

COVID-19, the *Hukou* System and Migrant Food Security in Urban China

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Abstract

The COVID-19 pandemic has issued significant challenges to food systems and the food security of urban and mobile populations. COVID-19 has had a disproportionate negative impact on household food security. In China, there have been no studies to date specifically focusing on the food security of migrants during the pandemic. This paper uses data from an online questionnaire survey of food security in Nanjing City, China, conducted in March 2020 to examine the different experiences of migrant and non-migrant households. The paper situates the research findings in the general literature on the migrant experience more generally during the pandemic and the specifics of the Chinese rural-urban migration policy of *hukou*. Using multiple linear regression and ordered logistic regression, the paper examines the impact of migration status on food security during the pandemic. The paper finds that during the COVID-19 outbreak in 2020, households without local Nanjing *hukou* were more food insecure than those with Nanjing *hukou*. These differences related more to the absolute quantity of food intake, rather than reduction in food quality or in levels of anxiety over food access.

Keywords

Hukou, food security, non-local households, insufficient food quantity

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1. Introduction

The COVID-19 pandemic has had a significant negative impact on the global food system, disrupting international and national food supply chains, increasing food prices, and reducing consumer access to affordable foods (Clapp and Moseley, 2021; Davila et al., 2021). To control the pandemic, many governments implemented mitigation measures including lockdowns, stay-at-home orders, mobility restrictions, and closure of public events and spaces (Hale et al., 2021). While these measures helped reduce the spread and number of fatalities from COVID-19, they also posed a significant threat to the food security of urban populations (Crush and Si, 2020). One consequence has been a sharp increase in the prevalence of food insecurity in many countries. In 2020, as many as 800 million people in the world faced hunger, an increase of 161 million from 2019. A total of 2.37 billion people were without access to adequate food in 2020 (FAO, 2021). After remaining virtually unchanged from 2014 to 2019, the Prevalence of Undernourishment (PoU) increased from 8.4% to around 9.9% between 2019 and 2020 (FAO, 2021).

Food security is when “all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (World Food Summit, 1996; Leroy et al., 2015). The COVID-19 crisis has reduced the physical and economic access of millions to sufficient, safe and nutritious food, compromised their food needs and preferences, and subverted their ability to pursue active and healthy lives (Smith and Wesselbaum, 2020). The pandemic has been particularly severe on the livelihoods and food security of the urban poor and marginalized, including many international and internal migrant workers (Crush et al., 2021). McAuliffe et al. (2022) describe COVID-19 as the “great disrupter” for migrants. Many of the world’s 280 million international and 750 million internal rural-urban migrants are employed in labour-intensive, low-paid (often informal), and precarious 3D (dirty, dangerous and demeaning) jobs with little employment security and limited access to social protection programs. Although these conditions and vulnerabilities pre-date the pandemic, they have been seriously exacerbated by COVID-19 (de Haan, 2020; Fassani and Mazza, 2020; Rajan, 2020; Suhardiman et al., 2021).

Migrants were laid off in large numbers as businesses shut down and reduced their employment rolls (McAuliffe et al., 2022; Rajan, 2020). Those who retained their jobs were particularly vulnerable to infection in unregulated and overcrowded workplaces and living spaces (Landry et al., 2021; Reid et al., 2022). Many migrant workers were initially quarantined in over-crowded accommodation, further increasing their vulnerability to infection and death (Alahmad et al 2020; Yee et al., 2021). In many countries, there was a “remittances shock” as transfers to family at home declined (Caruso et al., 2021; Takenaka et al., 2020; Withers et al. 2021). Internal urban-rural remittance flows also fell (Rajan et al., 2020). As the IMF has noted, “sharp output contraction, together with travel restrictions in major migrant hosting economies, jeopardized migrants’ employment countries and income

opportunities and brought into question remittances’ ability to smooth consumption in home countries” (Kpodar et al., 2021: 5).). The pandemic also imposed major constraints on international mobility, trapping migrants in destination countries as road, rail and air transportation halted and borders were closed to all but essential workers (Ahsan Ullah et al., 2021). By contrast, internal migrants facing unemployment, food insecurity and COVID-19 infection began moving en masse from the cities back to their rural homes in countries such as India (Muhra et al., 2020; Rajan and Bhagat, 2022)

The COVID-19 pandemic has therefore undermined global progress towards achieving the SDGs (Sustainable Development Goals) and especially SDG2 - “Zero Hunger” (Barbier and Burgess, 2020; Wang and Huang, 2021). Although there is a growing literature on the experiences of migrants during successive waves of the pandemic, the impact on migrant food security is underexplored (Crush et al. 2021; Sharma, 2020). In this paper, we contribute to understanding the complex relationship between COVID-19, internal migration and food security through an analysis of the impact of the pandemic on rural-urban migrants in China. Although China’s Zero-Covid policy meant that the first wave of the epidemic was relatively short-lived, it is clear from emerging research that there was a general increase in urban food insecurity in Chinese cities. The key question posed in this paper is whether internal migrants living in cities were unscathed or also experienced increased food insecurity.

This paper aims to contribute to three emerging areas of research on migration and food security (Crush, 2013; Crush and Si, 2020). First, the paper builds on the growing body of evidence in China and elsewhere on the impacts of COVID-19 during the first wave of the pandemic on food system functioning and resilience (Dou et al., 2021; Zhong et al., 2021) with associated challenges including food price increases (Ruan et al., 2021; Yu et al., 2020), changes in household food purchasing behaviour (Li et al., 2020, 2022; Yue et al., 2021), and the dramatic growth of online food purchasing (Dai and Qi, 2020; Gao, 2020; Liang et al., 2022; Lu et al., 2020). Second, it adds to a small number of case studies of the impact of COVID-19 household food consumption and food security in cities (Cui et al., 2021; Li et al., 2022; Zhang et al., 2020; Zhao et al, 2020). However, neither of these first two bodies of literature have focused on the pandemic experience of migrants in the city and how COVID-19 itself and the public health measures to control its spread impacted their food security as opposed to that of other urban residents. Third, the paper adds to our knowledge of the food security experience of the large urban migrant population during the pandemic. To date, studies have shown the negative impact of COVID-19 on migrant employment (Du et al., 2020), remittances (Zhang et al., 2021) and access to social protection (He et al., 2022), but have not specifically focused on the food security of migrants compared to their urban counterparts.

The first section of the paper provides a contextual overview of internal migration and the *hukou* (household registration) system, as well as a review of what is currently known about the impact of COVID-19 on migrants in Chinese cities. The second section of the paper describes the research methodology involved in collecting household-level data during the pandemic in the case study city of Nanjing as well as the food security indicators in the resulting data set. The paper then analyses the survey data using descriptive statistics and regression modelling, before concluding with recommendations for additional research.

2. Internal Migration, *Hukou* and COVID-19

In recent decades China has undergone a major transformation from a predominantly rural to a majority urban country (Fan, 2007; Lu & Xia, 2016; Tang, 2012). The proportion of China's population that is urbanized increased from 13% in 1953 to 64% in 2020 (State Council, 2021). There are two main types of urban resident: the population with local *hukou* in the city and those with *hukou* in another area (Chan & Wei, 2019). The latter are often referred to as migrants or the 'floating population' in urban areas. Their number increased from 121 million in 2000 to 221 million in 2010 and 376 million in 2020 (State Council, 2021). Migrants made up 16.5% of the total population in 2010 and 26.6% in 2020. Most of China's floating population is concentrated in the country's mega-cities. About 44% of the population in cities with over 5 million people are migrants (Chan, 2021). In 2020, most migrant workers were employed in manufacturing (27%), construction (19%), sales (12%), the hotel and catering industry (7%) and other services (National Bureau of Statistics, 2021b). Although wages are generally low, they have improved in the last decade. Migrants often work long hours, have little job security and few benefits. One study, for example, found a significant wage differential between migrant and urban workers, which they attribute to individual characteristics and differences in human capital between rural migrant and urban workers (Cheng et al. 2020).

Rural-urban migration is closely related to the longstanding Chinese policy of *hukou* (household registration) (Chan and Wei, 2019; Chan and Yang, 2020). Since the 1950s, the *hukou* system has acted as an important determinant of the pace and directionality of rural-urban migration and the prospects for permanent urban residence. All Chinese people are registered at birth at the local police station in the prefecture in which they were born (Luo et al., 2019). Each household *hukou* contains information on the head of household, household members and home address. Members of households with rural *hukou* are not stopped from migrating to the cities to live, work or study but are categorized as non-local or floating (National Bureau of Statistics, 2021). *Hukou* is thus both an information system of prefecture level registration and an identity label that distinguishes between local and non-local residents and their entitlements.

The *hukou* system affects the benefits and services to which non-locals are entitled in the city, especially compared to residents who have local urban *hukou* (Qian and Qian, 2017). Many cities in China require that buyers have a local *hukou* in order to purchase a home, for example. When urban households buy an apartment, ownership is recorded by a property management company which runs the residential complex. Households without local *hukou* in the city are more likely to be tenants and are *de facto* excluded from household registration by property management companies. In addition to limitations on home ownership and housing access, households with non-local *hukou* do not enjoy the same access as local households to children's education, healthcare and state-subsidized benefits (Afridi et al., 2014; Hung, 2022; Lei and Liu, 2012; Niu and Qi, 2015; Song and Smith, 2019; Song and Zhou, 2019; Wang, 2017; Wu and Wang, 2014; Zhan, 2011).

In 2014, China launched a major initiative to reform the *hukou* system by promoting the conversion of rural to urban *hukou* by migrant households (Chan, 2019; Government of China, 2014; Li et al., 2016; State Council, 2014). The conversion programme targeted smaller cities in order to incentivize rural-urban migrants to move to these centres and access a broader range of opportunities and benefits (Raimondo, 2019; Yang and Guo, 2018). By 2020, 100 million migrants had accessed the new policy (Chan, 2021). The majority of these conversions were in smaller cities. The 2019 Urbanization Plan requires that cities with populations between one and three million drop all restrictions on household registration. Cities of three to five million were to relax restrictions on new migrants and remove limits on key population groups, including university graduates. Thirteen cities, including Nanjing, are not scheduled for a relaxation of *hukou* restrictions. However, it would be incorrect to assume that all migrants with rural *hukou* necessarily want to convert to urban *hukou* and remain in the city (Chen and Fan, 2016; Hao and Tang, 2015; Tang and Hao, 2018).

The relationship between migration and food security is an increasing focus of research attention. Holdaway (2015) draws attention to the food security implications for migrants of their non-local *hukou* status in cities, noting that migrants are "a potentially vulnerable population in the urban context because their low incomes, long working hours and poor housing conditions limit their choice in terms of what they eat and how it is prepared." The links between food consumption, nutritional status and health outcomes of migrants in the city have been explored in several studies. Sun (2020) and Sun et al. (2021a), for example use national survey data for over 7,500 migrant households to show that urbanicity (the degree of urban infrastructure where migrants live) has a significant impact on food intake and health. Sun et al. (2021b) find a significant gender effect on energy intake and its share from protein among migrants. Cheng (2021) shows that dietary quality is positively associated with migrants' level of education. Comparative studies include Liu et al. (2022) on variations in children's nutritional status between rural *hukou* households in cities and the countryside. Liao (2018) shows that in Shanghai migrant households have more diverse and nutritious diets than

local households. Other studies have compared patterns of food consumption by migrants and local urban households and attributed differences to the *hukou* system (Chen et al., 2015; Han et al., 2019; Wang et al., 2021).

In early 2020, mitigation strategies to control the spread of COVID-19 had a major impact on the everyday lives of most residents of Chinese cities (Zha et al., 2022). While Wuhan was the only city to experience a complete residential and workplace lockdown, most other cities implemented policies that curtailed the mobility of the population and its access to income earning opportunities, to educational institutions and to usual food sources such as wet markets and supermarkets. Evidence is beginning to emerge that migrants were particularly negatively affected. Chen et al. (2020), for example, estimate that at least 30 to 50 million migrants had lost their jobs by late March 2020, considerably more than local urban workers. He et al. (2022) note that migrants were particularly affected by layoffs in labour-intensive, export-oriented industries, while many were trapped in rural areas unable to return to work in cities after the Spring Festival. Zhang et al (2021), for example, found that 70% percent of migrant workers lost part of their wage income during the pandemic lockdown period and those working in small and medium enterprises were most affected. About 50% of remittance-receiving households in rural areas were adversely affected by declining in remittances with an average decline of 45%. These pandemic-related impacts on the livelihoods of migrants would, in theory, have had spin-off effects on their food security in cities. This is the first study we know of to explore these short-term impacts.

3. Methodology

3.1 Study Area

Nanjing is the capital city of Jiangsu Province, located in eastern China, about 300 kilometres west of Shanghai. The population of the city increased by in-migration and natural population growth from 8.01 million in 2010 to 9.32 million in 2020 (Nanjing Statistical Yearbook, 2021). In Jiangsu Province, rural unemployment is a major driver of migration to cities such as Nanjing (Lyu et al., 2019). Nanjing was selected as the study site for three main reasons. First, the city has a sizeable migrant population. The number of non-locals increased from 1.91 million in 2010 to 2.65 million in 2020 accounting for 28.5% of the urban population in 2020 (Nanjing Municipal Bureau of Statistics, 2021). Second, there is a considerable body of prior research on the food system of Nanjing, included a pre-pandemic household food security survey which provides a baseline from which

to measure the impact of the COVID-19 pandemic on the food security of households (Si and Zhong, 2018). Finally, Nanjing was selected as the research site because its pandemic experience is typical of many second-tier cities in the country. They were neither the pandemic epicentre nor unaffected by COVID-19. Measures taken by the local authorities to contain the spread of COVID-19 in these centres included mobility controls, partial lockdown of residential communities and encouragement of online food purchasing (Chang et al.2020). While residents were required to stay at home and had restrictions on their everyday mobility, supermarkets and wet markets generally remained open to offer daily necessities and the public transportation system was still in operation

3.2 Household Survey

This paper draws on data from an online survey of household food security conducted in March 2020 in Nanjing. As residential neighbourhoods were still under partial lockdown with restricted outside access, it was not possible to conduct a face-to-face survey. The online survey was therefore designed and implemented using the electronic questionnaire platform Wenjuanxing. The platform ensured that only residents of Nanjing could access the survey by limiting the IP addresses to the city. WeChat was used to distribute the questionnaire. A total of 1,445 responses were received from Nanjing residents and after screening for incomplete surveys, there were 968 validated questionnaires for analysis. Of these 536 households answered all questions relevant to the analysis in the paper.

Four main types of information were collected from respondents. First, basic information about the household, including size, membership, structure, housing type, property rights and *hukou* status was collected. Second, respondents were asked what kinds of lockdown (complete or partial) and quarantine measures their residential community had experienced. Third, the survey collected detailed information about household food purchasing and consumption behaviour in the previous month of the pandemic. Finally, to assess the extent of food security in the previous month, all households were asked nine common frequency-of-occurrence questions from Coaytes et al (2007) designed to capture different dimensions of household food insecurity (Table 1).

The dependent and independent variables used in the analysis of household food security during the pandemic are summarized in Table 2.

Table 1: Dependent and Independent Variables

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Dependent Variables	Definitions and Coding
Food Security Status	
<i>HFIAS</i> (HFIAS score)	Household Food Insecurity Access Scale score, ranging from 0 to 27
<i>HHS</i> (HHS score)	Household Hunger Scale score, ranging from 0 to 6
<i>FA</i> (Food anxiety)	Household food anxiety level, ranging from 0 to 3
Never	
Rarely	
Sometimes	
Often	
<i>LFQ</i> (Limited food quality)	Limited food diversity and unsatisfied food preference in households, ranging from 0 to 9
<i>IFQ</i> (Insufficient food quantity)	Insufficient food obtaining and food consumption in households, ranging from 0 to 15
Independent Variables	
Migration Status (explanatory)	
<i>Hukou</i>	If the household has a Nanjing hukou, <i>Hukou</i> = 1; otherwise, <i>Hukou</i> =0
Local households	
Migrant households	
Household Characteristics (control)	
<i>NFT</i> (Number of food types)	Number of types that were affected in household food consumption (0-24)
<i>HT</i> (Household type)	If the household is female-headed (without a male partner), <i>HT</i> = 1; otherwise, <i>HT</i> = 0
Female-centered households	
Other households	
<i>FE</i> (Food expenditure)	If household spent more money on food than before COVID-19 pandemic, <i>FE</i> = 1; otherwise, <i>FE</i> = 0
Higher than pre-pandemic	
Equal to/lower than pre-pandemic	
<i>HS</i> (Household size)	If the household members are less than 5, Household size = 1; otherwise, Household size = 0
Five members or less	
More than five members	
<i>ME</i> (Medical expenditure)	Household medical expenses because of COVID-19 (CNY)

3.3 Food Security Metrics

Nine frequency-of-occurrence questions from Coates et al. (2007) were derived to capture the level of household food insecurity in Nanjing during the COVID-19 pandemic (Table 2). These questions form the basis of two standardized and validated cross-cultural metrics: the Household Food

Insecurity Access Scale and the Household Hunger Scale (Ballard et al., 2011; Coates et al., 2007; Leroy et al., 2015). Three additional measures were used to identify different dimensions of food insecurity and insufficient quantity of food: Food Anxiety, Limited Food Quality. The coding of the five food security measures used as dependent variables in the analysis was as follows:

Table 2: Food Security Questions

In the past four weeks:
Q1: Did you worry that your household would not have enough food?
Q2: Were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?
Q3: Did you or any household member have to eat a limited variety of foods due to a lack of resources?
Q4: 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?
Q5: Did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
Q6: Did you or any household member have to eat fewer meals in a day because there was not enough food?
Q7: Was there ever no food to eat of any kind in your household because of lack of resources to get food?
Q8: Did you or any household member go to sleep at night hungry because there was not enough food?
Q9: Did you or any household member go a whole day and night without eating anything because there was not enough food?

Source: Coates et al. (2007)

- Household Food Insecurity Access Scale (*HFIAS*) (Q1-9) is an overall measure of food insecurity based on all nine questions in Table 2. The frequency-of-occurrence for each question was coded as 0 (Never), 1 (Rarely), 2 (Sometimes) and 3 (Often). The scale allocates each household a score from 0 to 27. The higher the *HFIAS* score, the more food insecure the household, and the smaller the score, the more food secure the household.
- Household Hunger Scale (*HHS*) (Q7-9) is a secondary indicator focused on household responses to food shortages and hunger. The scale assigns the following values: 0 (Never), 1 (Rarely/Sometimes) and 2 (Often). The range of *HHS* scores is therefore 0 to 6. The higher the *HHS* score, the more intense the household experience of hunger, the lower the score, the less the experience of household hunger.
- Food Anxiety (*FA*) (Q1) captures the frequency of uncertainty or anxiety about the household food supply. This metric is an ordinal four-category variable: Never, Rarely, Sometimes and Always.
- Limited Food Quality (*LFQ*) (Q2-4) captures the quality and diversity of the household diet on a scale ranging from 0 (good quality and diversity) to 9 (poor quality and diversity).
- Insufficient Food Quantity (*IFQ*) (Q5-9) is a measure of whether the quantity of food to which the household has access is sufficient to meet household needs on a scale from 0 (completely sufficient) to 15 (extremely insufficient).

3.4 Migration Status

Household migration status was the control variable in the analysis. To distinguish between migrant and urban households, household registration status (*hukou*) was used. Households with Nanjing *hukou* were classified as local or

non-migrant. Households whose *hukou* was not in Nanjing were classified as migrant. A total of 431 households (80%) had Nanjing *hukou* and 105 households (20%) were migrants with non-Nanjing *hukou*.

3.5 Household Characteristics

Five variables reflecting different household characteristics during the pandemic were included in the analysis: (a) Number of Common Food Types (*NFT*) foregone captured by the question “Has the COVID-19 outbreak affected your consumption of the following foods?” Respondents were presented with a list of 24 common food types to respond to; (b) Household type (*HT*) – female-centred (i.e. households with a female head and no male spouse/partner) and other; (c) Food Expenditure (*FE*) more than before COVID-19 or the same/less than before; (d) Household Size (*HS*) of less or more than five members and (e) COVID-related Medical Expenditure (*ME*).

3.6 Data Analysis and Limitations

Five multiple regression models were used to compare the food security of migrant and non-migrant households and determine the significance of any differences between them. Model I used the Household Food Insecurity Access Scale (*HFIAS*) as the dependent variable to represent the overall experience of household food insecurity during the pandemic. Model II used the Household Hunger Scale (*HHS*) as the dependent variable to represent the frequency of experience of hunger during the pandemic. Model III used insufficient food quantity (*IFQ*) as the dependent variable to represent the frequency of insufficient food intake. Model IV used *limited food quality* (*LFQ*) as the dependent variable to represent the frequency of consuming undesirable foods. Model V uses anxiety about the food supply (*FA*) as the dependent variable.

The analysis and conclusions have several limitations. First, pandemic restrictions meant that the household sample

was not randomly selected but were the result of a form of snowball sampling. This means that the sample is not necessarily representative of the migrant and non-migrant population as a whole. Second, the relatively small sample of migrant households reflects the difficulties of accessing the floating population through online surveys. In particular, the methodology may have under-sampled households living in lower-income areas of the city. Third, the distinction between migrant and non-migrant households by *hukou* means that migrant households that have acquired Nanjing *hukou* are not considered as part of the floating population of the city. Finally, by focusing on the household as a unit of data collection and comparison, the individual experience of household members and intra-household dynamics is not captured in the analysis.

4. Results

4.1 Household Profile

This section provides an overview of the findings from all of the respondent households. The average HFIAS score for all households was 4.82 out of a possible 27 (SD = 5.51). While

the HFIAS score is relatively low by international standards, it represents an increase from an earlier pre-pandemic survey of Nanjing when the HFIAS was only 0.61 (Si and Zhong, 2018). The mean Household Hunger Score was 0.5 out of a possible 6. According to Ballard et al. (2011), an HHS of 0-1 indicates that there is little hunger in a household. The mean IFQ and LFQ were 1.42 and 2.42 respectively, suggesting that poor food quality was a more important issue for households than the amount of food they could access. Just over 40% of households said they had never worried that the household would not have enough food during the pandemic, while 22% had sometimes worried and 8% had often been worried.

Some 11% of the respondents were from female-centred households and only 7% were from larger households. The number of food types that households had gone without as a direct result of the pandemic was 2.29 on average (SD = 3.48). Food expenditures increased during the COVID-19 pandemic for two-thirds of households, a clear reflection of the impact of rising food prices. In terms of medical expenditure in response to the pandemic, the average expenditure was CNY1.07 thousand (SD = 1.72).

Table 3: Mean Household Values

Variables	%	Mean	SD
Food Security Status (dependent)			
HFIAS (HFIAS score)		4.82	5.21
HHS (HHS score)		0.50	1.17
FA (Food anxiety)			
Never	40.6		
Rarely	28.7		
Sometimes	22.4		
Often	8.2		
LFQ (Limited food quality)		2.42	2.43
IFQ (Insufficient food quantity)		1.42	2.92
Migration Status (explanatory)			
Hukou			
Local households	80.4		
Migrant households	19.6		
Household Characteristics (control)			
NFT (Number of food types)		2.29	3.48
HT (Household type)			
Female-centered households	10.6		
Other households	89.4		
FE (Food expenditure)			
Higher than pre-pandemic	65.5		
Equal to/lower than pre-pandemic	34.5		
Variables	%	Mean	SD
HS (Household size)			
Five members or less	93.1		
More than five members	6.9		
ME (Medical Expenditure)		1.07	1.72

4.2 Migration and Food Security

There are clear and consistent differences in food insecurity between local households with Nanjing *hukou* and migrant households without Nanjing *hukou* (Table 4). On all of the food security metrics, migrant households performed more poorly than local households. For example, migrant households scored an average 6.86 on the HFIAS, compared with 4.33 for local households. Similarly, the HHS, IFQ and LFQ were all higher for migrant than local households. Thus, migrant households on average experienced more hunger, less food quantity and more limitations on food quality than local households. Migrant households also expressed higher levels of anxiety about the household food supply with 17% often feeling anxiety compared to 6% of local households.

Table 4: Food insecurity of local and migrant households			
	All households	Households with Nanjing <i>hukou</i>	Households without Nanjing <i>hukou</i>
Sample size	536	431	105
Percentage	100%	19.59%	80.41%
Variable classification	Mean (Standard Deviation) / Number (%)		
<i>HFIAS</i> (<i>HFIAS</i> score)	4.82 (5.51)	4.33 (4.98)	6.86 (6.94)
<i>HHS</i> (<i>HHS</i> score)	0.50 (1.17)	0.40 (4.98)	0.89 (1.56)
<i>IFQ</i> (Insufficient food quantity)	1.42 (2.92)	1.16 (2.55)	2.46 (3.95)
<i>LFQ</i> (Limited food quality)	2.42 (2.43)	2.24 (2.32)	3.15 (2.73)
<i>FA</i> (Food anxiety)	Number (%)		
Never	218 (40.67)	186 (43.16)	32 (30.48)
Rarely	154 (28.73)	121 (28.07)	33 (31.43)
Sometimes	120 (22.39)	98 (22.74)	22 (20.95)
Often	44 (8.21)	26 (6.03)	18 (17.14)

Table 5 presents the results of Model I, Model II, Model III, Model IV and Model V with *HFIAS*, *HHS*, *IFQ*, *LFQ* and *FA* respectively as the dependent variables. The first three models all show that the independent variable *hukou* has a significant impact on food security. Model 1 indicates that migrant status has a significant negative impact on the *HFIAS* score. The value of the coefficient of the *hukou* variable is approximately -1.277, meaning that the value of *HFIAS* of households with Nanjing *hukou* is about 1.277 lower than that of households without Nanjing *hukou*, holding other variables constant.

Table 5: Regression results for the impact of *hukou* on household food insecurity

Dependent variables	Independent variables	Model I	Model II	Model III	Model IV	Model V
		HFIAS	HHS	IFQ	LFQ	FA
<i>Hukou</i>		-1.277** (0.624)	-0.251* (0.141)	-0.678* (0.353)	-0.423 (0.269)	-0.344 (0.212)
<i>Number of food types (NFT)</i>		0.612*** (0.101)	0.111*** (0.024)	0.289*** (0.059)	0.238*** (0.041)	0.172*** (0.029)
<i>Household type (HT)</i>		1.606** (0.725)	0.294 (0.180)	0.835* (0.448)	0.704** (0.296)	0.194 (0.249)
<i>Food expense (FE)</i>		1.157*** (0.401)	0.188** (0.089)	0.585*** (0.210)	0.401** (0.195)	0.323* (0.172)
<i>Household size (HS)</i>		2.057*** (0.681)	0.075 (0.176)	0.482 (0.404)	1.011*** (0.302)	1.438*** (0.437)
<i>Medical expense (ME)</i>		0.460** (0.188)	0.089** (0.044)	0.222* (0.114)	0.175*** (0.060)	0.157** (0.078)
Constant		1.113 (0.885)	0.126 (0.218)	0.146 (0.521)	0.751* (0.388)	/
N		536	536	536	536	536
R-squared		0.247	0.174	0.196	0.192	/
Pseudo R2		/	/	/	/	0.070

Note: The values in parentheses are robust standard errors. *, ** and *** denote significance at 10%-level, 5%-level, 1%-level.

Model I also confirms that as the number of food types affected by the COVID-19 pandemic increased, so did household food insecurity. Female-centred households and those with higher expenditure on food were also more likely to be food insecure. Larger households and households that spent more on medical items were less likely to be food insecure.

Models II and III use household hunger (*HHS*) and insufficient food quantity (*IFQ*) respectively as the dependent variable. Both models indicate that migrant households were more likely to be affected by hunger and food shortages than local households, holding other variables constant. Model IV (*LFQ*) shows that there was no significant difference in the quality of food consumed between local and migrant households during the pandemic. Model V (*FA*) indicates that there was no significant difference in anxiety about the food supply between local and migrant households.

5. Conclusion

The complex relationships between migration and food security have been identified as a neglected but important research area going forward (Crush, 2013; Crush and Caesar, 2017; Orjuela-Grimm, 2021). COVID-19 has focused new attention on the relationship for two main reasons: first, increased food insecurity has been a pervasive feature of the pandemic at scales from the global to the local; and second,

migrants have been particularly vulnerable to infection and to the negative social and economic impacts of the pandemic. Research on COVID-19 has increasingly focused on the pre-pandemic conditions that rendered some groups more vulnerable than others to the pandemic's negative health, economic and social impacts (Bottan et al., 2020; Cuéllar et al., 2021; Nanda, 2020; Onyango et al., 2021). In their impact typology, Katikireddi et al. (2021) propose that these inequalities produced different 'pathways' including initial exposure to the coronavirus, vulnerability to infection/disease, health consequences of the disease, its social and economic consequences, effectiveness of pandemic control measures, and adverse consequences of control measures. Along all these pathways, migrants working in other countries or away from home in their own countries have proved to be most vulnerable and negatively affected (Alrob and Shields, 2022; Freier and Espinoza, 2021; Jesline et al., 2021; Mengesha et al., 2022; Mukumbang, 2020; Quandt et al., 2021).

Oliva-Arocas et al (2022) note that migrants are "a group specifically affected but poorly studied" in the pandemic context. There has been a particular dearth of analysis on the impacts of COVID-19 on the food security of migrant populations. This paper is therefore a contribution to understanding the ways in which migrant food security was affected during the early months of the pandemic in an area close to the original epicentre in the Chinese city of Wuhan. Online survey data from Nanjing collected during

the first wave of the pandemic confirms that migration status households were consistently more food insecure than local households with Nanjing *hukou*. Migrant households had higher household scores on three main indicators: the Household Food Insecurity Access Scale, the Household Hunger Scale and the Insufficient Food Quantity measure. However, this analysis found no significant differences between local and migrant households in the experience of reduction in food quality or in levels of anxiety over food access.

The findings in this paper are sufficiently suggestive to prompt further research on migration-food security linkages in three areas. First, it is necessary to explore through a broad-based mixed methodology how the pre-existing economic and social situation of Nanjing's two million migrants, pre-disposed them to greater food insecurity compared with households with Nanjing *hukou*. More information is clearly needed on the employment sectors and incomes of migrants, their formal and informal livelihood strategies, their remitting practices, their degree of access to social protection, their living conditions, and their access to and types of accommodation. Tang and Li (2021) and Li and Luo (2021) suggest that it is also important to appreciate differences within the migrant population in terms of access to stable employment, shelter, housing, and family and kinship support in the city and the countryside. A similar argument has been advanced by Rajan et al. (2022) in India.

Second, in seeking a nuanced explanation for the differential food security experience of migrant and local households during the pandemic, it will be necessary to explore the more qualitative dimensions of their experience. One hypothesis is that the "residential wall" between migrants and local households disadvantaged the former in various ways. For example, some migrants live in dormitories and housing in old neighbourhoods or urban villages isolated from other urban residents (Tang and Li, 2021). Taken with loss of income as labour-intensive industries shut down, this reduced their ability to access food (Tang and Li, 2021). In addition, these migrants may not have had the same information about food sources or degree of access to the online food purchasing that became so critical during the pandemic (Liang et al., 2022). Even better-off migrants renting accommodation in residential complexes were at a distinct disadvantage compared to local owners. Most non-local households, for example, were excluded from the collective food purchase and food information publicity organized by the property company managing a complex.

Third, the findings from this online survey need to be validated through a larger and more representative survey of migrant households in Nanjing. Similar surveys in other Chinese cities would also facilitate more comparative study of the pandemic experience of migrant versus non-migrant households (Zhong et al., 2021). One of the key unanswered questions is whether the pandemic disruptions of early 2020 were enduring or temporary. Although migrants experience a range of economic and social disadvantages compared to local households, there is no evidence that food security was particularly widespread amongst migrant households

prior to the pandemic. The key question, therefore, is whether pre-pandemic levels of food security were restored or whether migrant households still feel its effects two years later. This is of particular importance in building resilience to better cope with the food insecurity consequences of future waves of COVID-19 or any other future pandemic.

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