The random intercept model with one independent variable can be written as follows:

$$y_{ti} = \beta_{0i} + \beta_{1i}x_{1ti} + e_{ti}$$

Concentration index is nowadays the most widely used analytic tool to measure the relative magnitude of inequality in health economics. The corresponding regression-based decomposition methods firstly proposed by Wagstaff et al. are being used in a large number of settings and

populations [16]. However, this kind of approach has predominantly applied to cross-sectional data. The cross-sectional concentration index at certain time point is as follows:

$$CI^t = \frac{2}{\bar{y}_t} cov(y_{it}, R_i^t)$$

Where y_{it} is a cardinal measure of the health of individual i at t time, $\bar{y}_t$ is the average health of individual i at t time, R_i^t is the relative rank of individual i in the distribution of N incomes in period t .

With the increasing amount of data from cohort study, the dynamics of health and their relation to socioeconomic characteristics as revealed by longitudinal data should be paid more attention to.

Shorrocks introduced the concept of income mobility to capture the degree to which income inequalities fade as the time window over which the population being analysed extends, and therefore considered inequality in the distribution of individual incomes averaged over a sequence of time periods [17]. Subsequently, under the Shorrocks's framework, Jones and López-Nicolás developed a health-related income mobility index to measure the gap between cross-sectional and longitudinal income-related health inequality concentration indices [18]. Longitudinal

concentration index is as follows:

$$CI^T = \frac{2}{\bar{y}^T} cov(y_i^T, R_i^T) = \sum_t \omega_t CI_t - \frac{2}{NT\bar{y}^T} \times \sum_i \sum_t (y_{it} - \bar{y}^t)(R_i^t - R_i^T)$$

Where $\omega_t = \frac{\bar{y}^t}{T\bar{y}^T}$, R_i^T is the relative rank of individual i in the distribution of average incomes after T periods, y_i^T is the average health of individual i after T periods.

Health-related income mobility could be calculated from following formula:

$$M^T = 1 - \frac{CI^T}{\sum_t \omega_t CI_t} = \frac{2}{N \sum_t \bar{y}^t CI_t} \times \sum_i \sum_t (y_{it} - \bar{y}^t)(R_i^t - R_i^T)$$

Where M^T is the mobility index of y after T periods.

The mobility index could also be decomposed into the contributions of different determinates with the use of following expression:

$$M^T = \sum_{k=1}^k \hat{\beta}_k \frac{\sum_t \bar{x}_k^t CI_{xk}^t}{\sum_t \bar{y}^t CI^t} M_{xk}^T + residual$$

Where $\hat{\beta}_k$ is the coefficient for kth variable, $\bar{x}_k^t$ is mean of kth variable at time t, CI_{xk}^t is concentration index of kth variable at time t. $\bar{y}^t$ is the mean of y at time t. CI^t is the concentration index of y at time t. M_{xk}^T is the mobility index of kth independent variable after T period. *residual* is the residual error.

All statistical analyses were carried out on SAS 9.4. A p value of 0.05 or less is considered statistically significant in the study.

Results

Summary statistics of respondents' characteristics at baseline are presented in Table 1. A total of 3940 adults, including 1814 (46.04%) men and 2126 (53.96%) women, participated in the study with the mean (standard deviation, SD) age of 49.63 (12.55) years. More than 90% were married, and over 31% of respondents had middle school educational attainment. 1745 (44.29%) of respondents lived in Western China, while 1234 (31.32%) and 961 (24.39%) lived in Central and Western China, respectively.

-Table 1 Characteristics of respondents at baseline-

Figure 1 shows the mean scores of food preference by characteristics groups over time. According to what has been revealed by the figure, the mean scores of food preference showed an increasing trend from 2006 to 2015, improving from 17.641 to 18.881. The richest people had the highest mean scores of food preference compared to other income groups in each year. Eastern China consistently showed the highest mean scores of food preference in every year compared to Central and Western China, and this trend increased after 2009. From 2006 to 2015 the lines were

overlapped among residents with elementary, middle school, and high school attainments. However, residents with university degree were evidently higher than others, and the illiterate had the lowest scores. Although there was little difference between married and unmarried, residents with other marital status (including widowed, separated, and divorced) had absolutely the lowest scores among all groups.

-Figure 1 The mean score of food preference by characteristics groups over years-
Table 2 shows the factors associated with food preference identified from multi-level random intercept model. Age, gender, income, education, and dietary knowledge score were positively associated with food preference. Higher values of these variables indicated higher scores (healthier) of food preference. People living in Central and Western China had relatively lower food preference score compared to respondents living in Eastern China with the control of other covariates.

-Table 2. Adjusted association between food preference and determinants-
Table 3 shows the concentration and mobility indices for food preference by year. The concentration indices of food preference score on income in each year were presented in CI^I column. The indices were all positive, indicating that there were pro-rich inequalities in food preference with the rich had the higher food preference score in each period. The longitudinal concentration indices were presented in CI^T column. In a long run, the degree of pro-rich inequality in food preference were larger than that at the baseline. Term 1 and Term 2 explained what have driven this increase. Term 1 is the weighted average of the cross-sectional concentration indices up to corresponding year. There was a slight upward trend in term 1, as the cross-sectional concentration indices for the later period were larger than that at the baseline. It is worth

mentioning that the weighted average cross-sectional concentration indices were smaller than the indices with the distribution of longitudinal averages. Term 2 shows the difference between period specific income ranks and ranks for average income over all periods and their relationship to food preference. Accordingly, the estimates in Term 2 column were all negative except at baseline. This makes long run inequality greater than what we obtained with cross-sectional measures. This effect increased the long-run income-related inequality by 14.26%, which reflected by the mobility index of -0.1426.

-Table 3 Concentration and mobility indices for food preference by year-

The results of decomposition analysis of food preference mobility index are showed in Table 4. The first column presents the longitudinal concentration index of independent variables. In a long run prospective, higher income, educational attainment, urbanization index, and married were concentrated in the rich, which means there was a pro-rich inequality in these characteristics. Whereas the longitudinal concentration indices of age, other marital status, living in Central and Western China were negative, indicating that these characteristics were more concentrated in the poor. The second column shows the mobility index of independent variables, which measures how much the longitudinal perspective alters the picture that would emerge from cross-sectional view. A negative mobility index of independent variables indicates that the weighted sum of the cross-sectional concentration indices of independent variables underestimates the degree of long-run inequality, and vice versa. In a long run, income and marital status were overestimated, however, education, age, central and western china were underestimated using the cross-section perspective. The third column shows the elasticity of food preference score with respective to each determinant variable. Last column shows the contribution of independent variables on mobility indices for

food preference score. Married, and living in Western China made healthy food preference more concentrated among the rich in the long run, whereas increasing age and dietary knowledge contributed to making good food preference behavior less concentrated among the rich in the long run.

-Table 4 Decomposition of the mobility index of food preference by determinants-

Discussion

Among a set of health maintenance behavior, healthy eating is one of the best things people can do to maintain their weight and prevent health problems such as heart disease, high blood pressure, type 2 diabetes, and some types of cancer. Healthy eating starts with healthy food choices. In today's fast-paced world, however, more and more individuals are choosing to remove certain foods from their daily consumption habits based on personal preferences. Our study observed a significant change in the increase of healthy food preference score over the 10-year period. There are likely many reasons to explain this phenomenon. In macroscopic level, many initiatives were conducted by Chinese government in this period. Firstly, Dietary Guidelines, which was published to guide Chinese people to make healthy food and beverage choices, was updated by the Chinese Academy of Preventive Medicine and the Chinese Nutrition Society in 2007. Secondly, in order to improve the level of nutritional diagnosis and treatment, many policies and support measures have been issued by national health commission to ask tertiary hospitals and qualified secondary hospitals to set up clinical nutrition departments, encouraging other level of hospitals to set up nutrition clinics and provide corresponding services to individuals. Thirdly, Nutrition Food and Nutrition Development Outline was issued by the general office of the State Council of China to

promote the dietary education activities in 2014. Fourthly, although there are many advertisements for unhealthy food on TV, internet, newspapers, and magazines, such as fast food, programs on healthy food and nutrition also plays an important role in providing residents with numerous dietary knowledge by mass media. In microscopic level, people have become increasingly more health-conscious than they used to be. They have developed the idea that good health is above wealth, and hence try to seize any chance to seek nutrition knowledge for improving their health[19]. The National Health Commission has carried out a dynamic system in monitoring the health literacy of Chinese people since 2012. The monitoring data showed that the health literacy level of residents had steadily improved from 8.8% in 2012 to 19.17% in 2018 [20].

Our study found that healthy food preferences were distributed unequally among the demographic characteristic groups by each year. First, there was an increasing trend that the difference in food preference scores between Eastern China and Western China were getting larger and larger. The underlying reason may be that economic development between two areas is extremely imbalanced. Although Western China has experienced a remarkable development during the past decade with the implementation of China's Western Development Strategy (WDS), the convergence between two regions is happening too slowly. The Western regions continue to play economic catch-up with the East [21]. Secondly, people with other marital status, including widowed, separated, and divorced had lower food preference score compared to married and unmarried. Being in these kinds of marital status are widely regarded as a traumatic event. Some studies have documented that these kinds of marital status alter the social meaning for them and unfortunately give negative effects on eating behaviors and nutrient intakes [22].

Our study identified some factors to be the determinants of healthy food preference for Chinese

adults. Most determinants were similarly reported in previous studies[7, 23-25]. Firstly, our study found that food preferences were strongly influenced by their sociodemographic characteristics. As expected, increasing age, higher educational attainment, and being married were positively associated with healthy food preference [23]. Our study confirmed the evidence from cross-sectional studies that there was a statistical difference in food preference between male and female [26, 27]. Since more than 25% of men were unwilling to increase their knowledge about food and nutrition, men were less likely to form a healthy preference compared to women [28].

Longitudinal analysis is more powerful than cross-sectional analysis in detecting gender association with food preference.

Secondly, positive association between economic characteristics and food preference was also confirmed in our study. A study on adolescents in China found that income was negatively associated with healthy food preference with the controlling of covariates [29]. This difference may be resulted by two reasons. First reason is that the study populations in the two studies were different. The adolescents are more likely to have irrational food beliefs than adults. They prefer taste to health reasons in making food choices. The other reason is that only cross-sectional data was used in the former study, therefore more strong evidence could be obtained from more powerful study design.

Thirdly, in line with previous studies, our study found that geographic regions and urbanization index were both associated with food preference. People living in Western and Central China had a lower food preference score compared to people living in Eastern China. The possible reasons are that residents in Central and Western China have less access to informed dietary knowledge, poorer judgment of nutritional information from tangled mass media, and fewer opportunity to get

advice from dietitians [30]. Unlike a previous cross-sectional study, our study found a positive association between an urbanization index and food preference score [23]. Since previous studies simultaneously included two variables urban/ rural and urbanization index into one model, it may be the collinearity, causing estimator of urbanization index on healthy food preference to be negative in the model[23]. People living in a place with a higher urbanization level have more nutritional education from school, more ability to identify correct health knowledge, and then consequently tend to have higher probability to develop healthy preference [30].

Lastly, our study found higher dietary knowledge was a predictor of healthy food preference, which meant that their knowledge in diet and eating habits could automatically transfer to healthier food preference. This highlighted the importance of nutrition education programme to help people make healthy food and beverage choices. Some previous studies were contradictive on the association between nutritional knowledge and dietary behavior. While some studies found the correlation, some studies provided the evidence that the connection between nutritional knowledge and eating behavior were mediated by body dissatisfaction [31-34].

Our study found that there was pro-rich inequality in food preference score across different income groups. People with a higher income were more likely to have a higher food preference score. This is especially true when we adopt a long-term perspective view. Weighted cross-sectional concentration index underestimated this pro-rich inequality. The reason was that respondents with income downwardly mobile tended to have below average levels of food preference score compared to upwardly mobile respondents. The downward income mobile had a larger influence on food preference than upward mobile. Future public intervention measures could take people with decreasing income into consideration as targeted population.

The idea that health is determined by factors outside the traditional health-care setting has become an increasing recognized approach in improving public health and addressing health disparities. Previous cross-sectional studies found out that income and education contributed a large proportion to health sector variables, such as chronic disease incidence and health service use [35-40]. Our study found income did not contribute as pro-rich inequality in food preference in a longitudinal view as much as cross-section data obtained. Our results showed that in the long run living in Western China was more concentrated in the poor, and it was more obvious when using the longitudinal view than using cross-sectional approach. Since this characteristic had a negative association with healthy preference, living in Western China contributed to increasing pro-rich inequality in food preference in the long run. It is notable that urbanization index also contributed to pro-rich inequality by 3% in the long run. Despite China launched western development strategy in 2000, the regional gap between different areas is still very large. Chinese government could strengthen the effort to reduce the regional gap between Eastern and Western China and the gap between urban and rural areas. Our results showed that the unequal distribution of dietary score was more concentrated among the rich in the long run, and the elasticity of food preference with respect to this characteristic was positive, thus this characteristic contributes to making healthy food preference more concentrated among the advantaged in the long run.

It is worth highlighting some limitations of our study. Firstly, all the data were self-reported, thus recall bias may have affected the validity of our findings. Secondly, our study focuses on a sample aged 18 years and over. This selected sample limits the ability to generalize the results to the minors. Thirdly, potential determinants of the food preference considered in the study were selected from the survey questions. Other unobserved factors that may affect dependent variables

were not included in multilevel regression model.

Conclusions

The results of this study showed that the mean of food preference score increased from 2006 to 2015. Some factors, such as age, income, dietary knowledge score, and urbanization index were positively associated with food preference score, whereas living in central and western China were the negative predictors of healthy food preference. There was pro-rich inequality in food preference score with the rich had higher preference scores in each period. Longitudinal concentration index indicated that the degree of pro-rich inequality in food preference was larger than that at the baseline in the long run. The cross-sectional measure of food preference score was underestimated in the long run. Further decomposition analysis on mobility index showed that living in Western China and urbanization index contributed to the increase of pro-rich inequality in food preference in the longitudinal perspective. Our study suggests that people with decreased income could be taken as targeted population in future public intervention measures; and narrowing the regional gap between eastern and western China and between urban and rural areas could be strengthened in future Chinese policies.

Abbreviations

CHNS: China Health and Nutrition Survey; SD: standard deviation; WDS: Western Development Strategy

Declarations

Ethics approval and consent to participate

Approval for this study was given by the medical ethics committee of Health Science Center of Xi'an Jiaotong University (approval number 2019-1168). All respondents gave written informed consent prior to data collection.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analyzed during the current study are available at <https://www.cpc.unc.edu/projects/china>.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

YJX, LZ, YTZ conceptualized and designed the study; YJX and SYZ contributed to data analysis and data interpretation. YJX and YTZ wrote the manuscript, AP and LYL performed a critical revision of the manuscript. All authors read and approved the final manuscript.

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Figures

Figure 1

The mean score of food preference indices over time by groups