

## Original Article

# Dynamic shifts in Chinese eating behaviors

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The purpose of the study is to examine the dynamic eating behaviors of the Chinese people, focusing on snacking and the choice of cooking methods, and to identify the influences of socioeconomic factors on these eating behaviors. Data for this study were from the China Health and Nutrition Survey (CHNS). There were 12808 subjects, older than two years (y), from the 1991 and 11527 from the 2004 surveys respectively. Logistic regressions of pooled data were performed to evaluate how socioeconomic status (SES) was associated with two eating behaviors: snacking and consuming excessive amounts of fried foods. Simulation techniques were used to clarify the effects of the results that included significant interaction terms. Results showed that the rapid shift in the food and nutrient profile of the Chinese population is accompanied by equally profound changes in meal and cooking patterns. Snacking behavior is beginning to emerge and there are shifts away from the steaming and boiling of food to the, less healthy, frying of food. Income is positively associated with the consumption of both snacks and excessive fried food. Urban residents are also more likely to snack and to consume excessive amounts of fried foods than rural residents. These findings indicate that eating behaviors are beginning to change rapidly toward less healthy options in China. SES plays a vital role in the early stages of the eating behavior transition in China. Future health promotion programs targeting the higher-SES population will exert far-reaching effects on the improvement of health status in this group.

**Key Words: Socioeconomic status, eating behaviors, trends, diet survey, Chinese**

## INTRODUCTION

Extensive literature has noted the shift in dietary patterns in China, as well as in much of the world, especially with regard to a diet linked with obesity and an increase in other nutrition-related noncommunicable diseases (NR-NCDs).<sup>1-3</sup> In the United States and other higher-income countries, these changes have been shown to be related to increased away-from-home food intake, increased snacking, fast food consumption and increased portion sizes.<sup>4-6</sup> In contrast, little change in such behaviors has been found in earlier research in China and there is limited literature on these types of changes across the developing world.<sup>7</sup> This study attempts to systematically look at a few of the key eating behaviors that have changed in China in the past 15 years to allow us to understand some of the dynamics of that change that is most likely also occurring in other rapidly changing countries.

Snacking behavior has been studied extensively in the United States (US), where snacks account for 20–25% of the calories of all age-gender groupings. In many cases, these additional calories represent a fourth, and even a fifth meal.<sup>8-11</sup> Typically, snacking is self-defined by the respondent in dietary surveys. In China, a snack is a distinct eating behavior occurring outside of the normal mealtimes for breakfast, lunch or dinner. The effects of snacking on energy intake and weight is unclear, as there are conflicting results in the literature and few longitudinal studies or controlled trials.<sup>10-13</sup> In the US where the energy density of snacks has increased, a potential negative effect may result, but further research is needed to

understand how snacking behavior affects overall energy intake.<sup>8,9</sup>

The consumption of more foods and less healthy food preparation techniques are areas less studied.<sup>14,15</sup> There are studies on the effect of consuming French fried potatoes in the higher-income countries (called pomme frites or by other names in varying countries) on weight gain.<sup>4,14,16</sup> In many countries, these represent the major “vegetable” consumed by segments of the population.<sup>17</sup> There is not, however, analysis of the overall role of fried foods in the diet despite the considerable amount of nutrition education globally that focuses on mean to shift to healthier cooking methods.

There is a growing body of literature that shows that socioeconomic status (SES) plays an important role in influencing health status through various pathways.<sup>18-21</sup> One main pathway is through the influence on lifestyles (e.g., diet, physical activity, and so forth). Recent studies mainly examine the association of SES and diet from the aspect of food and nutrient intake.<sup>22-25</sup> However, the way

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foods are cooked and the times they are eaten — what we term in this study as eating behaviours — is another key determinant of dietary structure.

Thus, research on how changes in SES influence eating behaviors may be useful. To date, few studies have focused on the impacts of SES on snacking and cooking practices.

Much of the literature indicate that the way diet shifts in various stages of the nutrition transition focuses on economic development stages and specific backgrounds.<sup>1, 2, 26, 27</sup> For example, research shows that China, as a lower-SES country, compared with developed countries, has undertaken a shift toward an unhealthy diet of higher-fat levels.<sup>3</sup> Eating behavior, as a key determinant of dietary structure, may undergo a specific transition. The association between SES and eating behavior in developing countries may be different from developed countries due to different stages of development and lower-SES levels. A study of how SES influences eating behaviors in the Chinese population helps in making a comparison between China, a developing country, and developed countries.

In light of the absence of research identifying the association between SES and dynamic eating behaviors, this paper aims to (a) examine these behaviors, focusing on snacking and consuming fried food among Chinese people and (b) investigate the impact of SES on these eating behavior by simulating the impact of SES changes.

## METHODS

### *Data and subjects*

This analysis uses two waves of data, collected in 1991 and 2004, from the China Health and Nutrition Survey (CHNS) — designed to study how the socio-economic transformation of Chinese communities and society affect the health, nutritional behavior and status of this populations. The CHNS was initiated in 1989, involving nine provinces that varied in demography, geography, economic development, public resources, and health indicators. A multistage, random cluster process was used to draw the sample surveyed in each of the provinces. Counties in the nine provinces were stratified by local income and then we randomly selected four counties from within the high, medium and low income strata in each province. Villages and townships within the counties as well as urban and suburban neighborhoods within the cities were selected randomly. The same households were surveyed during each wave to allow for a longitudinal study. Detailed study design and data collection have been previously described.<sup>7, 28, 29</sup> In this study, 12808 subjects older than two years were selected from 1991 and 11527 from 2004 surveys, respectively.

### *Dietary data*

Diet data from 24-hour recalls on three consecutive days included information about meal types and preparation methods. Chinese meals are very strictly delineated by time of the day by the tradition of the area. Meal types were collected according to both time of consumption, as well as the respondents' definition of the eating occasion (breakfast, lunch, dinner, snack in morning, afternoon, evening). Based on the stricter and more precise measures,

snacks refer to all foods and drinks consumed outside of the context of the three main meals (breakfast, lunch, or dinner).<sup>8, 30</sup> Preparation methods were categorized as healthy (i.e., boiled, steamed, or eaten raw), baked (i.e., baked and others), and fried (i.e., stir-fried, deep-fried, or grilled). Baked foods were those prepared by prolonged cooking of food by dry heat acting by conduction; grilled foods were those prepared by direct heat but processed in a manner where partial frying is a component. In Chinese culture, large amounts of edible oil or lard are used with this technique. It is not charcoal grilling but cooking with a grilling pan and essentially the process is closer to deep frying than to charcoal grilling with regard to health effects. Trends in percentage of calories consumed from the foods prepared by these three methods were evaluated.

For the analyses presented, we focused on two eating behaviors: snacking and consuming excessive fried foods. We defined a person who snacks as a person who consumes any snack during the investigated three days. We define a person who consumes excessive fried foods as the person who consumes more than 20% of his/her calories from fried food. This is an arbitrary cutoff selected to provide some sense of the distribution of fried food intake.

### *Socioeconomic measures:*

SES indicators including income and education were the main independent variables. Deflated family income per capita was categorized into tertiles (i.e., low-, medium- and high-income). Education was divided into three sub-categories based on the number of years of education in a formal school; the low-education group included subjects with no formal education; the middle-education group included subjects with formal education up to or including a sixth grade education; the high-education group included subjects with more than a sixth grade education. Education of the household head preparing food was used for children up to age 18 y.

### *Statistical analysis*

We first summarized the distribution of variables, prevalence of snacking, and distribution of energy from healthy, baked and fried foods among the analysis sample. Chi-square tests were used to access the differences by survey year.

Logistic regression analyses were used to examine the magnitude of effect and association with the prevalence of snacking or consuming excessive amounts of fried foods, after controlling for demographic factors, including age, gender, and area of residence (i.e., urban or rural). We categorized age, in years, into three groups (children: 2-18.9 y, adults: 19-59.9 y, and elders: more than 60 y). We pooled the data from 1991 and 2004, and introduced a time indicator variable to indicate the survey year. Similarly, we assigned indicator variables for main effect variables (SES) and demographic variables. Survey year 1991, low-income, low education, ages 2-18 y, rural area residents, and the male gender were chosen as referent groups in all of the analyses.

The full models included time variables, income and education (used as the main effect variables), time-income interactions, time-education interactions and income-education interactions, as well as demographic

variables (control variables). To evaluate the interaction and confounders, we performed Wald Test and likelihood-ratio tests ( $p < 0.001$ ) to compare the full model with a reduced model without interaction terms or any confounders.

Then, based on the fully adjusted regression model above, we used the STATA PREDICT command to evaluate the average predicted probability of snacking or consuming excessive amounts of fried foods, holding the coefficients of covariates constant and assigning each subject to one main exposure group by time. We evaluated the effects of different SES distributions by simulating these changes with the results of our regression models. All analyses were performed using STATA 9 and SAS 9.1 statistical software and significance levels of  $p < 0.05$  were used.

## RESULTS

Distributions of education level, age, and area of residence between the two years (1991 and 2004) were significantly different as table 1 indicates (see Table 1).

Prevalence of snacking increased significantly over time in all age groups. In addition, the percentage of children who ate snacks was significantly higher compared with adults and elders in both 1991 and 2004. On the other hand, the proportion of calories consumed from fried foods increased significantly over time, while the proportion of calories consumed from foods prepared with traditional methods declined. There was no difference among age groups (see Table 2).

Table 3 shows the magnitude of the main effects and positive or negative associations with the prevalence of snacking or consuming excessive amounts of fried foods.

**Table 1.** Socioeconomic and sociodemographic characteristics among analysis sample by year

	1991		2004	
	Number of Subjects (N)	Percent of Analysis Sample (%)	Number of Subjects (N)	Percent of Analysis Sample (%)
<b>INCOME</b>				
Low	4277	33.4	3895	33.8
Medium	4439	34.7	3893	33.8
High	4092	31.9	3739	32.4
<b>EDUCATION*</b>				
Low	4147	32.4	3118	27.0
Medium	2593	20.2	1281	11.1
High	6068	47.4	7128	61.8
<b>AGE*</b>				
Children (2–18 y)	4157	32.5	2048	17.8
Adults (19–59 y)	7323	57.2	7307	63.4
Elders (≥60 y)	1328	10.4	2172	18.8
<b>GENDER</b>				
Male	6314	49.3	5608	48.7
Female	6494	50.7	5919	51.3
<b>AREA OF RESIDENCE*</b>				
urban	3893	30.4	3867	33.5
rural	8915	69.6	7660	66.5

\* $p < 0.05$

**Table 2.** Dynamic eating behavior among the Chinese population over time by age group

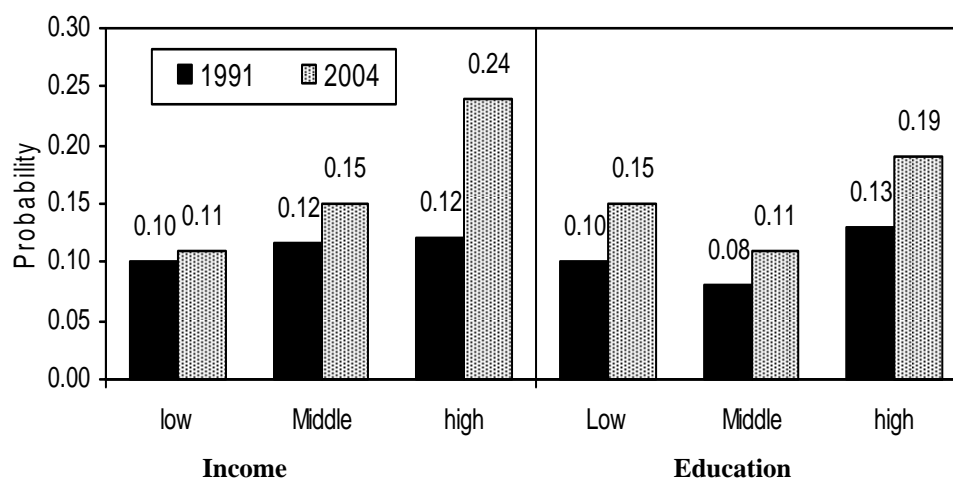
A. Proportion of persons consuming snacks (%)						
Age (Year)	1991			Change		
Children: 2-18	15.4			5.2*		
Adults: 19-59	9.3			6.5*		
Elders: 60+	8.7			7.2*		
B. Proportion of energy from food prepared by different methods (%)						
Age (Year)	1991			Change (from 1991 to 2004)*		
	Healthy	Baked	Fried	Healthy	Baked	Fried
Children: 2–18	81.5	2.0	16.5	-7.2	2.4	4.8
Adults: 19–59	82.0	1.8	16.2	-6.5	2.2	4.4
Elders: 60 +	81.8	2.3	15.9	-6.4	1.8	4.6

\* $p < 0.05$

**Table 3.** Factors associated with snacking and consuming excessive fried foods

Factor	Snacking <sup>#</sup>		Consuming excessive fried food <sup>#</sup>	
	Model 1	Model 2	Model 1	Model 2
Intercept	-2.87 <sup>a</sup>	-2.67 <sup>a</sup>	-1.24 <sup>a</sup>	-1.18 <sup>a</sup>
Medium income	0.27 <sup>a</sup>	0.19 <sup>a</sup>	0.35 <sup>a</sup>	0.35 <sup>a</sup>
High income	0.64 <sup>a</sup>	0.22 <sup>a</sup>	0.44 <sup>a</sup>	0.45 <sup>a</sup>
Medium education	-0.30 <sup>a</sup>	-0.31 <sup>a</sup>	0.04	0.09
High education	0.32 <sup>a</sup>	0.31 <sup>a</sup>	0.26 <sup>a</sup>	0.22 <sup>a</sup>
Year 2004	0.47 <sup>a</sup>	0.11	0.48 <sup>a</sup>	0.48 <sup>a</sup>
Adults: 19–59 y	-0.57 <sup>a</sup>	-0.59 <sup>a</sup>		
Elders: 60+ y	-0.37 <sup>a</sup>	-0.41 <sup>a</sup>		
Female	0.22 <sup>a</sup>	0.23 <sup>a</sup>		
Urban	0.90 <sup>a</sup>	0.92 <sup>a</sup>	0.23 <sup>a</sup>	0.18 <sup>a</sup>
Medium income *2004		0.15		
High income *2004		0.75 <sup>a</sup>		
Medium education *Urban				-0.15
High education *Urban				0.11
Likelihood-ratio test	$p < 0.001$		$p = 0.006$	

\*Indicates the interaction between two variables. <sup>a</sup> $p < 0.05$ . <sup>#</sup>The referent in the model was year 1991, low income, low education, rural, male and children (aged 2–18 years old).

**Figure 1.** The Predicted Probability of Snacking Behavior in China, 1991 and 2004

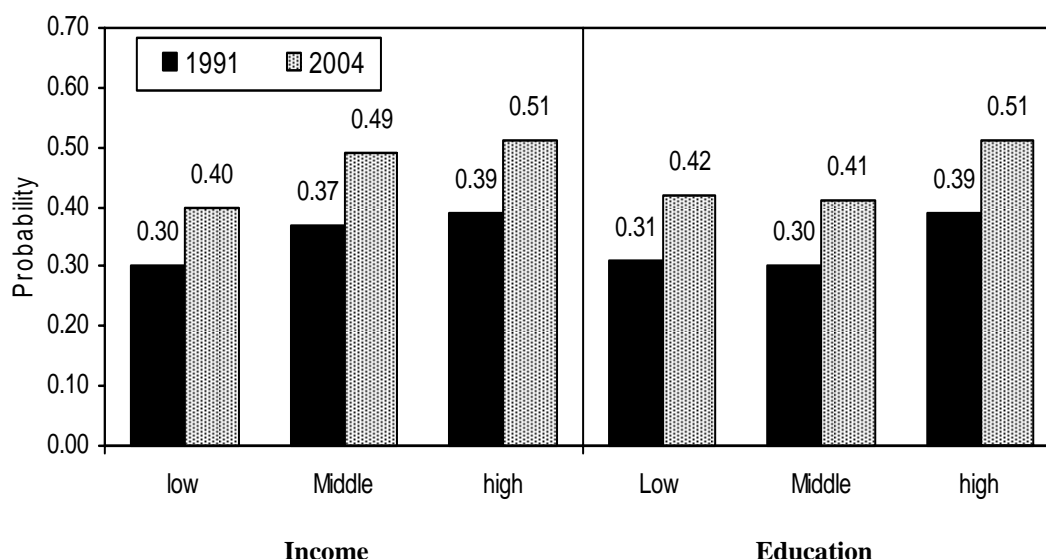
For each type of eating behaviors (i.e., snacking and excessive fried foods), Model 1 is used without interaction to examine the independent effect. Model 2 only adds significant SES-time or SES-area of residence interaction term because the interaction between income and education was not significant.

There was a significantly increasing trend in snacking prevalence over time. Income and education had opposite associations with an increased likelihood of snacking. The likelihood of snacking increased with increasing income; medium-educated people had less likelihood to eat snacks compared with both low-educated people and high-educated people. Time-income interactions in model 2 increased the risk of snacking. Urban residents were more likely to eat snacks than rural residents (see Table 3).

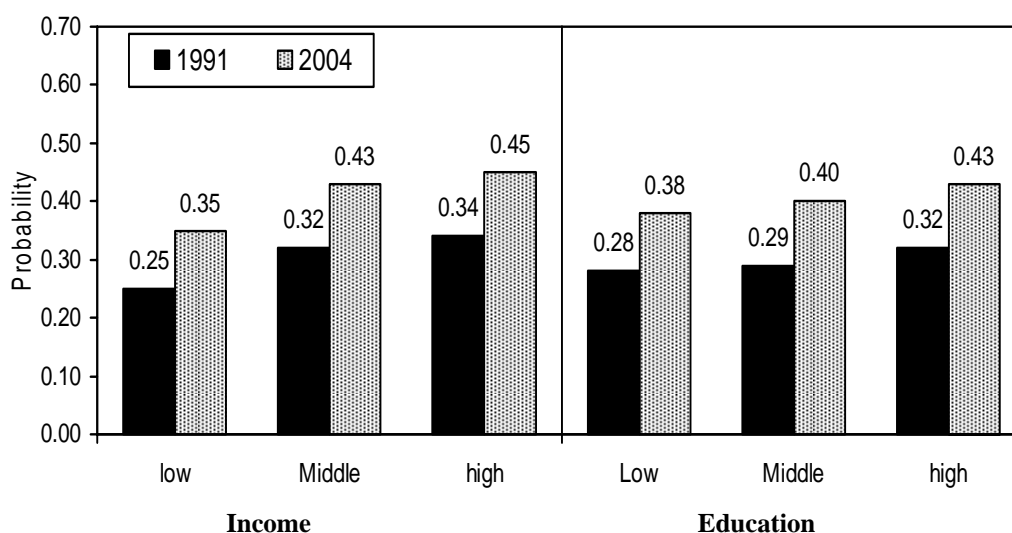
The prevalence of consuming excessive fried foods also had an increasing trend over time. The risk of consuming excessive fried foods increased with increasing income or increasing education level. Urban residents

have a higher risk of consuming excessive fried foods than rural residents. Model 2 showed that area of residence modified the relationships between SES and consumption of higher levels of fried foods; that is, higher education residents in the urban areas have a higher risk than those in the rural areas (see Table 3).

We provide a clearer interpretation of these results in Figures 1–3. As indicated, there was a rapid increase in the predicted probability of snacking with the simulated increase in income over time. The probability of snacking among high-income groups was about twice as many in 2004 as in 1991—a dramatic increase over time. Both low- and high-educated people had a higher probability than middle-educated people (see Figure 1). We observed a similar income effect pattern—predicted probabilities of consuming excessive fried food increased with increasing income over time, but education had different effects on two eating behaviors. As noted there is a significant interaction between education and urban residence. So we show these results in two slides. (see Figures 2 and 3).



**Figure 2.** The Predicted Probability of Consuming More than 20% of daily caloric Intake from Fried Foods in Urban Chinese Residents, 1991 and 2004



**Figure 3.** The Predicted Probability of Consuming More than 20% of daily caloric Intake from Fried Foods in Rural Chinese Residents, 1991 and 2004

## DISCUSSION

This study showed a large shift in eating behaviors in the sampled Chinese population. On the one hand, the traditional pattern of regularly eating three meals per day was shifting toward a mixed meal pattern (three meals plus snacks). Two studies showed that the snacking prevalence among U.S. children, aged 2–18 years, increased from 77% to 91% and the prevalence among U.S. young adults, aged 19–29 years, increased from 77% to 84% between 1977 and 1996.<sup>8, 9</sup> Our study showed that the average snacking prevalence among Chinese children increased by from 15.4% to 20.6% and the prevalence among Chinese young adults, aged 19–29 years, increased from 10.1% to 17.2% between 1991 and 2004. Snacking prevalence in China was still lower among all age groups when compared to the US. While the secular shift among children was slower and among young adults, the increase in prevalence points of snacking was similar to those of the U.S. population. The reason for this lower prevalence was possibly due to different cultural backgrounds and lower-

income levels; traditionally, regular meals are preferred by the Chinese population. On the other hand, these relationships are consonant with the economic development of each country. In that sense, snacking behavior in the Chinese population as with all other dietary behaviors are changing rapidly but still at an earlier stage of the nutrition transition -similar to one prevailing several decades ago in the United States.<sup>1, 31</sup> At the same time cooking practices have undergone a significant shift from traditional healthy methods to unhealthy methods in China. In the Chinese culture, there are a wide range of foods typically fried and popular fried foods include higher-fat red meat such as pork, eggs and egg products, various vegetables, legumes and bean products, and starchy roots and tubers. It is difficult to make a comparison due to the small amount of research on trends in cooking methods.

This study further examined the influence on eating behavior exerted by income and education by applying multivariate analyses on secular trends, socioeconomic, and demographic data. Income and education are

important contributors to snacking and consuming higher proportion of fried foods, but had different associations with these two eating behaviors.

Income was found positively and significantly related to snacking and cooking methods. Furthermore, the association is graded—higher-income groups have a higher risk of snacking and consuming a higher proportion of fried foods than lower-income groups. This finding is consistent with that of one study that found, among U.S. children, a higher proportion of snackers at the higher-income and higher-education levels than at the lower-levels.<sup>7-9, 32-34</sup> When it comes to cooking methods, frying generally implies eating more edible oils and cooking special foods (e.g., animal foods), which are also strongly related to purchasing power. The influence pattern of income on snacking and cooking methods is similar to the pattern on other eating behaviors in developing countries (e.g., food purchase and eating away from home).<sup>7,35</sup> Moreover, secular trend analyses of the socioeconomic determination of snacking revealed that the association between income and eating behaviors was stronger in 2004 than in 1991, especially at high-income levels; the predicated probability of snacking in 2004 was twice as high as in 1991.

However, the association between education and eating behaviors is an interesting issue. As for snacking, medium-educated groups were less likely to eat snacks compared to low-educated groups and high-educated groups. As for frying, this study showed a strong and graded association between education and consuming higher proportion amounts of fried food. One recent study also showed the opposite effect of SES on lifestyles in countries of different development levels; people with high-socioeconomic status were most likely to lead an unhealthy lifestyle in China, while the low SES group was likely to lead a healthier lifestyle.<sup>20</sup>

This study has several strengths. First, it extends studies about the association between SES and eating behaviors by examining socio-economic differences in snacking and cooking methods in a developing country. Furthermore, we performed multivariate and secular trends analyses, as well as considering confounding effects of other factors when examining income and education effects. As a result, the conclusions drawn from such analyses are more convincing than ones from single indicator analyses of limited earlier research.<sup>8, 9, 30</sup>

A limitation of this study is that it did not consider the contribution of energy added to food from edible oil used by the household due to complication and inaccuracy. In effect, it is clear that frying uses more edible oil than other cooking methods, so that the proportion of energy from fried food might be much higher and the proportion of persons consuming more than 20% of their energy from fried food might be higher than this recent analyses. Future analysis will explore the nutritional implications of these changes.

Findings from this study have important policy and intervention implications. To date, health implications of snacking are still unjustified or conflicting, even though several researchers have indicated that snacking contributes to excessive energy intake and higher-energy density. They also assert that there is a strong possibility that

snacking has contributed to the epidemic of obesity in U.S. children and adults.<sup>8-10, 32, 33</sup> In the absence of strong evidence, we cannot simply classify snacking as an unhealthy behavior because many other factors such as snacking time, food groups and energy density of snacks, regular meals, and physical activity levels might jointly influence health outcomes.<sup>8</sup> For example, special bedtime snacking combined with lower or even no physical activity most likely increases the risk of overweight or obesity. On the other hand, we know for infants and preschoolers with limited stomach capacity, snacking is a critical eating behavior. Systematically, longitudinal studies focusing on the impact of snacking on health outcomes may help further clarify the association. But, it is important to promote the choice of healthy snacks and to eliminate sedentary lifestyles for the purpose of nutrition intervention and health promotion, especially in the crucial period of the nutrition transition in China.

It is likely that consuming fried foods are unhealthy and are strongly associated with increased risk of obesity and possibly other noncommunicable diseases. One study showed that patients confirmed as having coronary atherosclerosis were more likely than those with normal coronary vessels to rank deep-fry, stir-fry, and pan-fry as their preferred cooking methods over steaming or boiling.<sup>36</sup> Other studies have shown that fried red meat is associated with an increased risk of lung and breast cancer.<sup>37, 38</sup> Thus, the increasing proportion of energy from fried foods is most likely a harmful shift in China. Traditional healthy cooking practices such as steaming and boiling should be advocated.

Given the potential effect of eating behaviors on health outcomes and the increased role of income and education in eating behaviors discussed above, targeting policies or intervention programs at higher-income and higher-educated populations — the most susceptible groups — may be a high priority due to limited public health sources.

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#### AUTHOR DISCLOSURES

Zhihong Wang, Fengying Zhai, Shufa Du and Barry Popkin, no conflicts of interest.

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## Original Article

**Dynamic shifts in Chinese eating behaviors**Zhihong Wang MS<sup>1,2</sup>, Fengying Zhai MD<sup>2</sup>, Shufa Du PhD<sup>1</sup> and Barry Popkin PhD<sup>1</sup>*1 Carolina Population Center, University of North Carolina at Chapel Hill, USA**2 Institute of Nutrition and Food Safety, Chinese Center for Disease Control and Prevention, PROC***中國人飲食行為動態變化**

本文旨在研究中国人群零食摄入和烹调方法选择等饮食行为的动态变化，并探讨社会经济因素对饮食行为的影响。数据来源于中美合作课题“中国健康与营养调查”，研究对象为 2 周岁以上人群(1991 年 12808 人，2004 年 11527 人)。采用 Logistic 多元回归方法分析社会经济因素与零食摄入和消费过多油炸食品之间的关系。应用模拟技术探讨交互作用对这种关系的影响。结果显示中国人群食物和营养素摄入的快速变迁，相伴随的是用餐模式和烹饪方法的深刻变化，零食消费行为逐渐显现，烹调模式逐渐从蒸、煮向不健康油炸的方式变迁。家庭收入水平与这两种饮食行为呈显著的正相关关系；与农村居民相比，城市居民消费零食和过多油炸食品的可能性较大。本研究表明中国人群饮食行为正逐渐向不健康的模式变化，社会经济因素在饮食行为变迁的早期阶段起着重要作用，未来健康促进项目以社会经济水平较高的人群为重点将有效改善该人群的健康状况。

关键字：社会经济状况、饮食行为、趋势、膳食调查、中国。