

The changing dietary patterns and health issues in China

Changing
dietary
patterns and
health issues

143

Ming Yuan

*College of Economics and Management, China Agricultural University,
Beijing, China*

James Lawrence Seale Jr

*Department of Food and Resource Economics, University of Florida, Gainesville,
Florida, USA*

Thomas Wahl

*Department of Agribusiness and Applied Economics,
North Dakota State University, Fargo, North Dakota, USA, and*

Junfei Bai

*College of Economics and Management, China Agricultural University,
Beijing, China*

Received 25 December 2017
Revised 1 March 2018
Accepted 9 March 2018

Abstract

Purpose – The purpose of this paper is to offer an overview of dietary transition patterns and a discussion of the food-related health issues in China.

Design/methodology/approach – The paper builds on a review of the existing literature on food consumption and diet changes in China, and highlights with specific attention to increasing food consumed away from home, the rising demand for fast and processed foods, and the popularizing of western-style foods in Chinese diets.

Findings – China's food consumption patterns rapidly transitioned from one in which grains and vegetables dominated to one having more animal products and more diversification. More foods are consumed away from home and in the form of fast and processed. Income growth played and will continue to play a critical role in shifting the structure of food consumption. On the other hand, China is on a fast track from a lean population to one in which being overweight or obese. The associations between health outputs and food transitions, however, are inconclusive.

Originality/value – The main findings of this study have implications for better understanding the key trends and driving forces of China's food demand system. Moreover, the results from this review are essential for food-related policymaking in many emerging economies where coexistence of undernutrition, deficiency of micronutrients and overweight and obesity is a common challenge to the society and individual households.

Keywords China, Health, Food consumption, Changing diet

Paper type General review

1. Introduction

In a matter of a few decades, China transitioned from a country in which parents worried from where their children's next meal would come to one in which the prevalence of obesity and chronic diseases has become a serious public concern (Popkin 2008; Popkin *et al.*, 2010, 2012; Du *et al.*, 2014; Gordon-Larsen *et al.*, 2014). In 1970, a newborn boy could expect to live to age 63, but by 2013, that same boy could expect to live to 76 years. In 2010, the underweight rate for children less than five years old, a commonly used proxy of health status of a country, was 3.6 percent compared to 74 percent in 1990. On the other hand, a recently published article in *The Lancet* shows that China has passed the USA to become the frontrunner in the absolute number of obese citizens (NCD Risk Factor Collaboration (NCD-RisC), 2016). In 2014, China's men and women contributed 16.3 and 12.4 percent, respectively, to global obesity. Although these numbers did not consider China's huge population base, they reflect a sharp increase from 1975 when only 2.1 percent of men and



2.5 percent of women were obese (NCD-RisC, 2016), but with a high prevalence of undernutrition. All of these changes occurred in less than 40 years.

Several questions naturally arise. What kind of significant diet and food-consumption-pattern changes have occurred in China? What are the newly emerging patterns in food consumption and health? To what degree does the changing diet and transitioning consumption patterns contribute to the rising health concerns? A better understanding of these questions is essential for food-related policymaking in many emerging economies like China where coexistence of undernutrition, deficiency of micronutrients and overweight and obesity is a common challenge to the society and individual households. In the world's most populous country – China, this is, particularly true considering that any small change in food consumption patterns and dietary structure in the nation could result in enormous impacts on both domestic and global food markets.

In this paper, we first review the main changes in food consumption patterns and diets in China. We then discuss several long-realized but not well-documented trends. More specifically, food consumed away from home, the increasing demand for fast and processed food, and the westernization of Chinese diets are discussed. The impact of nutrient intake and dietary pattern changes on the increase in overweightness and obesity in developed countries is well studied and documented (Costa, 2015; Zhou *et al.*, 2015). However, these kinds of studies in developing countries are limited, and their results are inconclusive (Popkin *et al.*, 2010; Du *et al.*, 2014). To understand the relationship between food consumption and health outcomes in China, we will also discuss the degree to which these realized changing diets and consumption patterns are related to the increases in prevalent overweightness and obesity. These discussions rely heavily on a rigorous review of existing literature and our own studies conducted in recent years. These studies are selected mainly on the base of their relationship and closeness to this topic. The latest version is used for studies which have more than one version found. We conclude with several unfinished but important issues related to China's food consumption.

2. Changing diets

This section reviews the main changes in Chinese diets and food consumption patterns. It is imperative to note that most of the numbers cited in this section are based on household survey data collected by the National Statistical Bureau of China (NBSC). In addition, the data from the China Health and Nutrition Survey (CHNS) are widely used (e.g. Popkin, 2008; Popkin *et al.*, 2010, 2012; Du *et al.*, 2014; Gordon-Larsen *et al.*, 2014). The NBSC data compared to the CHNS data have significant advantages in terms of national representativeness and survey duration[1], although the NBSC data have been widely criticized for excluding food-away-from-home (FAFH) consumption (Ma *et al.*, 2006; Bai *et al.*, 2010; Seale *et al.*, 2012; Zhou, Yu, Abler and Chen, 2014; Zhou, Liu, Cao, Tian and Wang, 2014).

Food consumption in China has experienced dramatic changes over the last four decades, a period characterized by incredibly rapid economic growth. As shown in Figure 1, between 1980 and 2012, per capita disposable income for urban households increased by 803 percent, from 2,721 yuan to 24,565 yuan (in 2012 constant prices), and per capita net income for rural households has increased by 747 percent, from 935 yuan to 7,917 yuan. During the same period, urban households' per capita expenditure on food increased 400 percent (from 1,529 yuan to 7,651 yuan in 2012 prices) and in rural households by 363 percent (from 554 yuan to 2,563 yuan). As a result, the Engel's coefficient, the proportion of income spent on food, has sustainably declined from 57 to 36 percent for urban household and from 62 to 39 percent for rural ones (Figure 1).

In quantity, over the period 1980–2012 China's food consumption patterns rapidly transitioned from one in which grains and vegetables dominated to one having more animal

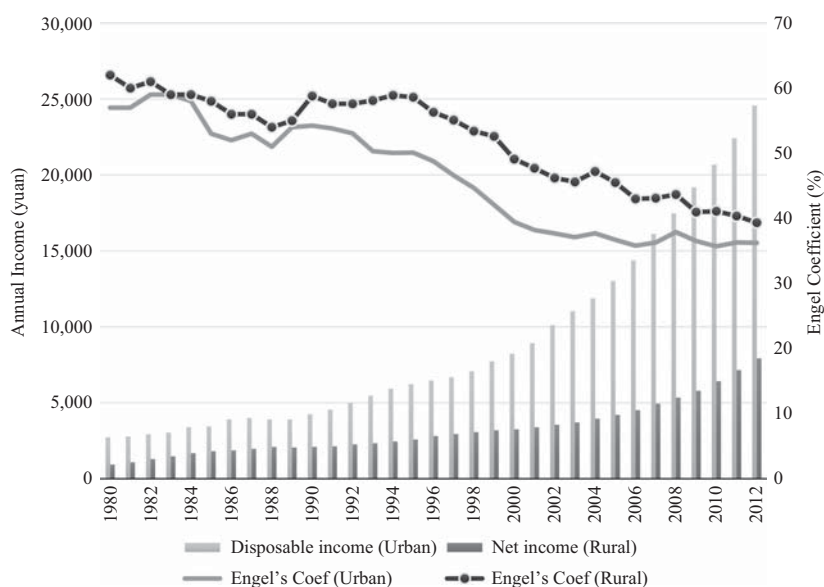


Figure 1. Income and Engel's coefficient in rural and urban China, 1980–2012

Source: *China Statistical Yearbooks*

products and more diversification. Figure 2 shows that per capita grain consumption in rural areas has declined from 257 kg in 1980 to 164.3 kg in 2012 while per capita vegetable consumption dropped from about 127 kg to 84 kg. In contrast, during the same period, consumption for all animal products, including meat (pork, beef and mutton), poultry, eggs, aquatic and fluid milk sustainably increased, especially for meat, which rose to 21.3 kg in 2012, a level triples that in 1980 (7 kg) (panel C, Figure 2). As mentioned above, these statistics do not include FAFH consumption.

Similarly, per capita annual consumption in urban households has declined by half for grain (from 154 kg to 78 kg) and by nearly 30 percent (from 154 kg to 112 kg) for vegetables. Per capita consumption for all kinds of animal products, except meat, has grown faster in urban households compared with their rural counterparts, of which, the most remarkable change is in milk consumption. As shown in Figure 2 (panel D), fluid milk consumption has increased dramatically since the end of the 1990s until reaching its peak at 18 kg per annum around 2004 and then declining until recently (Huang, 2014).

Income growth apparently plays a critical role in shifting the structure of food consumption. For example, per capita meat consumption (including pork, poultry, beef and mutton) for the richest 10 percent of urban households was 38.3 kg in 2011, which is 77 percent higher than that of the poorest 5 percent of urban households (21.6 kg) (Table I). Per capita consumption of milk, measured in fresh milk equivalent, in the highest income group is about three times as high as in the lowest income group. Similarly, the positive association between food consumption and income is found for eggs, fish, vegetables and fruit, with the only exception being grain. Similar results are also applicable for rural households (Table II).

The positive income effect and the significant gap between rural and urban income levels jointly raise the question, whether food consumption in rural China will catch up with its urban counterpart as economic growth continues in the future? It is interesting to note that for all products presented in Figure 2, except for vegetables and poultry, rural per capita consumption in 2012 is roughly equal to the corresponding urban products consumption

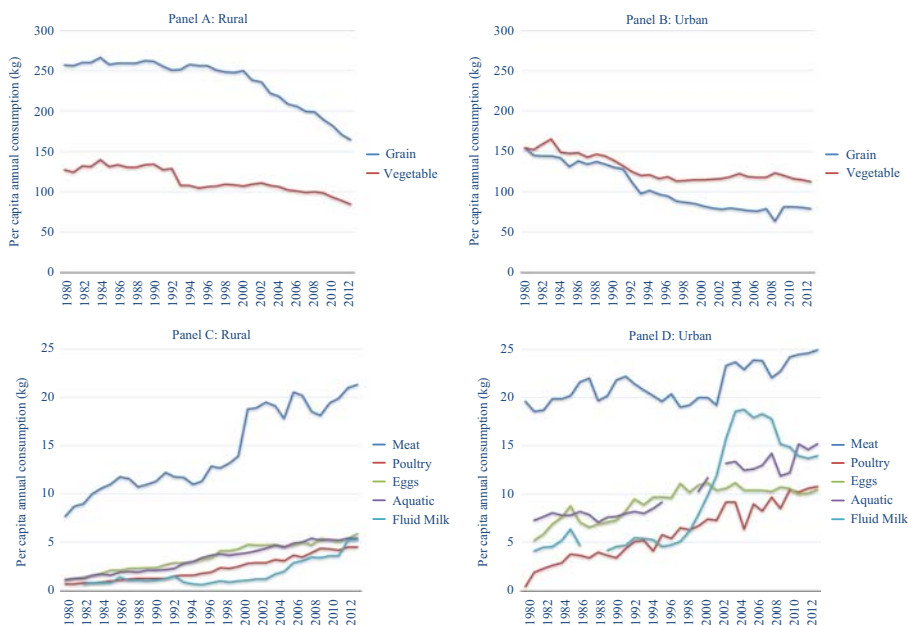


Figure 2. Per capita food consumption in rural and urban China, 1980–2012

Notes: Meat includes pork, beef and mutton; the discontinuous line means no data available
Source: Authors' combination based on data from *China Statistical Yearbooks*

Table I. Per capita food consumption (kg) of urban households by income, 2011

	Poorest (first five percent)	Lowest income (1st decile)	Low income (2nd decile)	Lower middle income (2nd quintile)	Middle income (3rd quintile)	Upper middle income (4th quintile)	High income (9th decile)	Highest income (10th decile)
Rice	35.0	36.3	37.4	39.6	39.9	40.2	39.9	40.3
Pork	13.6	15.2	18.1	20.4	21.5	22.5	23.2	23.5
Beef/mutton	2.7	2.7	3.1	3.7	4.3	4.6	4.7	4.5
Poultry	5.3	5.3	6.6	7.5	8.2	9.1	9.7	10.4
Eggs	7.1	7.5	8.6	9.9	10.7	11.3	11.4	11.0
Fish	6.6	6.6	8.5	10.2	11.6	13.5	14.8	16.0
Vegetable	90.4	94.5	102.3	113.1	120.1	123.4	124.8	120.4
Fruit	29.9	32.9	40.5	47.7	54.3	60.7	65.6	67.8
Milk	10.3	11.9	14.8	18.6	22.4	26.0	29.0	30.1

Source: *China Urban Life and Price Yearbook* (2012)

three decades earlier. Nevertheless, it does not necessary mean that food consumption in rural households, with future income growth, will catch up with that of urban households, at least for some types of food. Qiu *et al.* analyzed the NBSC household data in 2005. Their findings indicate that, after controlling for income, the consumption of major grains (rice and wheat) in rural and urban areas are still quite different. Taking rice as an example, in each income group, per capita consumption of rice in rural households is about the 2–2.5 times as high as the level of its corresponding income group in urban households. The difference for the lowest income group is even larger, being 53.8 kg in rural vs 13.9 kg in urban. However, there is not as much difference for meat and fish consumption between

Table II.
Per capita food consumption (kg) of rural households by income, 2011

	Low income (1st 20%)	Lower middle income (2nd 20%)	Middle income (3rd 20%)	Upper middle income (4th 20%)	High income (5th 20%)
Grain ^a	165.7	167.2	172.6	176.0	174.1
Pork	11.6	13.1	14.4	16.0	18.3
Beef/mutton	2.1	1.7	1.6	1.7	2.5
Poultry	3.0	3.7	4.5	5.3	6.9
Eggs	3.7	4.6	5.6	6.3	7.4
Fish	2.5	3.6	4.9	6.6	10.8
Vegetable	72.1	83.9	91.5	100.6	105.4
Fruit	9.8	11.5	13.2	15.9	20.0
Milk	4.3	4.8	5.0	5.6	6.5

Note: ^aPaddy rice instead of rice is used in calculating the total grain consumption

Source: *China Yearbook of Household Survey* (2012)

rural and urban consumers in the same income group. A possible reason is rooted in the missing FAFH, which is believed to be much higher in urban areas than in rural areas.

In order to better understand food consumption patterns and future trends, one often relies on demand elasticity estimates. Numerous studies on China's food consumption using a wide range of models and data sources can be found in the literature (e.g. Gao *et al.*, 1996; Gould and Villarreal, 2006; Huang and Rozelle, 1998; Yen *et al.*, 2004; Zheng and Henneberry, 2009; Seale *et al.*, 2012)[2]. While overall income elasticities are positive and own-price elasticities are negative, the estimated results widely distribute in various dimensions such as study period, focused areas, data level, etc., and are sometime even controversial (Abler, 2010; Zhou, Yu, Abler and Chen, 2014; Zhou, Liu, Cao, Tian and Wang, 2014). As a result, projections for China's food demand differ significantly. Based on a collection of 143 income elasticity estimates for cereal and 240 estimates for meat and meat products, Zhou, Yu, Abler and Chen (2014) and Zhou, Liu, Cao, Tian and Wang (2014) conducted a meta-analysis. Their findings show that income elasticities for most cereals (general cereals, rice and coarse grains) and all meat products (general meat, pork, poultry, beef and mutton) tend to decline as per capita income increases. Their results also indicate that national-level income elasticities for cereals and meat were 0.40 and 0.48, respectively, in 2000, and that they are projected to decline to 0.12 and 0.36, respectively, by 2030. The income elasticity for wheat inversely is projected to rise from 0.46 to 0.59 over this same time period. The likely explanations include the westernization of Chinese diets and the associated demand for high-protein wheat (Bai *et al.*, 2014) and diet diversification across regions. For instance, those Chinese who are traditional rice eaters are diversifying to wheat but their income elasticity for wheat could be much higher in comparison to traditional wheat consumers[3].

3. Changing food consumption patterns

Beyond the well-recognized movements and variations reviewed in the last section, a number of specific diet and consumption pattern changes emerge. In this section, we review these transitions by focusing on rising consumption of food away from home, the increasing demand for fast food and processed food, and the westernization of Chinese diets. These changes are not only reshaping the food supply chain and agricultural production through market power in China, but also exporting their influence to the world market. However, compared with overall structural changes over time, these changes or trends are relatively less documented in the literature.

3.1 Increasing food away from home consumption

For many years, official data on food demand in China is suspected to be underestimated. One of the criticisms is the largely missing food away from home (FAFH) consumption in

official statistics (Ma *et al.*, 2006; Bai *et al.*, 2010, 2016). Until recently, the Urban Household Income and Expenditure (UHIE) survey data collected by the NBSC were the only large-scale data set used for China's official statistical reports and most food demand-related studies in China (i.e. Huang *et al.*, 1999; Guo *et al.*, 2000; Fan *et al.*, 1995). While the UHIE data report expenditures on FAFH, they include no information about FAFH quantity. Another data widely used in the past are the CHNS data jointly collected by the University of North Carolina at Chapel Hill and the National Institute for Nutrition and Health, Chinese Center for Disease Control and Prevention[4]. While FAFH consumption is covered in the CHNS survey, a three-day survey period could result in a higher standard variation because of the infrequent purchase of FAFH and a potential bias in the estimation of dining out consumption if it is significantly different between weekday and weekend. With this lack of data, the literature provides little information about FAFH. Several recently published studies indicate that the share of household expenditure on dining out has risen dramatically in urban China (Bai *et al.*, 2010, Ma *et al.*, 2006). These studies, however, only focused on expenditure but not on quantity. Without taking FAFH into consideration, any study assessing China's food security and its challenges to human health, natural resources and environment may draw incomplete and perhaps misleading conclusions.

In this subsection, we summarize primary findings from our recent publications, including Bai *et al.* (2010, 2012, 2016), Seale *et al.* (2012) and Liu *et al.* (2015). The data used in these studies were collected using a weeklong food diary survey conducted in 11 cities in China from 2007 through 2012. These cities and the survey year are: Beijing 2007; Nanjing 2009; Chengdu 2010; Xi'an, Xiamen, and Shenyang 2011; and Taiyuan, Harbin, Nanning, Taizhou, and Lanzhou 2012. These cities represent different regions and economic conditions[5]. The households in our sample were a subset of the households in the UHIE survey conducted by the NBSC. In total, 2,328 households were surveyed, with sample size in each city ranging from 190 to 315 with an exception of Xiamen, where 149 households were surveyed due to its relatively small size of total population. The surveys were conducted using a face-to-face interview plus a drop-off and pick-up approach. The selected households were asked to record all food items their family members consumed for one-week beginning with the drop-off day. FAFH in these studies is defined to include meals that are not prepared at home. The definition, however, does not include food purchased ready-to-eat from food retail stores, such as supermarkets, convenience stores and specialty food stores. For a comprehensive picture, data on food at home consumption were also collected.

FAFH accounts for a significant proportion in total food consumption, in both volume and value, but its share varies by food category. As shown in Bai *et al.* (2016), the average per capita weekly expenditure on FAFH consumption in the sampled cities is 41.15 yuan in 2010 value (or about US\$6 using the average exchange rate in that year), which is about 32 percent of the total food expenditure (Table III). By food category, people on average spent the most on meat (14.68 yuan/week), followed by grain (7.71 yuan), drinks (5.28 yuan), vegetables (5 yuan) and aquatic products (4.34 yuan). The proportion of expenditure on FAFH in total food expenditure ranges widely by food category, with drinks highest at 55 percent, followed by beans (39 percent), meat (37 percent) and aquatic products (33 percent). Expenditure on grain and vegetables accounts for 32 and 28 percent, respectively.

In terms of quantity consumed, per capita weekly FAFH is 1.95 kg, accounting for about 17 percent of total food consumption (Table III). Grain, vegetables and meat consumed away from home top the list, with average per capita weekly consumption of 0.54 kg, 0.41 kg and 0.34 kg, respectively. Eggs, aquatic products, fruit and dairy products, in contrast, are at the bottom with per capita consumption less than 0.1 kg each. In addition, food consumption

Table III.
Weekly per capita consumption and expenditure away from home

	FAFH expenditure ^a		FAFH quantity	
	Amount (yuan)	% of total food type	Amount (Kg)	% of total food type
Grain	7.71	32	0.54	20
Vegetables	5.00	28	0.41	13
Meat	14.68	37	0.34	28
Drinks	5.28	55	0.25	37
Beans	1.35	39	0.14	29
Eggs	1.10	25	0.09	20
Aquatic	4.34	33	0.08	20
Fruits	1.09	9	0.06	3
Dairy	0.60	10	0.04	8
Total	41.15	32	1.95	17

Note: ^aExpenditures are measured in 2010 price

Source: Bai *et al.* (2016)

structures differ remarkably between FAFH and FAH. Table III shows that China's urban consumers tend to consume more meat and drinks but less fruits and vegetables when they dine out relative to at-home consumption. One possible explanation is that meat is commonly preferred for celebrations and eating out is often viewed as a celebration of sorts, even if there is sometime no specific event being celebrated. Another possible reason is that cooking meat could be a bit more technically challenging than cooking vegetables and eggs for most Chinese households.

Like in many developed countries such as the USA (Okrent and Alston, 2012) and Spain (Mutlu and Gracia, 2006), FAFH consumption is positively related to income in China. As shown in Table IV, high income levels are not associated with urban households eating more at home, in fact, both expenditure and quantity at home slightly declines in the richest group. It is, however, associated with a large increase in FAFH consumption, both in terms of expenditure and quantity. As a result, the combined food expenditure is still growing with rising incomes, while the combined food quantity consumed stagnates when income reaches the fourth highest group (Table IV). These results suggest that excluding FAFH, as many previous studies have done, could cause a misunderstanding of food demand patterns and food security in China.

The income effect on FAFH (and overall food) varies by food category. Table V shows that, as income grows, the total quantity of per capita grain consumption sustainably decreases,

Income group	Expenditure (yuan)		Quantity (kg)	
	FAFH	FAH	FAFH	FAH
Lowest 1/5	27.4	72.9	1.6	8.9
Lower 1/5	40.0	87.0	2.0	9.5
Middle 1/5	45.1	88.1	2.0	10.1
Higher 1/5	52.5	97.5	2.5	10.1
Highest 1/5	76.1	93.2	2.9	9.6

Notes: 1. The data used in Tables IV and V were collected through a weeklong food diary survey conducted by the authors in 11 cities in China during the years 2007 through 2012. These cities and the survey year are Beijing in 2007; Nanjing in 2009; Chengdu in 2010; Xi'an Xiamen and Shenyang in 2011; and Taiyuan, Harbin, Nanning, Taizhou and Lanzhou in 2012, representing different regions and economic conditions. The households in the sample were a subset of the Urban Household Income and Expenditure survey conducted by NBSC in each city, selected by a stratified random sampling method. More detailed information about the survey and the data can also be found in Bai *et al.* (2012, 2016). 2. Expenditures are measured in 2010 price

Table IV.
FAFH consumption rises with income

largely contributed to by the declining FAH consumption rather than FAFH consumption, which remains nearly unchanged across income groups. For meat and aquatic products, with income growth per capita consumption of FAH gradually stagnates around 1 kg/week and 0.34 kg/week, respectively, but combined consumption of FAH with FAFH shows a sustainable increase for these products (Table V). For vegetables, income also has an observable positive effect on FAFH consumption, but the combined consumption of FAFH and FAH shows a relatively small variation across income groups (Table V).

3.2 Significant proportion of FAFH consumed in fast food outlets

A significant proportion of FAFH consumption occurs in fast food venues in urban China. Figure 3 presents the sample statistics of per capita FAFH expenditure and consumption by dining-out-venue type and income over the survey week. As one can see, although the expenditure in restaurants is about twice as high as that in fast food venues (panel A), in quantity fast food is similar to restaurants and canteens (panel B), accounting for about 30 percent of total FAFH consumption each[6]. Moreover, Figure 3 shows that fast food consumption seems positively related to income growth, both in quantity and expenditure.

Yet, whether the increasing fast food consumption is truly caused by rising income is in question. Bai *et al.* (2012) indicated that income has positive and significant effects on household participation in dining out in restaurants and the associated expenditures, but it is insignificant for both decisions for eating out in fast food venues. These results suggest that the growth of fast food demand could be the result of higher time opportunity cost for preparing food at home rather than the result of higher income (Bai *et al.*, 2010; Liu *et al.*, 2015). In addition, the demand for fast food has a non-linear (such as quadratic) relationship

Table V.
FAFH and FAH
consumption by food
category and income

	Grain (kg)		Meat (kg)		Aquatic (kg)		Vegetables (kg)	
	FAFH	FAH	FAFH	FAH	FAFH	FAH	FAFH	FAH
Lowest 1/5	0.43	1.96	0.26	0.79	0.05	0.21	0.35	2.6
Lower 1/5	0.53	1.79	0.32	0.93	0.07	0.27	0.45	2.55
Middle 1/5	0.45	1.77	0.34	0.91	0.09	0.36	0.44	2.8
Higher 1/5	0.56	1.67	0.41	0.96	0.1	0.36	0.55	2.71
Highest 1/5	0.59	1.57	0.52	0.89	0.16	0.36	0.7	2.5

Source: See note 1 in Table IV

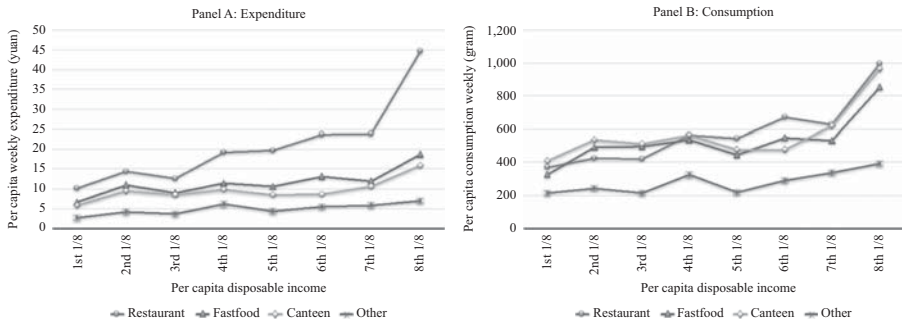


Figure 3.
Per capita weekly
FAFH consumption
by venue and income

Notes: Data used in Figures 3 and 4 are only from surveys in 9 out of 11 cities, with Beijing and Nanjing excluded; the reported expenditures are converted into 2010 price; also, see note 1 in Table IV for data source information

with income due to its relative low quality to meals in restaurants. In contrast, Xue *et al.* (2016) found a negative relationship between income and fast food consumption.

Evidence of the income effect on fast food from industrialized countries is also mixed. For example, McCracken and Brandt (1987) examined FAFH expenditure in the USA and found that income growth for the average consumer significantly increased expenditure at restaurants and other food facilities, but not at fast food facilities. In contrast, they found that busier consumers spent more at fast food and other food facilities than at time-intensive, full-service restaurants. Jekanowski *et al.* (2010) suggested that the availability of establishments could positively influence demand for dining out at fast food facilities. Using diary-based survey data by the Bureau of Labor Statistics, Stewart and Yen (2004) analyzed American household food consumption at full-service restaurants and fast food facilities. They predicted that per capita spending could rise 12 percent more in full-service restaurants than in fast food outlets between 2000 and 2020 given an assumed modest growth in household income. Nayga (1996) analyzed FAFH expenditure by dining out occasions and by meal types and found that fast food in the USA dominated the market for breakfast and lunch but lagged in dinner sales, while the reverse held true for restaurants.

3.3 Increasing demand for processed food

Processed food consumption in many low- and middle-income countries is growing rapidly (Veeck and Veeck, 2000; Minten *et al.*, 2010), including in China (Reardon *et al.*, 2012; Zhou *et al.*, 2015). Using a large-scale data set collected in 2011, Zhou *et al.* (2015) indicate that 74.5 percent of survey participants consumed processed foods (excluding edible oils and other condiments). The study also indicates that on average nearly 30 percent of consumers' total daily energy intake is from processed foods. This proportion is even higher for children and adolescents in megacities. Despite energy intake and food consumption in quantity are not directly comparable, their findings indicate that a significant proportion of food purchased in China is processed.

Similar results are also found in our own surveys. According to the household food consumption data we collected in 11 cities in China, per capita expenditure on processed food is about 40 yuan per week, only 20 yuan less than spent on raw food purchased for home consumption (Figure 4). In Beijing, the capital city of China, nearly half (49.5 percent) of food consumption in quantity at home is purchased as either semi-processed or ready-to-eat foods, of which, ready-to-eat food alone accounts for 42 percent of total food expenditure at home (Wang *et al.*, 2010)[7]. Semi-processed food, however, only accounts for a small margin in both quantity and expenditure.

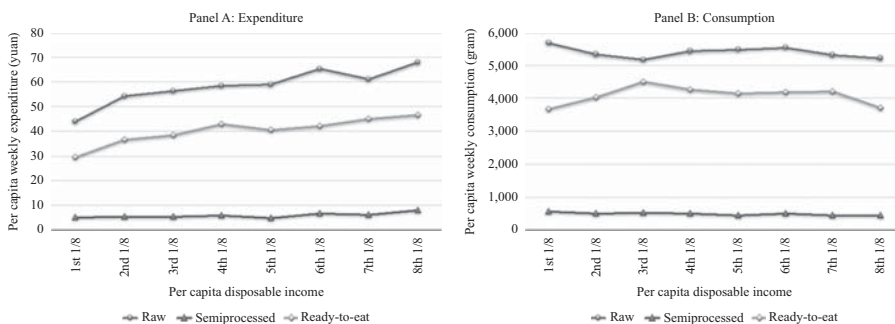


Figure 4. Per capita weekly FAFH consumption by processed degree and income

Source: See note 1 in Table IV

Figure 4 also shows that income has a linearly positive effect on expenditures for processed food (panel A), but shows an inverted-U shape relationship with quantity (panel B). This suggests that the demand for processed food may start declining when income reaches some level in the future.

3.4 Westernization of Chinese diets

China's success in economic growth and integration into the world economy has resulted in a sizable number of middle-income and affluent consumers who are willing to incorporate food items from relatively developed cultures into their conventional diets (Pingali 2007). This "dietary westernization" phenomenon has occurred in many Asian countries such as Japan (Tokoyama *et al.*, 2002), Korea (Lee *et al.*, 2006), Indonesia (Fabiosa 2006) and Malaysia (Sheng *et al.* 2008). An open research question is:

RQ1. To what extent dietary westernization has or is occurring in China?

Curtis *et al.* (2007) used a survey in Beijing to examine consumers' preferences for French fries, mashed potatoes and potato chips. They find that female gender, higher income levels, younger adults and the existence of children in the home all have a significant influence on processed potato consumption. Moreover, the study found that consumers holding positive opinions on the taste of western foods are more likely to purchase potato products. Using our weeklong household diary data collected in Beijing, Nanjing and Chengdu in China, Bai *et al.* (2014) empirically investigated the non-traditional food consumption in Chinese breakfasts and the factors that affect consumption. The study shows that western-style items are common on Chinese breakfast tables, suggesting that these western-style foods have become increasingly popular in urban areas. Fluid cow milk is the most popular, with over 70 percent of the households sampled in these cities reporting consumption. Following fluid cow milk are bread and cake products, with 47.3 and 16.1 percent of surveyed households reporting consumption of these items, respectively. Although less frequently consumed, it is notable that sausage, cheese and coffee, three very western items, have been incorporated into many Chinese breakfast menus.

Income, as expected, has a significantly positive effect on the incorporation of the western-style food items. The number of breakfasts during the one-week-sample period that included at least one type of western-style food is 3.83 for the lowest income group, while it increases to 4.63 for the highest income group. Similar trends are found for bread, milk and other western food consumption in terms of meal numbers. For bread, the weekly consumption frequency for the highest income group is 2.42 breakfasts, which is one breakfast more than the lowest income group (McCluskey *et al.*, 2012). Moreover, families with children and adolescents tend to more frequently consume bread, milk products and other western-style foods in their breakfast relative to adults and seniors, suggesting that younger generations play a leading role in the westernization of Chinese breakfast (Bai *et al.*, 2014). In the future, with income growth, we expect demand for non-traditional foods will continue to grow in China.

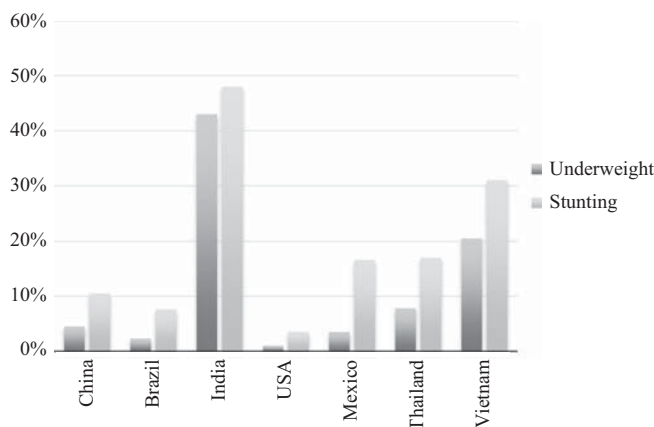
4. From thin to obese

Diets and consumption patterns are highly related to health. In this section, we first review trends for a number of health indicators. Then, we discuss the relationships between food consumption and an individual's body mass index (BMI). By doing so, we provide evidence in the literature to show whether the shifting diets and changing consumption patterns significantly contribute to the increasing observations of overweightness and obesity in China.

China has undoubtedly made progress in improving population health and in moving toward universal health coverage since the late 1980s. According to the Food and

Agriculture Organization of United Nations (FAO, 2015), the world achievements in reducing malnourishment over the last two decades are largely from developing countries in East and Southeast Asia. China alone contributes to the most reduction. The prevalence of undernourished in total population has declined from 23.9 percent in 1990–1992 to 9.3 percent in 2014–2016 (FAO, 2015). A number of indicators reflecting child growth and health, such as height, weight, prevalence of malnourishment, insufficiency of food consumption, unbalanced nutrition intake, etc., have been sustainably improved in China over the last three decades. For example, in 2010 the underweight rate for Chinese children below five years old was 3.6 percent, down by 74 percent from 1990. The stunting rate, which reflects children’s long-term chronic malnutrition, was 9.9 percent in 2010, dropping by 70 percent since 1990. The prevalence of iron-deficiency anemia dropped from 16.5 percent in 1990 to 12.6 percent in 2010. All of these achievements made China realize early success in reaching the United Nation (millennium) development goals. Figure 5 shows that several primary indicators of child nutrition and health conditions have exceeded many other Asian countries and have moved closer to the level in developed nations such as the USA.

Not all of China has been as fortunate. A study of food consumption in nationally recognized poorer areas of China shows that resident’s nutrient intake in these counties is far behind the national average and poorly balanced compared with the recommended nutritional intake (Bi, 2010). Nutritional disparities of Chinese children under five years old are significant in various dimensions. For example, the prevalence of underweight and growth stunting of children under five years old in rural China was three or four times higher than in urban areas. These numbers are twice as much when comparing the level of the recognized national-level poor counties to that in urban China. Children nutritional status in poor and remote areas is also found to be worse among girls than among boys (Shi *et al.*, 2012, Luo *et al.*, 2009). The left-behind children are another group of people whose nutrition and health warrants public attention. A report released by the Ministry of Education of China in September 2012 shows that school age children accompanying their migrating parents reached 12.6m and that left-behind children were about 22m. These children’s nutrition and health are of concern. According to Peng (2008) and Luo *et al.* (2011), anemia prevalence in left-behind children is remarkably higher than for their counterparts in urban areas, and height and weight are relatively lower. The prevalence of stunting and being underweight for



Notes: Data for China is in 2010, the others are between 2006 and 2010
Source: The State of the World’s Children (2012)

Figure 5. International comparison of malnutrition prevalence of zero- to five-years old children

left-behind children is also significantly higher than for other rural children, and insufficient calcium intake is prevalent (Duan, 2010).

On the other hand, China is on a fast track from a lean population to one in which being overweight or obese and its associated diseases has become one of the most prominent problems threatening human health in the society. According to three nationwide surveys, mean BMI in Chinese adults aged 18–69 years increased from 22.7 in 2004 to 23.7 in 2010. Mean waist circumference increased from 78.4 cm to 80.2 cm during the same period. As a result, among Chinese people older than 18 years old, the overweight and obesity rate in 2004, based on the international BMI (≥ 25 as overweight and ≥ 30 as obesity) was 19.6 and 3.3 percent, respectively. In 2010, just six years later, these numbers increased to 28 and 5.2 percent, respectively (Jiang *et al.*, 2015). The increase was more evident in men, young adults (aged 18–39 years), and in developed regions than in women, older adults (aged 40–69 years), and in less developed regions, respectively.

A recently published article in *The Lancet* shows that China has exceeded the USA to become the frontrunner in absolute number of obese people, both men and women, contributing 16.3 and 12.4 percent of global obesity in 2014, respectively. Although these numbers did not account for China's large population base, they reflect a sharp comparison with those in 1975 when only 2.1 percent of obese men and only 2.5 percent of obese women lived in China (NCD-RisC, 2016). As a result, non-communicable diseases, including type 2 diabetes, cardiovascular diseases and cancer, have become China's top health threats, contributing to more than 80 percent of the country's 10.3m annual deaths and to nearly 70 percent of its total disease burden (The Lancet Editorial, 2014). The situation has worsened in recent years as more young people and low-income people became obese (Popkin, 2008; Yan *et al.*, 2012).

Why is this happening? While it is generally true that the overweight/obesity epidemic reflects increases in caloric intake and reduced activity in daily life (Alston *et al.*, 2016), the answer to this question in China seems inconclusive. Public media and many open sources often blame the introduction of highly processed fast food and adoption of western aspirations, combined with the increasingly sedentary lifestyle. However, academic voices so far are mixed. To date, research in China addressing the notable rise in overweightness and particularly childhood obesity has mainly relied on public health data with basic descriptions of these trends, but few studies that focus on driving force identification have been completed (Martinson *et al.*, 2015). A study by Zhang *et al.* (2012) indicated a weak relationship between fast food consumption and overweight/obesity in China. Instead, they find the factors that are most associated with higher BMI are consumers' incorrect dietary knowledge, food retail environment, and sociodemographic variables. A more recently published paper also did not find a significant association between fast food consumption and obesity in China although it reports that fast food consumption measured as having consumed western fast food in the past three months has significantly increased for school age children in China from 2004 to 2009 (Xue *et al.*, 2016). One of possible explanations for the mixed relationship between fast food consumption and overweight/obesity in China might be associated with the data and methodology used in different studies.

Based on the authors' collected household data in China's cities, we also examined the relationship between FAFH consumption and BMI, with the hypothesis that FAFH may positively contribute to BMI due to its relatively higher calorie content compared to food prepared at home. Our empirical results, however, show the effect of FAFH consumption on urban Chinese residents' BMI is small in magnitude even though it is statistically positive (Anfinson *et al.*, 2016). Based on the same data, Xie *et al.* (2015) tried to narrow down FAFH specifically into fast food consumption and to identify the impact on BMI by age group. The results are quite similar with Anfinson *et al.* (2016), that is, fast food consumption has a significant and positive effect on one's BMI in China, but the marginal effect is minor for all age groups.

Will consuming more processed food contribute to a higher BMI? The literature appears to support this hypothesis in many countries (Pereira *et al.*, 2005; Liu *et al.*, 2002; Asfaw, 2011). A study by Zhou *et al.* (2015), however, does not fully support this result in China. Their results indicate that the impact of processed food intake on individual BMI can only be found in Chinese children and adolescents. A possible explanation for this “anticipated” result is that processed food consumption in China is still lower compared to its developed counterparts such as the USA. With the rapid growth of processed food consumption in China, its impact in the long run on an individual’s BMI and health needs more attention.

5. Conclusions and the unfinished agenda

Driven by dramatic income growth, market development, and changing lifestyle with urbanization and globalization, Chinese diets and food-consumption patterns have dramatically changed. At the same time, food-related health problems have rapidly increased in China, resulting in a coexistence of undernutrition, deficiency of micronutrients, and overweightness and obesity. This paper reviews and discusses the main trends of food-consumption transitions and the potential associations between these transitions and the rising health problems. We document increasing food consumption away from home, the rising demand for fast and processed food, and the popularization of western-style foods in urban Chinese diets. Meanwhile, this review also indicates that Chinese consumers are on a fast track from thin to obese. As a result, non-communicable diseases, including type 2 diabetes, cardiovascular diseases, and cancer have become China’s top health threats, potentially threatening China’s health care system. However, to what degree these health problems are related to the changing diets and food consumption transitions in China remains inconclusive. More studies that are scientific are required.

Given China’s huge population size, any change, even a small change, could not only generate a significant effect on domestic food demand and supply equilibrium, but also influence the world market. Accordingly, existing studies are far from sufficient to completely understand the entire picture of China’s food consumption transition as well as the associated impacts on health. Moreover, this review suggests that more updated research is needed for better understanding FAFH consumption in China and associated health issues.

Notes

1. The NBSC survey covers all provinces in Mainland China, including both urban and rural households. The data are collected by asking the sampled households to record their food purchased (and consumed in rural China) and to report this information (most reporting twice a month, but, in a few provinces, the data are collected monthly) to the local office of the NBSC over three consecutive years. Detailed information about the NBSC survey data is provided in Zhou, Yu, Abler and Chen (2014), Zhou, Liu, Cao, Tian and Wang (2014), pp. 6-8.
2. An extensive list of estimated demand elasticities can be found in You (2014) and Zhou.
3. The explanation of diversifying diet across regions was pointed out by one of the anonymous referees.
4. Detailed information about the CHNS data can be found at www.cpc.unc.edu/projects/china/
5. These studies are jointly conducted by researchers from China Agricultural University, Center for Chinese Agricultural Policy, University of Florida, and North Dakota State University.
6. The differences between restaurants and fast food outlets in our surveys were defined by several visible features (restaurant vs fast food) including: full service vs partial service, pay after food served vs pay before food served, have menu book vs board menu, and order seating vs order standing. For any confusing case, the judgment was made by the respondent’s self-stated sense.

7. The processed or semi-processed foods in our surveys are defined by jointly using direct edibility and packaging. Processed foods are directly edible items (without significant cooking time and skill to make it ready-to-eat at home), with exceptions of fresh fruits and vegetables. Semi-processed are foods mostly packed but not directly edible or ready-to-eat, with an exception of packed rice, wheat flour and other cereals. The uncooked and unpacked noodles, meatballs or similar products made of rice, cereal flour, meat or any other ingredients that are not directly edible are viewed as semi-processed products. All cooking oils are treated as semi-processed items although some of them are directly edible as seasoning. Other food items not categorized as the processed or semi-processed are treated as raw products. It is noticed that direct edibility is based on the common sense that the respondent holds. We did not provide any criteria for that during the survey.

References

- Abler, D. (2010), *Demand Growth in Developing Countries*, TAD/CA/APM/CFS/MD(2010)9, OECD, Paris.
- Alston, J., MacEwan, J. and Okrent, A. (2016), "The economics of obesity and related policy", *Annual Review of Research Economics*, Vol. 8 No. 1, pp. 443-465.
- Anfinson, C., Wahl, T., Seale, J. Jr and Bai, J. (2016), "Factors affecting adolescent obesity in Urban China", in Schmitz, A., Kennedy, P.L. and Schmitz, T.G. (Eds), *Food Security in a Food Abundant World (Frontiers of Economics and Globalization)*, Vol. 16, Emerald Publishing Limited, pp. 105-114.
- Asfaw, A. (2011), "Does consumption of processed foods explain disparities in the body weight of individuals? The case of Guatemala", *Health Economics*, Vol. 20 No. 2, pp. 184-195.
- Bai, J., McCluskey, J., Wang, H. and Min, S. (2014), "Dietary globalization in Chinese breakfasts", *Canadian Journal of Agricultural Economics*, Vol. 61 No. 3, pp. 325-341.
- Bai, J., Wahl, T., Lohmar, B. and Huang, J. (2010), "Food away from home in Beijing: effects of wealth, time and 'free' meals", *China Economic Review*, Vol. 21 No. 3, pp. 432-441.
- Bai, J., Zhang, C., Qiao, F. and Wahl, T. (2012), "Disaggregating household expenditures on food away from home in Beijing by type of food facility and type of meal", *China Agricultural Economic Review*, Vol. 4 No. 1, pp. 18-35.
- Bai, J., Zhang, C., Wahl, T. and Seale, J. (2016), "Dining out, the missing food consumption in China", *Applied Economics Letters*, Vol. 23 No. 15, pp. 1084-1087.
- Bi, J. (2010), "Food consumption of Chinese rural low-income households", master thesis, Chinese Academy of Agricultural Sciences, Beijing.
- Costa, D. (2015), "Health and the economy in the United States from 1750 to the present", *Journal of Economic Literature*, Vol. 53 No. 3, pp. 503-570.
- Curtis, K.R., McCluskey, J. and Wahl, T. (2007), "Consumer preferences for western-style convenience foods in China", *China Economic Review*, Vol. 18 No. 1, pp. 1-14.
- Du, S.F., Wang, H.J., Zhang, B., Zhai, F.Y. and Popkin, B.M. (2014), "China in the period of transition from scarcity and extensive undernutrition to emerging nutrition-related non-communicable diseases, 1949-1992", *Obesity Reviews*, Vol. 15 No. S1, pp. 8-15.
- Duan, D. (2010), "A diet and nutrition survey on China's rural children aged 2-6", Zhong Nan University, Hunan (in Chinese).
- Fabiosa, J.F. (2006), "Westernization of the Asian diet: the case of rising wheat consumption in Indonesia", CARD Working Paper No. 06-WP 422, Iowa State University, April.
- Fan, S.G., Wailes, E.J. and Cramer, G.L. (1995), "Household demand in rural China: a two-stage LES-AIDS model", *American Journal of Agricultural Economics*, Vol. 77 No. 1, pp. 54-62.
- FAO (2015), "The state of food insecurity in the world 2015, the FAO hunger map", available at: www.fao.org/hunger/en/

- Gao, X.M., Wailes, E.J. and Cramer, G.L. (1996), "A two-stage rural household demand analysis: microdata evidence from Jiangsu province, China", *American Journal of Agricultural Economics*, Vol. 78 No. 3, pp. 604-613.
- Gordon-Larsen, P., Wang, H. and Popkin, B.M. (2014), "Overweight dynamics in Chinese children and adults", *Obesity Reviews*, Vol. 15 No. S1, pp. 37-48.
- Gould, B.W. and Villarreal, H.J. (2006), "An assessment of the current structure of food demand in urban China", *Agricultural Economics*, Vol. 34 No. 1, pp. 1-16.
- Guo, X., Mroz, T.A., Popkin, B.M. and Zhai, F. (2000), "Structural change in the impact of income on food consumption in China, 1989-1993", *Economic Development and Cultural Change*, Vol. 48 No. 4, pp. 737-760.
- Huang, J. and Rozelle, S. (1998), "Market development and food demand in rural China", *China Economic Review*, Vol. 9 No. 1, pp. 25-45.
- Huang, J., Rozelle, S. and Rosegrant, M.W. (1999), "China's food economy to the twenty-first century: supply, demand, and trade", *Economic Development and Cultural Change*, Vol. 47 No. 4, pp. 737-766.
- Huang, Y. (2014), "The 2008 milk scandal revisited", *Forbes Asia*, July, available at: www.forbes.com/sites/yanzhonghuang/2014/07/16/the-2008-milk-scandal-revisited/#868dd8f44282
- Jekanowski, M.D., Binkley, J.K. and Eales, J. (2010), "Convenience, accessibility, and the demand for fast food", *Journal of Agricultural and Resource Economics*, Vol. 26 No. 1, pp. 58-74.
- Jiang, Y., Xu, Y., Bi, Y., Wang, L., Zhang, M., Zhou, M., Li, Y., Xu, M., Lu, J., Wang, T., Dai, M., Zhang, D., Wang, W., Ning, G., Wang, L. and Zhao, W. (2015), "Prevalence and trends in overweight and obesity among Chinese adults in 2004-10: data from three nationwide surveys in China", *The Lancet*, Vol. 386 p. S77.
- Lee, H., Summer, D. and Ahn, B. (2006), "Consequences of further opening of the Korean dairy market", *Food Policy*, Vol. 31 No. 3, pp. 238-248.
- Liu, H., Wahl, T., Seale, J. Jr and Bai, J. (2015), "Household composition, income, and food away from home consumption in Urban China", *Food Policy*, Vol. 51 No. 3, pp. 97-103.
- Liu, S., Manson, J., Buring, J., Stampfer, M., Willett, W. and Ridker, P. (2002), "Relation between a diet with a high Glycemic load and plasma concentrations of high-sensitivity c-reactive protein in middle-aged women", *American Journal of Clinical Nutrition*, Vol. 75 No. 3, pp. 492-498.
- Luo, R., Shi, Y., Zhang, L., Liu, C., Rozelle, S. and Sharbono, B. (2009), "Malnutrition in China's rural boarding schools: the case of primary schools in Shaanxi province", *Asia Pacific Journal of Education*, Vol. 29 No. 4, pp. 481-501.
- Luo, R., Wang, X., Liu, C., Zhang, L., Shi, Y., Miller, G., Rozelle, S., Yu, E., Sharbono, B. and Martorell, R. (2011), "Alarming high Anemia prevalence in western China", *Southeast Asian Journal of Tropical Medicine and Public Health*, Vol. 42 No. 5, pp. 1204-1213.
- McCluskey, J., Bai, J., Wang, H., Seale, J. Jr and Wahl, T. (2012), "The westernization of Chinese breakfast", GAIN Report No. 1/20/2012, FAS, US Department of Agriculture.
- McCracken, V.A. and Brandt, J.A. (1987), "Household consumption of food-away-from-home: total expenditure and by type of food facility", *American Journal of Agricultural Economics*, Vol. 69 No. 2, pp. 274-284.
- Ma, H., Huang, J., Fuller, F. and Rozelle, S. (2006), "Getting rich and eating out: consumption of food away from home in Urban China", *Canadian Journal of Agricultural Economics*, Vol. 54 No. 1, pp. 101-119.
- Martinson, M., Chang, Y., Han, W. and Wen, J. (2015), "Social determinants of childhood obesity in Shanghai, China: a cross-sectional child cohort survey", *The Lancet*, Vol. 386 No. 1, p. S50.
- Minten, B., Reardon, T. and Sutradhar, R. (2010), "Food prices and modern retail: the case of Delhi", *World Development*, Vol. 38 No. 12, pp. 1775-1787.
- Mutlu, S. and Gracia, A. (2006), "Spanish food expenditure away from home: by type of meal", *Applied Economics*, Vol. 38 No. 9, pp. 1037-1047.

- Nayga, R.M. Jr (1996), "Analysis of food away from home expenditures by meal occasion", *Agribusiness*, Vol. 12 No. 5, pp. 421-427.
- NCD Risk Factor Collaboration (NCD-RisC) (2016), "Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19.2 million participants", *The Lancet*, Vol. 387 No. 10026, pp. 1377-1396.
- Okrent, A.M. and Alston, J.M. (2012), "The demand for disaggregated food-away-from-home and food-at-home products in the United States", Economic Research Report Number No. 139, US Department of Agriculture, August.
- Pereira, M.A., Kartashov, A.I., Ebbeling, C.B., Van Horn, L., Slattery, M.L., Jacobs, D.R. and Ludwig, D.S. (2005), "Fast food habits, weight gain, and insulin resistance the CARDIA study: 15-year prospective analysis", *The Lancet*, Vol. 365, pp. 36-42.
- Pingali, P. (2007), "Westernization of Asian diets and the transformation of food systems: implications for research and policy", *Food Policy*, Vol. 32 No. 3, pp. 281-298.
- Popkin, B.M. (2008), "Will China's nutrition transition overwhelm its health care system and slow economic growth?", *Health Affairs*, Vol. 27 No. 4, pp. 1064-1076.
- Popkin, B.M., Adair, L.S. and Ng, S.W. (2012), "Global nutrition transition and the pandemic of obesity in developing countries", *Nutrition Reviews*, Vol. 70 No. 1, pp. 3-21.
- Popkin, B.M., Du, S., Zhai, F. and Zhang, B. (2010), "Cohort profile: the China health and nutrition survey-monitoring and understanding socio-economic and health change in China, 1989-2011", *International Journal of Epidemiology*, Vol. 39 No. 6, pp. 1435-1440.
- Reardon, T., Timmer, C.P. and Minten, B. (2012), "Supermarket revolution in Asia and emerging development strategies to include small farmers", *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 109 No. 1, pp. 12332-12337.
- Seale, J Jr, Bai, J., Wahl, T. and Lohmar, B. (2012), "Household Engel curve analysis for food, Beijing, China", *China Agricultural Economic Review*, Vol. 4 No. 4, pp. 427-439.
- Sheng, T.Y., Shamsudin, M.N., Mohamed, Z., Abdullah, A.M. and Radam, A. (2008), "Complete demand systems of food in Malaysia", *Agricultural Economics-Zemedelska Ekonomika*, Vol. 54 No. 10, pp. 467-475.
- Shi, Y., Chang, F., Su, X., Luo, R., Zhang, L. and Rozelle, S. (2012), "Parental training, anemia and the impact on the nutrition of female students in China's poor rural elementary schools", *China Agricultural Economic Review*, Vol. 4 No. 2, pp. 151-167.
- Stewart, H. and Yen, S.T. (2004), "Changing household characteristics and the away-from-home food market: a censored equation system approach", *Food Policy*, Vol. 29, pp. 643-658.
- The Lancet Editorial (2014), "Obesity: a growing threat to health in China", *The Lancet*, Vol. 384 No. 9945, p. 716.
- Tokoyama, Y., Takagi, S., Ishibashi, K. and Chern, W.S. (2002), "Recent food consumption pattern of Japanese households: driving forces behind westernization", *Paper Provided by American Agricultural Economics Association (New Name 2008: Agricultural and Applied Economics Association) in its series 2002 Annual meeting, Long Beach, CA, July 28-31*.
- Veeck, A. and Veeck, G. (2000), "Consumer segmentation and changing food purchase patterns in Nanjing, PRC", *World Development*, Vol. 28 No. 3, pp. 457-471.
- Wang, H.N., McCluskey, J., Bai, J. and Mancino, L. (2010), "Food consumption trends in China: degree of processing, westernized breakfast, and wine preferences", paper presented in the Agricultural and Applied Economics Association Annual Meeting, Denver, CO, July 26.
- Xie, C., Zhang, C. and Bai, J. (2015), "Impact of fast food consumption on body mass index by age group in China", master thesis, School of Economics, Central University of Finance and Economics, Beijing.
- Xue, H., Wu, Y., Wang, X. and Wang, Y. (2016), "Time trends in fast food consumption and its association with obesity among children in China", *Plos One*, Vol. 11 No. 3, e0151141, available at: <http://dx.doi.org/10.1371/journal.pone.0151141>

- Yan, S., Li, J., Li, S. and Zhang, B. (2012), "The expanding burden of cardiometabolic risk in China: the China health and nutrition survey", *Obesity*, Vol. 13 No. 9, pp. 810-821.
- Yen, S.T., Fang, C. and Su, S.J. (2004), "Household food demand in urban China: a censored system approach", *Journal of Comparative Economics*, Vol. 32 No. 3, pp. 564-585.
- You, J. (2014), "Dietary change, nutrient transition and food security in fast-growing China", in Jha, R., Gaiha, R. and Deolalikar, A.B. (Eds), *Handbook on Food: Demand, Supply, Sustainability and Security*, ISBN 978 1 7810 0428 9, Edward Elgar Publishing Limited, Cheltenham, pp. 204-245.
- Zhang, X., Lans, I. and Dagevos, H. (2012), "Impacts of fast food and the food retail environment on overweight and obesity in China: a multilevel latent class cluster approach", *Public Health Nutrition*, Vol. 15 No. 1, pp. 88-96.
- Zheng, Z.H. and Henneberry, S.R. (2009), "An analysis of food demand in China: a case study of urban households in Jiangsu province", *Applied Economic Perspectives and Policy*, Vol. 31 No. 4, pp. 873-893.
- Zhou, D., Yu, X., Abler, D. and Chen, D. (2014), "Projecting meat and cereals demand for China based on a meta-analysis of income elasticities", Global Food Discussion Papers No. 34, Georg-August-University of Göttingen, available at: <http://ageconsearch.umn.edu/handle/168528>
- Zhou, Y., Du, S., Su, C., Zhang, B., Wang, H. and Popkin, B. (2015), "The food retail revolution in China and its association with diet and health", *Food Policy*, Vol. 55, pp. 92-100.
- Zhou, Z., Liu, H., Cao, L., Tian, W. and Wang, J. (2014), "Food consumption in China, the revolution continues", Edward Elger, Cheltenham and Northampton, MA.

Further reading

- Byrne, P.J., Capps, O. Jr and Saha, A. (1998), "Analysis of quick-serve, mid-scale, and up-scale food away from home expenditures", *The International Food and Agribusiness Management Review*, Vol. 1 No. 1, pp. 51-72.
- Huang, J. and Bouis, H. (2001), "Structural changes in the demand for food in Asia: empirical evidence from Taiwan", *Agricultural Economics*, Vol. 26 No. 1, pp. 57-69.
- Lu, J., Bi, Y. and Ning, G. (2016), "Curbing the obesity epidemic in China", *The Lancet Diabetes & Endocrinology*, Vol. 4 No. 6, pp. 470-471.
- Min, I., Fang, C. and Li, Q. (2004), "Investigation of patterns in food-away-from-home expenditure for China", *China Economic Review*, Vol. 15 No. 4, pp. 457-476.

Corresponding author

Junfei Bai can be contacted at: jfbai@cau.edu.cn