



Urban food insecurity and the impact of China's affordable food shop (AFS) program: A case study of Nanjing City

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ABSTRACT

Food subsidies are widely implemented as part of government policies globally to mitigate food insecurity amongst the urban poor. Subsidies to retail outlets are one type of supply-side subsidy designed to make food more affordable to low-income consumers. China's Affordable Food Shop (AFS) program introduced by the central government in 2011 and implemented by municipal governments is one example. To date, there has been little research examining the effectiveness of the AFS program despite more than a decade of implementation. This paper presents a case study of the program's effectiveness in Nanjing which was one of the first Chinese cities to introduce the program which grew very rapidly in the years that followed. In early 2020, the Nanjing program was closed which raises important questions about its effectiveness and impact. We show that food insecurity in Nanjing is generally low but that increased food insecurity is associated with lived poverty, lower income, and unaffordability of staple foods. Food insecurity is not mitigated by proximity to an AFS Program shop. The paper argues that the program had various deficiencies and a limited effect in reducing food insecurity and increasing food accessibility. These included inappropriate targeting, program redundancy, and competition from supermarkets and public markets. In the circumstances, the decision by the city government to close the program is understandable.

1. Introduction

Food subsidies and price controls are widely used social protection policy tools to mitigate poverty and food insecurity, and to make staple foods and fresh produce more affordable to low-income households (Feltenstein, 2017). During periods of rapid food price increase and volatility, such as during the global economic crisis of 2007–2008, such measures take on added salience (Bakker, 2015; Bellemare, 2015; Smith, 2014). One analysis of food price policies in 14 countries, for example, found extensive use of “bandage (sic) solutions” such as short-term subsidies for food as a response to price volatility, crisis, and potential social unrest (Pinstrip-Andersen, 2014, p. 481). As Ismail (2021, p. 3) notes in a review of the literature on the relationship between food prices and popular protest, food subsidies and price controls are “policy

interventions that may address rising food prices and mitigate the rise of violent collective action.” Subsidies are also deployed by governments to increase competitive advantage or during longer periods of disruptive social and economic transformation.

The rapid urbanization of the Global South in recent decades and a growing crisis of urban food insecurity, for example, has unveiled many of the global and local drivers of food prices and food (un)affordability and prompted renewed interest in subsidies as a mitigation strategy (Clapp, 2009; Crush et al., 2012). As the contributors to Crush et al. (2021) show, the complex connections between urbanization and urban food insecurity include expanded urban populations from rural-urban migration, declining domestic food production, increased food imports and vulnerability to global markets, bottlenecks in supply chains, and growing poverty, precarious employment and incomes.

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Table 1
Types of food subsidy programs.

Program	Country	Subsidy category	Subsidy allocation method	Subsidized/targeted food items
Affordable Food Shop Program, China (Jiangsu Provincial Government, 2012)	China	Retailer subsidy	<ul style="list-style-type: none"> • Subsidizing food retailers; • Business establishment subsidy per shop; • Annual operation subsidy per shop; • Selling food at regulated prices 	Vegetable price 15% lower than the mean price confirmed by Jiangsu price administration; Grain, cooking oil, meat and eggs: priced 5% lower than mean price
Public Distribution System, India (PDS) (George & McKay, 2019) Pulse subsidy program included in PDS, India (Chakrabarti et al., 2018; Kaushal & Muchomba, 2015)	India	Price subsidy	<ul style="list-style-type: none"> • Fair-price shops owned and operated by government selling subsidized food; • Issuing ration cards; • Two thirds of market price with quota 	Central government: rice, wheat, sugar, and kerosene oil; State government: additional food items
Public Distribution System (PDS), Iraq (Krishnan et al., 2019)	Iraq	Price subsidy	<ul style="list-style-type: none"> • Rationing: 13 food products available at subsidized prices within ration quota 	Rice, flour, oil, sugar
Public Food and Energy Subsidies, Iran (Esmaeili et al., 2013; Hosseini et al., 2017)	Iran	Price subsidy/ Consumer subsidy	<ul style="list-style-type: none"> • Price subsidy for targeted food items • Initially subsidies did not target particular income groups but were equally distributed; replaced by targeted policy in 2010 of consumer subsidy cash transfers • In first phase, all Iranians were eligible. In the second phase, 10 million no longer eligible 	Water, wheat, bread, rice, edible oil, milk and sugar
National Food Authority Program, Philippines (Jha & Ramaswami, 2010)	Philippines	Price subsidy	<ul style="list-style-type: none"> • National Food Authority selling rice to accredited retailers and requiring them to sell rice with mandated below-market price. • Unlimited purchase 	Rice
Food Subsidy Program, Egypt (Talaat, 2018)	Egypt	Price subsidy	<ul style="list-style-type: none"> • Licensed ration shops selling subsidized commodities; • Beneficiaries holding ration card with quota of food (before 2014); • Beneficiaries holding smart card with monthly allowance (since 2014) 	<i>baladi</i> bread, cooking oil, rice, sugar and macaroni (before 2014) more than 50 commodities (since 2014)
<i>Pilersuisoq</i> stores, Greenland (Galloway, 2017)	Denmark (Greenland)	Price subsidy	<ul style="list-style-type: none"> • State-owned stores • Regulated prices 	Wide variety of food items including vegetables, fruit, meat products, milk, eggs, nuts, cooking oil, fish
Nutrition North Canada (Galloway, 2017; St-Germain et al., 2019)	Canada	Retailer subsidy	<ul style="list-style-type: none"> • Subsidizing food retailers on a per kg basis with two levels (partial and full subsidy) in remote northern communities; • No price caps; • Grocery stores operated by companies 	Perishable, nutritious foods on eligible food item list Retailing with eligible communities
New York City's Food Retail Expansion to Support Health (FRESH) Program, USA (Elbel et al., 2015)	USA	Retailer subsidy	<ul style="list-style-type: none"> • Financial and zoning incentives to decrease costs of food retailing in underserved communities 	No less than 46.5 sq m for fresh produce and 30% of floor space for selling perishable products
New Markets Tax Credit Program, USA (Freedman & Kuhns, 2018)	USA	Retailer subsidy	<ul style="list-style-type: none"> • Providing investors with a tax credit for business operation and real estate development in low-income communities; 	Promoting food retail establishment development without no specific requirements on food items sold
Supplemental Nutrition Assistance Program (SNAP), US (Chang et al., 2015)	USA	Consumer subsidy	<ul style="list-style-type: none"> • Issuing Electronic Benefits • Transfer card 	Wide variety of food items such fruits, vegetable, meat, poultry, fish, cereals, dairy products, etc.
Child Support Grant Program (Granlund & Hochfeld, 2017; Patel & Hochfeld, 2011)	South Africa	Consumer subsidy	<ul style="list-style-type: none"> • Monthly cash grant to all households with children under • Designed to improve child nutrition and poverty 	Monthly cash grants to primary caregivers of USD33 per child for 12 million children (2018)

Sources: compiled by authors.

Food affordability is important for the food security of urban populations and the maintenance of social order (Haug & Hella, 2013). Affordability generally refers to the food expenditure of a household relative to its income and the price of a basic basket of goods (Lee et al., 2013). Policies to ensure affordability involve measures on either the supply or the demand side or both. Demand-side interventions include price subsidies on essential foods, stabilizing or raising household income (e.g. cash transfers, basic income grants or minimum wage legislation) and subsidizing other basic needs such as water, electricity, health care, and education. Common supply-side interventions include guarantees for agricultural producers and subsidies for food marketers and retailers.

In China, considerable attention is devoted to supply-side subsidies in the form of subsidization of agricultural production (Huang & Yang, 2017; Huang et al., 2013; Lopez et al., 2017; Meng, 2012; Shimokawa, 2010; Yi et al., 2015). While agricultural subsidies are critical to increased production of grain and non-grain foodstuffs, less attention is paid to how agricultural subsidies have impacted on food access and utilization in the cities. Similarly, the impact of other supply-side subsidies on urban food security have not yet been explored in systematic fashion. This paper focuses on the nature and impact of China's Affordable Food Shop (AFS) program which was announced by the central government in 2011 with the aim of stabilizing urban food prices through food retail shops which were financially subsidized by local governments in middle and lower-income neighbourhoods.

After nearly a decade of continuous expansion in cities such as Nanjing, the AFS program was shut down in early 2020 after the research for this paper was complete. The termination of the program raises important questions about its effectiveness in achieving its core goals of making food more affordable and accessible and improving the food security situation of lower-income households. In this respect, we build on previous studies of the Nanjing food system to assess whether the affordable food shop program had a positive effect on levels of food security in the city (Qi et al., 2019; Si et al., 2019; Zhong et al., 2018, 2019; Yuan, Si, Zhong, Huang, & Crush, 2021).

Section 2 of the paper provides an overview of different forms of food price subsidization strategy in order to contextualize the AFS approach. This is followed in Section 3 by a description of the methodology and sources used for the Nanjing case study, one of the lead Chinese cities in AFS planning and implementation. Using primary data from a city-wide household food security survey, the paper then models the relationship between household characteristics and poverty and food insecurity in order to first evaluate the determinants of household food insecurity in Nanjing, and then to assess whether the program achieved its stated aim of improving the food security of low-income households in the city. Potential reasons for the ineffectiveness of the AFS Program are presented in the Discussion. The Conclusion reflects on the overall implications of the study for the study of food retail subsidies more generally.

2. Food retail subsidization programs

2.1. Types of program

The rising global tide of overnutrition and obesity has tended to elicit food taxes on unhealthy foods rather than subsidies on healthy food (Powell & Chaloupka, 2009). There are three main types of food retail subsidy: price subsidies, retailer subsidies, and consumer subsidies (see Table 1 for examples of each). Price subsidies involve selling food to consumers at discounted prices. In Egypt, for example, designated retail outlets sell food items such as cooking oil, sugar flour, and *baladi* bread at subsidized prices (Ramadan & Thomas, 2011). Retailer subsidies aim to contain food price increases and improve food accessibility by subsidizing the operations of food retailers. In some jurisdictions, this involves the provision of credits to retailers who sell produce at state-mandated prices. For example, the National Food Authority program in the Philippines provides credits to retailers selling rice at mandated prices (Jha &

Ramaswami, 2010). Another example is where state-owned stores provide subsidized food. In India, for example, the Public Distribution System sells rice, wheat, sugar, and kerosene oil at subsidized prices through state-run fair-price shops (Chakrabarti et al., 2018), a model also used in Iraq (Krishnan et al., 2019). Finally, consumer subsidies involve cash grants to targeted households or individuals for their own food purchase.

Evidence on the impacts of subsidization on food consumption and security is decidedly mixed. On the positive side, An's (2012) review of subsidies in seven countries including the USA, Canada, and Germany found that subsidies on healthier foods significantly increase the purchase and consumption of promoted products. One study in the US found that a 12.5% price discount (equivalent to the goods and services tax rate) significantly increased the purchase of healthier foods (Ni Mhurchu et al., 2009). This suggests that there could be a threshold above which price discounting can have a significant effect (Black et al., 2012; Blakely et al., 2020; Ni Mhurchu et al., 2009; Nnoaham et al., 2009; Powell & Chaloupka, 2009). The subsidy programs in Egypt, India, and Philippines all positively affected household access to food, increased food consumption by low-income households, and reduced the prevalence of underweight children (Anuradha & Raj, 2019). Chang et al. (2015) report that the food price subsidies of the Supplemental Nutrition Assistance Program in the US increased the consumption of fruits and vegetables.

In urban Iran, the implementation of the Targeted Subsidies Policy positively affected the consumption of fish and red meat while having a negative effect on the consumption of cereal and poultry meat (Hosseini et al., 2017). A study in New Zealand by Blakely et al. (2020) found an increase in the healthiness of supermarket-purchased foods because of three tax policies (on sugar, saturated fat, and salt), but not for a fruit and vegetable subsidy. In Canada, the food subsidies of the Nutrition North Canada program succeeded in lowering food prices (Naylor et al., 2020), but some argue that the program failed to meet the goal of addressing lack of access to perishable foods because of the lack of accountability and retail competition (Galloway, 2014, 2017; St-Germain et al., 2019). The New Markets Tax Credit Program in the US encouraged supermarket entry into low-income communities but did not substantially change household food purchasing patterns (Freedman & Kuhns, 2018). For example, the introduction of new government-subsidized supermarkets in New York City did not significantly increase household purchase of healthier food types such as whole grains, fresh fruits, and vegetables (Elbel et al., 2015). In the Philippines, the National Food Authority Program has had limited impact mainly due to program waste (Jha & Ramaswami, 2010), while the targeted Public Distribution System in India led to an increase in the consumption of subsidized food, including pulses, but not overall calorie and protein intake (Chakrabarti et al., 2018; Kaushal & Muchomba, 2015).

In assessing the impact of food retail subsidies on food security, there are two main research gaps. First, there has been little research investigating the impact of subsidies to food retailers designed to reduce food prices through regulating the cost of food in one type of food outlet. Second, there has been little research on the effect of geographical access to subsidized food outlets on food security (Downing & Larai, 2016). Although China has implemented an Affordable Food Shop (AFS) Program since 2011, very little research has examined the impact of the program with the exception of two papers focusing on its effect on a city's consumer price index or city-wide produce prices (Li & Xie, 2013; Zhu & Ding, 2014). There have been no studies to date investigating the impact of the AFS Program on household-level food security.

2.2. The AFS program in China

The Chinese AFS Program is a central government initiative aimed at supporting and growing the number of food shops to be financially subsidized by local government. The policy was first announced by the National Development and Reform Commission in May 2011 with the stated aim of stabilizing rising vegetable prices (National Development

& Reform Commission, 2011; 2012). Preferable locations for affordable food shops included urban areas with a high volume of food consumption, within or close to residential neighbourhoods, and in middle and low income communities (National Development & Reform Commission, 2012). In March 2012, the Commission increased the number of food items to be sold to include fruit, grain, cooking oil, meat, poultry, and eggs. In exchange for various local government subsidies, the policy required shops to sell vegetables and fruits at prices 15% lower than the local market price; and grain, cooking oil, meat, poultry and eggs at 5% lower than the local market price. AFS owners were provided with an online list of products, market prices, and selling prices to choose from by local government. Based on their reported sales, government provided a subsidy equal to the difference between the market and selling price. Affordable food shops were also required to accept performance assessments and shops failing to pass assessment were to be ejected from the affordable food shop program (National Development & Reform Commission, 2012). In Jiangsu Province, a potential AFS operator (of either an established or new shop) had to apply for a permit from the district (county-level) government. The shop was required to have a business area of no less than 50 square meters and to sell no less than 15 types of vegetables (Jiangsu Province Government, 2012a, pp. 54–57).

Provincial and city governments were given some discretion over the elements of the AFS program since they were primarily responsible for financing the subsidies from their own budgets. Funding for the program in Nanjing City came from two sources: the Nanjing Municipal Government and transfers from the Jiangsu Provincial Government. The Municipal Government was permitted to establish its own implementation policy provided that provincial government policies were incorporated. The Nanjing version of the AFS program offered subsidies to affordable food shops that included tax and fee allowances or exemptions, favourable prices for water and electricity consumption, and subsidies for business establishment and operations. The business establishment subsidy was CNY 100,000 (about USD15,000) per shop. The operations subsidy was paid quarterly based on a shop's performance as assessed by government. The average annual operations subsidy amounted to around CNY 55,000 (about USD8,000) in 2017 (Nanjing Bureau of Administration for Commodity Prices, 2017). The food shops had to sell no fewer than ten types of fresh produce at a discount on a produce list compiled by the Municipal Government. Consistent with the national directive, all prices had to be 15% lower than the average food price determined by the Municipal Price Administration based on a city-level food price monitoring system. Foods not on the produce list could also be sold but at prices no higher than those in nearby wet markets.

The differing capacity and financial resources of local governments meant that the actual implementation of the AFS program varied across the country. In some cities, shops were required by the municipal government to sell food at set prices every day, while in others they only had to do so when food prices significantly increased or during festivals such as the Spring Festival (Fuyang Municipal Government, 2021). Other variations include the particular food items on the list and differences in the subsidy level. Central government monitoring of the program was reasonably pragmatic in the sense that evaluation focused more on the actual impacts on food affordability than the specific approach that local governments chose to implement the program.

By 2013, there were 11,000 affordable food shops in 654 Chinese cities (National Bureau of Statistics, 2015; Xu, 2013), of which 20 percent were in Jiangsu Province, a leader in the implementation of the AFS program (Sun, 2014). The Jiangsu Provincial Development and Reform Commission issued a plan in 2012 to establish 2,000 affordable food shops in the province within one year (Jiangsu Provincial Jiangsu Province Government, 2012b). Shops in the province were required to sell local vegetables at prices 15 percent lower than in other retail outlets and to sell non-local vegetables at prices marginally lower than in other outlets (Jiangsu Province Government, 2011). Within Jiangsu, the capital Nanjing was the lead city in the implementation of AFS

Program, launching it in October 2011 (Nanjing Municipal Government, 2011). The number of shops increased rapidly from 50 at the end of 2011 (Sun, 2012) to over 200 in 2019. Some shops were established in response to the AFS Program while others pre-dated the program and applied to join. In 2019, most shops were privately-owned (about 91%) while the rest were owned by the state. In addition, about 69% of shop owners were individual entrepreneurs while the rest were company-owned.

Between 2015 and 2019, annual fiscal expenditure on subsidizing the affordable food shops ranged from CNY 8 million to 11 million Yuan (about USD\$ 1.1 to 1.6 million) in Nanjing. One report notes that consumers saved about CNY 420 million Yuan (about USD 60 million) from 2011 to 2018, an annual saving of CNY 53 million Yuan (about USD 7.6 million) (Phoenix New Media Limited, 2018). However, if the total annual saving is divided by the population of communities where AFS shops were located, an annual average of CNY 46/person (around USD\$ 6.6/person) was saved, accounting for only 0.8% of per capita annual food expenditure in 2019.

3. Materials and methods

3.1. Household food security survey

The analysis in this paper uses data from a city-wide household food security survey in Nanjing conducted by Nanjing University and the Hungry Cities Partnership (Zhong et al., 2019). A four-stage sampling method was used to select households to be surveyed with a target sample size of 1200 households. In the first stage, we allocated the 1200 household target to the City's 11 districts in proportion to their population. In the second stage, we randomly select sub-districts within each district. At the third stage, we selected residential communities in each sub-district and allocated the sample size to the selected communities. Finally, we sampled buildings and floors in each community and approached every third apartment for in-person interview. Further details about the sampling method are discussed at length in Si and Zhong (2018). Either the household head or an adult household member familiar with the household's food situation were interviewed. A total of

Table 2
Dependent variables and corresponding questions.

Occurrence Questions	Dependent variable
1: In the past four weeks, did you worry that your household would not have enough food?	Food Anxiety (<i>Anxie</i>): anxiety and uncertainty
2: In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	Food quality (<i>Quali</i>): Inadequate quality and desirability
3: In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	
4: In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	
5: In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	Food quantity (<i>Quanti</i>): Insufficient quantity
6: In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?	
7: In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	
8: In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	
9: In the past four weeks, did you or any household member go a whole day and night without eating anything because	

Source: Coates et al. (2007), Swindale and Bilinsky (2006a, 2006b)

1210 households were interviewed on a wide range of issues including household characteristics, food consumption and sourcing behaviour, and levels of food security.

3.2. Mapping affordable food shops

A listing of affordable food shops was obtained from the Nanjing Municipal Commission of Development and Reform, which included information on the establishment and cessation of food shops between 2011 and 2019. The list of shops included the name, address and year of business establishment/closure. To match the data of the household survey, we identified those shops which were in operation in 2015. We geocoded the location of all listed shops based on BaiduMap (map.baidu.com). The geocoding of shops and households allowed us to calculate the distance from each household to its nearest shop. Four main travel modes are used by households to buy food: car, public transit (bus or metro), bicycle (bike or electric bike), and on foot. While Manhattan distances are preferable in cities, this would vary with the type(s) of transportation used by each household. However, Manhattan data was not available, and because most households in Nanjing walk to shop for food, Euclidean distance was used as an appropriate proxy measure of accessibility (Ma et al., 2016). We therefore calculated the Euclidean distance from the GPS location of each household to its nearest affordable food shop. Finally, we conducted an audit of affordable food shops and recorded the food items sold.

3.3. Dependent variables

In this analysis, household food security was measured using the Household Food Insecurity Access Score (HFIAS). The HFIAS is a widely-used indicator for measuring food insecurity and dietary diversity developed by the Food and Nutrition Technical Assistance (FANTA) Project. The value of the HFIAS is calculated for each household based on responses to nine frequency-of-occurrence questions with a four week recall period: i.e. never = 0, sometimes = 1, often = 2, all the time = 3. (Coates et al., 2007; Swindale & Bilinsky, 2006a, 2006b) (Table 2). On a scale between 0 and 27, the higher the score, the greater the level of food insecurity. Other information pertinent to food consumption collected in the survey included household food sourcing and consumption, dietary diversity, food affordability, problems preventing households from meeting their food needs, and household food expenditure.

Four measures of food security were selected as dependent variables for our logistic regression analysis based on the answers to the nine HFIAS frequency-of-occurrence questions. These binary variables were created to capture different aspects of household food insecurity and are listed in Table 2. Besides the measure of overall food insecurity, the nine questions can be grouped into three domains of food insecurity: food anxiety and uncertainty, insufficient quality, and inadequate food consumption quantity (Coates et al., 2007). The three different domains reflect different aspects of food insecurity:

- (a) Food Insecurity (*Insecu*) was created based on the answers to all nine HFIAS frequency-of-occurrence questions and categorized each household as either food secure or food insecure: if a household was categorized as food insecure, *insecu* = 0. There are four options of frequency for Q1-Q9 in Table 2, including never or no, rarely, sometimes and often. A household was categorized as food secure if it answered “no” to Q2-9 and “no or rarely” to Q1. On the HFIAS scale a food secure household would have a score of 0 or 1.
- (b) Food Anxiety (*Anxie*) captures whether the household faced anxiety and uncertainty about the household food supply (Q1 of the HFIAS) where *anxie* = 1 if the response was rarely, sometimes or often, 0 for otherwise;
- (c) Food Quality (*Quali*) captures whether the food consumed was of inadequate quality and desirability. The value of *quali* = 1 if the

response to Q2-4 of the HFIAS was rarely, sometimes or often; 0 for otherwise; and

- (d) Food Quantity (*Quanti*) captures whether there was insufficient quantity of food in the household. The value of *quanti* = 1 if the response to Q5-9 of the HFIAS was rarely, sometimes or often; 0 for otherwise.

3.4. Independent variables

Table 2 lists the nine independent variables selected for the analysis, together with the predicted coefficient signs and an explanation for the choice of variable. The variables included the following:

- (a) Distance (*Distf*): represents the distance from a surveyed household to the nearest affordable food shop, as an increase in distance to food outlets generally means reduced physical access to food. Because most households in Nanjing walk to shop for food, physical distance is an appropriate proxy measure of accessibility (Ma et al., 2016; Si et al., 2019). The coefficient sign of the variable *dDistf* was expected to be positive, based on the expectation that an increase in distance to the nearest food shop would also increase the probability of a household being food insecure.
- (b) Lived Poverty (*Lpi*): Lived poverty is increasingly seen as an important factor influencing household food security (Frayne & McCordic, 2015; Su et al., 2017). The Lived Poverty Index (LPI) is a common instrument used to measure the degree of household access to medical care, clean water, food, cooking fuel, and cash income (Meyer & Keyser, 2016). The LPI score was calculated from household responses to five Likert scale consistency questions about infrastructure access. The variable represents a household's LPI score, with an expected positive coefficient since an increase in the LPI (on a scale from 0 to 4) is an indicator of increased lived poverty.
- (c) Food expenditure (*Foodex*). Household income is generally seen as a crucial factor influencing food security (Frayne & McCordic, 2015). However, Chinese households commonly underreport their income (Li & Sicular, 2014). Self-reported expenditure is therefore a more reliable indicator than income (Deaton & Grosh, 1998) and household expenditure is a reasonable indicator reflecting food security (Smith & Subandoro, 2007). This analysis therefore selected household expenditure rather than household income as a potential determinant of household food security. The variable *Foodex* was used to represent household food expenditure. As an increase in household expenditure can help improve food consumption, and households with higher food expenditure are less food insecure (Drewnowski, 2022), the coefficients of variable *Foodex* were expected to be negative.
- (d) Unaffordability (*Munaffordable*): food unaffordability is usually linked to food insecurity (FAO et al., 2020; McCordic & Frayne, 2017). Two questions were used to collect information on household food affordability: “Over the past six months have you or your household gone without certain types of food because of the price of food (it is unaffordable)?” (Yes/No) and “Which types of foods have you or your household gone without?”. The proportion of households reporting unaffordable meat ranked highest at 20%. The variable *Munaffordable* was used to represent whether a household experienced unaffordable meat and its coefficients were expected to be positive.
- (e) Hazard problem (*Hazardpro*): surveyed household were asked the question “Did any of the following problems prevent you from meeting meet your family's food needs in the past six months?”. The 20 different options included reduction in income, reduced or loss of employment, illness, natural or environmental hazards, and so on. If a household encountered any of these problems and hazards they would be more likely to be food insecure than those without problems. The variable *Hazardpro* was used to represent

Table 3
Independent variables.

Variable	Definition	Expected sign			
		insecu	anxie	quali	quanti
<i>Distf</i>	Distance to the nearest affordable food shop (100 m)	+	+	+	+
<i>Lpi</i>	Value of household Lived Poverty Index	+	+	+	+
<i>Foodex</i>	Monthly expenditure of food (hundred yuan)	-	-	-	-
<i>Munaffordable</i>	Whether meat was unaffordable in the past six months, 1 for yes and 0 for otherwise	+	+	+	+
<i>Hazardpro</i>	Whether experienced problems preventing from meeting food demand, 1 for yes and 0 for otherwise	+	+	+	+
<i>Femalcent</i>	Whether a female-centered household, 1 for yes and 0 for otherwise	+	+	+	+
<i>Malecent</i>	Whether a male-centered household, 1 for yes and 0 for otherwise	+	+	+	+
<i>Nuclearh</i>	Whether a nuclear household, 1 for yes and 0 for otherwise	+/-	+/-	+/-	+/-
<i>Otherh</i>	Whether a household other than female-centered, male-centered, nuclear and extended household, 1 for yes and 0 for otherwise	+/-	+/-	+/-	+/-
<i>Headedu</i>	The level of household head education, 1 = no formal schooling, 2 = some primary school, 3 = primary completed, 4 = some high school, 5 = high school completed, 6 = post-secondary qualifications not university, 7 = some university, 8 = university completed, 9 = post-graduate	-	-	-	-

whether a household encountered any of the 20 potential problems associated with food insecurity and is assumed to have positive coefficients.

- (f) Household Structure (*Femalcent*, *Malecent*, *Nuclearh* and *Otherh*): Type of household is another factor known to influence household food security (Balistreri, 2018; Drammeh et al., 2019). Female-headed households have been consistently shown to experience higher levels of food insecurity (Riley & Dodson, 2020). The household survey instrument classifies households into five categories: female-centered (with a female head and no spouse/partner), male-centered (with a male head and no spouse/partner), nuclear (with a household head and spouse/partner and their children), extended (household head and spouse partner/plus children any other relatives and non-relatives) and other (such as single person households). For this analysis, the category of extended household was used as reference group and four variables *Femalcent*, *Malecent*, *Nuclearh* and *Otherh* were generated to represent female-centered, male-centered, nuclear and other, respectively. The variable *Femalcent* and *Malecent* were assumed to have positive coefficients and the variable *Nuclearh* and *Otherh* could be positive or negative.

- (g) Household Head Education (*Headedu*). Various studies have drawn a link between household head characteristics and household food security (Mohamed et al., 2016; Obayelu & Oyekola, 2018). Some studies have shown that the educational status of the household head is positively related to food security

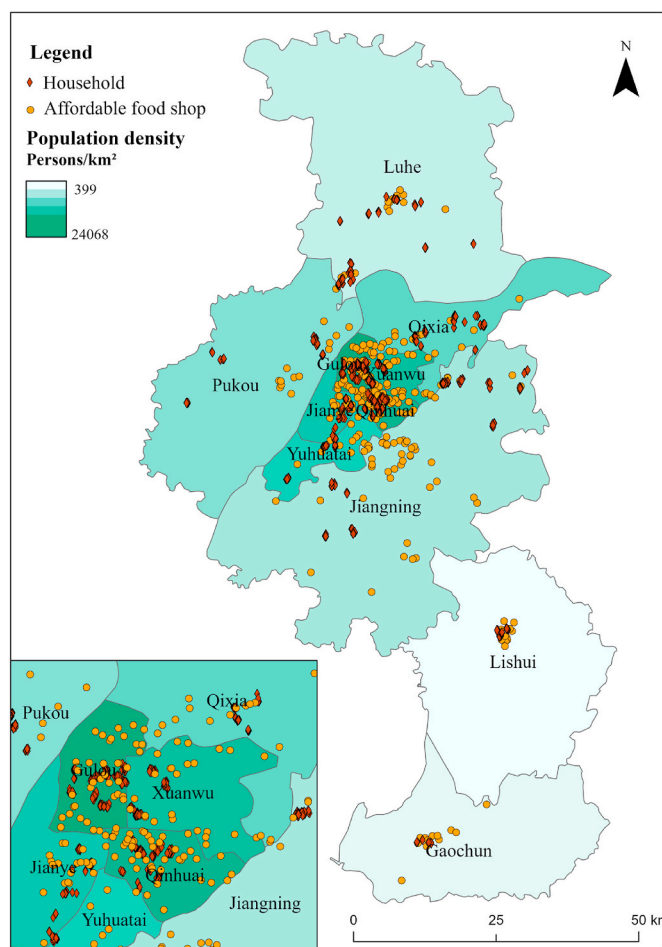


Fig. 1. Location of surveyed households and affordable food shops in Nanjing.

(Mutisya et al., 2016; Tarasuk et al., 2019). The variable *Headedu* was used to capture the level of household head education and is assumed to have negative coefficient, and is an ordinal variable with value given as shown in Table 3. The table lists the nine independent variables selected for the analysis, together with the predicted coefficient sign.

3.5. Binary logistic regression

Binary logistic regression is the most appropriate analytical approach for a study with binary dependent variables (Long & Freese,

Table 4
Foods sold by affordable food shops in Nanjing.

Food item	% of AFS shops selling food item
Meat	83.4
Fish	0.0
Fruit	0.0
Vegetables	92.2
Milk	0.0
Beans	59.5
Grain	82.9
Eggs	85.9
Condiments	0.0
Cooking Oil	84.4
Roots or tubers	88.8
Sugar	0.0

Source: (a) calculated from household food security survey, (b) calculated from AFS Program monitoring results provided by Nanjing Municipal Reform and Development Commission

2001). The logistic regression model for general household food insecurity (*insecu*) is:

$$\text{Logit}\{P(y = 1)|X\} = \alpha + \beta X$$

Where *y* is dependent variables including the variables *insecu*, *anxie*, *quali* and *quanti* (see Table 2); α is the constant term, *X* is the vector of the independent variables (see Table 3) and β is their coefficients vector.

Four regression models were estimated with *Insecu*, *Anxie*, *Quali* and *Quanti* respectively as the dependent variables and tests for goodness of fit included likelihood-ratio chi-squared, log likelihood, pseudo R² and correctly classified rate. The model with the higher Pseudo R² and rate of correctly classified was preferred. The values of AIC (Akaike information criterion) and BIC (Bayesian information criterion) were also calculated to judge which model was superior to the others. The model with the lowest AIC or BIC is the preferable one (Long & Freese, 2001).

4. Results

4.1. Spatial mapping

Fig. 1 shows the results of the geocoding and mapping of surveyed households and affordable food shops. The shops are heavily concentrated in the downtown area of the city with the highest population density (the districts of Gulou, Xuanwu and Qunhuai). There are also clusters of shops on urban land in the peri-urban areas of Luhe, Lishui and Gaochum. Two thirds of the households (68%) were located within 800 m of their nearest affordable food shop; that is, within relatively easy walking distance.

4.2. Foods sold in AFS shops

Table 4 shows the proportion of AFS shops in Nanjing selling food items in the 12 FAO food groups. Over 80% of the shops were selling meat, vegetables, grain, eggs, cooking oil, and roots or tubers, and 60% were also selling beans. No shops were selling fish, fruit, milk, condiments or sugar.

Table 9 shows where AFS shops sourced six common food items: rice, cooking oil, pork, eggs, vegetables, and pulses. The city's wholesale markets were the main source for all six items. Over 80% of shops sourced each of these products from wholesale markets. Very few, less than 2%, sourced their produce directly from farms or produced it themselves. And none sourced produce from supermarkets or wet markets, their main competitors.

4.3. Household food security status

The data from the household food security survey showed that 79% of surveyed households were food secure (HFIAS = 0) and 21% were food insecure to some degree (HFIAS >0) (Table 5). On the different dimensions of food insecurity, only 3% of households reported anxiety about their food supply and 4% had experience of insufficient food. In contrast, 20% had experienced inadequate quality and desirability of food. (Table 5). Of the food insecure households, 19% had insufficient food and 95% inadequate quality and desirability. Thus, food insecurity was related more to inadequacies in the quality and desirability of the diet rather than the amount of food consumed. Food insecure

Table 5
Descriptive distribution of food secure and insecure households.

	Food insecurity (<i>Insecu</i>)		Food anxiety (<i>Anxie</i>)		Food quality (<i>Quali</i>)		Food quantity (<i>Quanti</i>)	
	N	%	N	%	N	%	N	%
0	929	78.9	1160	96.7	945	79.6	1142	95.8
>0	249	21.1	39	3.3	242	20.4	50	4.2
Total	1178	100.0	1199	100.0	1187	100.0	1192	100.0

households had a lower household dietary diversity score than food secure households, or 7.2 and 8.0 (out of 12) respectively.

4.4. Regression models

4.4.1. Food insecurity

Table 6 presents two regression models (IN1 and IN2) with different independent variables. Regression equation IN1 has a larger Pseudo R², higher correctly classified rate, and smaller AIC value, which indicates that IN1 is preferable to IN2. The estimated odds ratios of the variables (with the exception of *Distf* and *Nuclearh*) are statistically significant. Household food security was significantly associated with six variables: household structure, household head education attainment, vulnerability to increase in the price of meat (unaffordability), hazards, lived poverty, and food expenditure.

The odds ratio of the variable *Munaffordable* is 12.33 in model IN1, meaning that the odds of being food insecure for a household that found meat unaffordable due to price increases was over 12 times greater than a household that could afford meat. The odds of being food insecure were 2.4 times greater for female-centered, 3.5 times greater for male-centered, and 10.8 times greater for other types of household, compared with extended households. There was no significant difference between extended households and nuclear households. The odds of being food insecure for households encountering a problem that prevented them from meeting their food needs were 3.2 times greater than households without experiencing any problem. For a unit increase in the Lived Poverty Index, the odds of being food insecure increased by a factor of 2.45, holding other independent variables constant. For each additional increase in the level of the household head's education, the odds of being food insecure decreased by a factor of 0.98. Finally, for each unit (one hundred yuan) increase in food expenditure, the odds of being food insecure also decreased by a factor of 0.98.

4.4.2. Anxiety about household food supply

Table 6 provides two models with anxiety and uncertainty about the household food supply (*Anxie*) as the dependent variable (AX1 and AX2). X1 has a larger Pseudo R² and BIC and is therefore preferable. Household anxiety and uncertainty about the food supply is significantly associated with four variables: unaffordability of meat, household structure, hazards, and lived poverty. There was no significant difference in anxiety and uncertainty about the food supply among female-centered, male-centered, nuclear, and extended households.

The odds ratio of the variable *Munaffordable* is 2.40, meaning that households unable to afford meat were 2.4 times as likely to experience anxiety. The odds ratio for the variable *Hazardpro* AX1 is 6.32, which means that the odds of anxiety were 6.3 times more likely among households encountering a hazard or problem meeting their food needs. For every unit increase in the Lived Poverty Index, the odds of anxiety increased by a factor of 4.1. The odds of worry and anxiety decreased by a factor of 0.93 for every 10 unit (one thousand yuan) increase in food expenditure. In AX2, the odds of worrying about the food supply decreased by a factor of 0.51 for each unit (one hundred yuan) increase in food expenditure and by 1.97 for each one thousand yuan increase in food expenditure.

4.4.3. Inadequate food quality

Table 6 provides two models with inadequate food quality (*Quali*) as the dependent variable (IQ1 and IQ2). IQ1 has a larger Pseudo R², higher correctly classified rate, and smaller AIC value and is therefore statistically superior to IQ2. The results show that inadequate food quality was significantly associated with six variables: unaffordability of meat, lived poverty, household structure, household head education, hazards, and food expenditure.

Households that found meat unaffordable due to price increases were 12.6 times more likely to report inadequate food quality and desirability in the household diet. For every unit increase in the Lived Poverty Index,

Table 6
Determinants of food insecurity.

Variable/Equation	Overall Food Insecurity (<i>Insecu</i>)		Anxiety About Food Supply (<i>Anxie</i>)		Insufficient Quality Food (<i>Quali</i>)		Insufficient Quantity of Food (<i>Quanti</i>)	
	IN1	IN2	AX1	AX2	IQ1	IQ2	IT1	IT2
Distance (<i>Distf</i>)	1.0009	1.0015	0.9923	0.9911	1.0008	1.0013	1.0035	1.0009
Meat unaffordable (<i>Munaffordable</i>)	12.3395*	11.2404*	2.3994***	2.6091*	12.2650*	11.3964*	1.6242	1.5571
Food expense (<i>Foodex</i>)		0.9797**		0.9345**		0.9826***		0.9707
Lived Poverty (<i>Lpi</i>)	2.4478**		4.0950**		2.1625***		3.8135**	
Female-centered (<i>Femalecent</i>)	2.4447**		2.6177		2.6584**		5.7326**	
Male-centered (<i>Malecent</i>)	3.5421*		0.6480		3.0630*		1.7048	
Nuclear (<i>Nuclearh</i>)	1.4609		1.1097		1.4187		1.5339	
Other-type household (<i>Otherh</i>)	10.7501**		18.7750**		11.9113**		65.7878*	
Household head education (<i>Headed</i>)	0.9228**		0.8446***		0.9252***		0.9009	
Problem (<i>Hazardpro</i>)	3.2438*	2.9942*	6.3169*	5.4684*	2.9262*	3.0501*	6.4614*	9.5894*
Constant	0.0887*	0.1613*	0.0223*	0.0489*	0.0834*	0.1416*	0.0133*	0.0340*
N of observations	947	908	961	921	951	913	955	916
LR chi ²	251.8900*	230.1100*	58.9500*	38.4400*	244.1300*	228.8800*	71.6600*	44.7900*
Pseudo R ²	0.2623	0.2378	0.2329	0.1577	0.2605	0.2404	0.2497	0.1507
Log likelihood	-354.2413	-368.6861	-97.1128	-102.6811	-346.5210	-361.6933	-107.6426	-126.1895
AIC	728.4827	747.3722	214.2256	215.3622	713.0420	733.3866	235.2851	262.3790
BIC	777.0157	771.4284	262.9054	239.4895	761.6172	757.4703	283.9022	286.4791
Correctly classified	84.1605	83.0396	97.0864	97.0684	83.7014	83.2421	97.2775	96.1790

Note : * significant at 1%, ** significant at 5%, *** significant at 10%; the numbers for each independent variable are Odds Ratio.

Table 7
Relationship between dependent and independent variables.

Independent Variables	Dependent Variables			
	<i>Insecu</i>	<i>Anxie</i>	<i>Quali</i>	<i>Quanti</i>
Distance (<i>Distf</i>)				
Meat unaffordable (<i>Munaffordable</i>)	✓	✓	✓	
Food expense (<i>Foodex</i>)	✓	✓	✓	
Lived Poverty (<i>Lpi</i>)	✓	✓	✓	✓
Female-centered (<i>Femalecent</i>)	✓		✓	✓
Male-centered (<i>Malecent</i>)	✓		✓	
Nuclear (<i>Nuclearh</i>)				
Other households (<i>Otherh</i>)	✓	✓	✓	✓
Household head education (<i>Headed</i>)	✓		✓	✓
Problem (<i>Hazardpro</i>)	✓	✓	✓	✓

Note: ✓ denotes statistically significant.

the odds of inadequate food quality increased by a factor of 2.2. The odds were 2.7 times greater for female-centered, 3.1 times greater for male-centered, and 11.9 times greater for other types of household, compared with extended households. For each additional increase in the level of the household head's education, the odds of being food insecure decreased by a factor of 0.93. Finally, for each unit (one hundred yuan) increase in food expenditure, the odds of being food insecure decreased by a factor of 0.98.

4.4.4. Insufficient food quantity

Finally, Table 6 provides two models with insufficient food quantity (*Quanti*) as the dependent variable. IT1 has a larger Pseudo R² and higher correctly classified rate, and smaller AIC and BIC value, which indicates that it is statistically superior to IT2. In IT1, insufficient food quantity was associated with three variables: lived poverty, household structure, and hazards.

For every unit increase in the Lived Poverty Index, the odds of anxiety increased by a factor of 3.8. The odds of having an insufficient quantity of food were 5.7 times greater for female-centered households and 65.8 times greater for other types of household, compared with extended households. The odds of experiencing insufficient food quantity for a household encountering problems preventing them from meeting their food needs were 6.5 times higher than households without experiencing any problems.

5. Discussion

5.1. Determinants of food insecurity

As noted above, approximately 20% of surveyed Nanjing households experienced some degree of food insecurity on the HFIAS scale. The first objective of the analysis was to determine which household characteristics were most strongly associated with food insecurity. Table 7 provides a summary of the statistically significant relationships between the dependent and independent variables in the analysis of data from the household food security survey in Nanjing and the mapping and geocoding of Affordable Food Shops.

With regard to overall food insecurity (*Insecu*), the odds of being food insecure were higher for female-centered and male-centered households (that is households with only one adult member), for households vulnerable to food price increases in a staple food (meat), and for households vulnerable to hazards or problems that interfered with their food supply. The odds of being food insecure decreased as the amount of education of the household head increased and the amount of expenditure on food also increased. Food insecurity was also related to level of poverty. As lived poverty increased, so did the odds of being food insecure.

A large number of studies globally have used the HFIAS to quantify levels of food insecurity and its determinants. The main methodological contribution of this paper of wider applicability is to disaggregate the HFIAS into its component parts: (a) anxiety and worry about the household food supply; (b) inadequate food quality and desirability; and (c) insufficient food quantity. By statistically modelling these three components, we were able to determine which was most influential in driving overall food insecurity. Table 2 confirmed that inadequate food quality and desirability was the most important of the three components as it was experienced by 20% of all households (and over 90% of food insecure households). The regression analysis in Table 5 demonstrated that the independent variables which had the strongest association with inadequate food quality and desirability were household structure, lived poverty, household head education, hazards, food expenditure, and unaffordability of meat. Female-centered and male-centered households were again more likely to be food insecure, as were households with higher lived poverty, lower levels of expenditure on food, and greater vulnerability to food price increases of a dietary staple, and hazards and problems that affected their food needs.

The two other components of food insecurity – anxiety and quantity – were strongly associated with a smaller number of independent

variables. The two significant relationships they had in common were hazards and lived poverty. Households with greater lived poverty were more likely to be anxious about their food supply and to experience insufficient food quantity, as were households that experienced a hazard or problem that affected their food needs. In addition, female- and male-centered households were more likely to experience both conditions than households with at least two adults.

5.2. Evaluation of the AFS program

5.2.1. Food security and accessibility to AFS shops

The distance between each household and the nearest affordable food shop is a measure of accessibility to this food source. The question therefore is whether food insecurity increases with increased distance from these outlets, and vice versa. Our analysis therefore assessed the strength of the relationship between distance and food security and found that it was extremely weak. As Table 5 shows, the association between household distance to the nearest affordable food shop (*Distf*) and food security is not statistically significant in any of the four models. For example, the odds ratio (OR) for the variable *Distf* in model IN1 is 1.0009. This indicates that an increase of one unit (100 m) of distance from an affordable food shop increases the odds of a household being food insecure by a factor of only 1.0009. Similar statistically insignificant ORs were found in relation to anxiety about the food supply and the adequacy and sufficiency of the household diet. In sum, the location of the AFS shops in Nanjing makes no appreciable difference to the food security of households in their vicinity. Several factors may help to explain this key finding.

5.2.2. Inappropriate targeting

Inappropriate targeting is a common problem in many food subsidy programs (Jha & Ramaswami, 2010). Ideally they should target low-income and food insecure communities and households, but they do not necessarily do so in practice (Esmaeili et al., 2013; Talaat, 2018). On the question of whether the Nanjing AFS program is appropriately targeted, Table 8 shows there are four possible combinations of food and consumer targeting. In Type I, both consumers and foods are targeted, while in Type IV neither consumer nor food are targeted. In Types II and III, one of either consumers or food is targeted.

The first question is whether the AFS Program was well targeted towards consumers with lower incomes. We found that the distance to the nearest shop of low-income, middle-income and high-income households was actually 2.61 km, 1.61 km and 1.15 km respectively ($F = 19.9420$ and significant at 1%-level). This is the complete opposite of what we would expect if targeting was optimal. In other words, high income households enjoyed the greatest physical access to affordable food shops and low-income households the least. The need for direct spatial targeting of low-income neighbourhoods and households was actually overlooked by all levels of government until the end of 2018 (Lishui District Government, 2018).

The second targeting issue is whether the right foods were targeted for subsidies. One survey of the diet of Nanjing consumers found that 71% of fish intake, 61% of fruit intake, and 47% of meat intake was lower than that recommended by Food Guide Pagoda (Wang et al., 2013). Vegetables were sold by 92% of shops but only 3% of surveyed households said that they were generally unaffordable. On the other hand, none of the shops sold fish or fruit, which were deemed unaffordable by 13% and 7% of households respectively. Although meat was

Table 8
Food and consumer targeting.

Consumer	Food	Targeted (+)	Non-targeted (-)
Targeted (+)		I (+,+)	II (+,-)
Non-targeted (-)		III (-,+)	IV (-,-)

Table 9
The main sources of food sold by affordable food shops in Nanjing (%).

Sources	Rice	Oil	Pork	Egg	Vegetable	Pulse
Wholesale market	83.2	82.1	83.2	87.4	81.6	82.1
Company	14.7	16.8	12.6	11.6	13.2	14.2
Farm	0.0	0.0	1.1	0.0	1.5	0.5
Self-produced	1.1	0.00	0.00	0.0	2.4	1.1
Other	1.0	1.1	3.1	1.0	1.3	2.1
Total	100.00	100.00	100.00	100.00	100.00	100.00

Note: The vegetable column includes any one of 20 different kinds of vegetables. Source: calculated by authors based on affordable food shop survey data.

deemed unaffordable by 20% of households and sold by over 80% of shops, only boneless leg of pork was included on the list of affordable food items. Other meat products such as beef, lamb, goat, chicken, and duck were all excluded from subsidization. Moreover, the diversity of food items sold by affordable food shops was much lower than that in wet markets. The items of food sold by the average affordable food shop was around 21 while a wet market sells over 80 types of food.

5.2.3. Short supply chains and transport cost

Besides offering subsidies to affordable food shops, the AFS Program expected the shops to buy direct from producers rather than intermediaries such as wholesale markets or wet markets. These direct supply-chains would supposedly allow the shops to decrease food prices for consumers. However, the ability of small food shop owners to purchase all their subsidized products from a single producer or area was very limited because of the transportation costs involved (Lin, 2019). Most affordable food shops found that the transportation costs to buy direct from farmers were significantly higher than they were from city wholesale markets (Lin, 2019). Farmers were also reluctant to sell produce to the shops at prices lower than they charged wholesale dealers or supermarkets who bulk purchase. Given the longer supply-chains and cost reductions through bulk purchase of competitors, there was little room for affordable food shops to sell produce more cheaply without the subsidies.

5.2.4. Missing discounts

Another factor undermining the impact of affordable food shops was the “missing discount” problem. Shops were required to sell produce at a 15% discount, but this was calculated using the city-wide average price provided by the government rather than the price at the nearest wet market or supermarket. While the shops sold food at 15% below the city average, their prices were often not 15% or more lower than those in the nearest wet market or supermarket. In some cases, food for sale at affordable food shops was the same price or even less affordable than in other retail outlets. The missing discount problem thus reduced the incentive of consumers to shop at affordable food shops.

5.2.5. Program redundancy

Nanjing has a highly competitive food retail market which helps keep food affordable. There are more than 300 wet markets and 170 supermarkets with fresh produce zones. The municipal policy of wet market development has ensured that the development of new wet markets has kept pace with population growth. The policy mandates that wet markets are constructed in all new residential developments (Zhong et al., 2019). There is also strong competition within wet markets. There are an average of around 40 food stalls within a typical wet market and competition between vendors is common. Supermarkets also price compete with each other and with wet markets. Competition avoids any chance of a monopoly over food sales and prices, thus contributing to food affordability. In a competitive environment AFS shops became progressively redundant.

5.2.6. Limited monitoring capacity

The municipal government encountered various challenges of field supervision and monitoring of the affordable food shops which intensified as the number of shops increased. At the beginning of the program, inspectors conducted field checks to monitor whether the food shops were complying with the required price discounts. Yet, as the program expanded, the municipal price administration department found it impossible to allocate enough staff to make intensive field checks. In recent years, an online monitoring system was introduced to inspect conformity by the shops, although extra staff were still needed to monitor these shops online.

5.3. Policy implications

In January 2020, the Nanjing Municipal Government closed the AFS Program in the city and stopped subsidizing the shops. Some shops in Nanjing closed while others continued to operate under the affordable shop banner but without the subsidies and directives about food pricing. The decision to stop the program after a decade of expansion raises the question of how effective it has been in meeting its primary goal of ensuring food security for lower-income residents of the city. This decision was reportedly a response to the provincial policy of reducing government intervention in the food value chain (Jiangsu Provincial Jiangsu Province Government, 2019). Local authorities in charge of the implementation of the AFS Program in Nanjing also expressed concern in interviews that its contribution to food security in the city was limited.

While this analysis is independent of the city's decision to do away with the program, it provides confirmation that the AFS Program was failing to deliver on its initial promise. The food security policy of wet market development and access has been much more successful in ensuring even and equitable coverage and access to wet markets across the city, including for low-income households. However, while low-income and food insecure households may enjoy similar levels of physical access to food outlets as higher-income households, they pay the same set prices for food. Some households are able to take advantage of the Minimum Living Standard Assistance (MLSA) program (Hovhannisyan & Shanoyan, 2020) which was introduced in 2008 for low-income households when increases in the consumer price index exceed 3% (Yu, 2008). Although more research is needed on the effectiveness of this alternative program in Nanjing, an income subsidy may be more desirable for low-income households in the city than subsidized food prices. And some of the subsidy budget saved could potentially be redeployed to provide targeted income support for needy households and more directly mitigate food insecurity. In sum, the end of the AFS Program in Nanjing is unlikely to create a gap in access to food or an increase in household food insecurity across the city.

5.4. Study limitations

There are several research and data limitations in this study. First, although it would have been useful to conduct a follow-up household food security at the time of the cessation of the AFS program in 2020, the outbreak of COVID-19 in China made this impossible. Second, our analysis and cross-sectional data comes from an earlier survey several years before closure. We therefore adjusted the analysis to only geocode AFS shops that were operational at the time of the survey. Third, the survey unfortunately did not collect data on household patronage of AFS outlets. For this analysis we therefore developed a proxy for accessibility by geocoding and mapping physical distance between every household and its nearest AFS. Finally, the HFIAS is based on a one-month recall period which therefore does not capture any fluctuations during the course of the year. However, we used a different metric – the MAHFP – to test the adequacy of household food supply over the course of the previous year and found a high level of consistency throughout the year (Si & Zhong, 2018).

6. Conclusion

To address the urban food security challenges accompanying rapid urbanization, China has made various efforts to develop and implement a series of city-focused food policies. Most of these policies emanate from the central government but implementation is often left to the discretion of provincial and city governments with central monitoring and oversight. Prominent among these initiatives is the strategy to facilitate greater access to healthy foods for lower-income urban households through retail subsidization. The main finding from the literature review on food subsidization is the considerable range of supply and demand-side subsidy programs across the Global North and Global South. Perhaps the closest program to that adopted in China is the Public Distribution System in India, with the notable difference that subsidized shops in India are state-owned whereas in China they are largely in private hands. There is also no unanimity on which strategies are most effective in mitigating food insecurity and improving access to nutritious food.

Against this backdrop, this paper focused on the development and implementation of China's Affordable Food Shop Program, using Nanjing as a case study. The AFS Program started in Nanjing in 2011 and aimed to foster food affordability and increased food security, particularly for lower-income households. However, data from a city-wide survey of Nanjing households indicated that as a food retail subsidy tool, the program has not had a significant impact on urban household food insecurity.

In the paper, we show that food insecurity in Nanjing was generally low but that an increase in the different dimensions of food insecurity was associated with lived poverty, household type, the education of the household head, household experience of hazards that impact on food security, and the unaffordability of a staple food because of price increases. None of these factors were offset by proximity to an AFS Program shop. The proximity to and accessibility of affordable shops to households made no difference to whether they were food secure or food insecure. In other words, the AFS Program was failing to meet one of its most basic goals. The paper suggests various reasons for this including inappropriate targeting, program redundancy, and competition from supermarkets and wet markets. In the circumstances, the closure of the program by the city government was all but inevitable.

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Declaration of competing interest

The authors declare that they have no conflict of interest.

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