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# Food system under COVID-19 lockdown in Shanghai: problems and countermeasures

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**Introduction:** Owing to the increased transmissibility of the Omicron virus, Shanghai implemented a citywide lockdown in 2022. This measure disrupted the normal functioning of the city's food system and led to incidents related to food insecurity within the city. To mitigate these challenges, the local government and various stakeholders devised various solutions.

**Methods:** In this context, we adopted a root cause analysis to report the disruptions caused by the lockdown on Shanghai's food system.

**Results:** According to disruptions, we listed the challenges faced by Shanghai's food system and solutions implemented by the government and stakeholders.

**Discussion:** We discussed the underlying reasons behind food system disruptions and listed advantages of Shanghai's solutions. We further scrutinized the sustainability of the solutions implemented in Shanghai. Finally, we discussed how to promote the urban food system resilience building based on research findings. The findings of this research are anticipated to provide valuable insights for other areas that may encounter similar challenges in the future while fortify their urban food systems.

## KEYWORDS

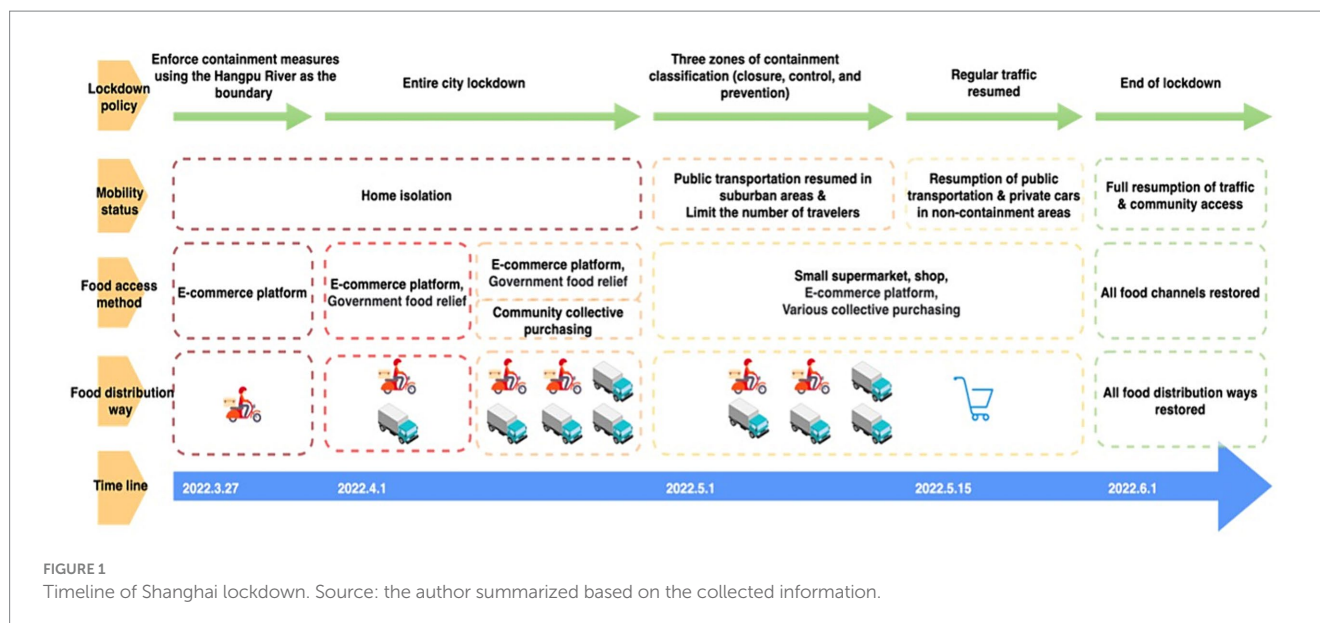
COVID-19 pandemic, lockdown, food system, food security, urban

## 1 Introduction

Since 2020, the novel coronavirus rapidly spread globally. Countries, sub-national regions, and cities worldwide responded to the COVID-19 pandemic through prevention and control measures. However, these measures significantly disrupted the infrastructure and systems upon which cities depend, in particular, impacting the food system functioning, and subsequently affecting food security.

The COVID-19 pandemic prevention and control measures profoundly influenced local food systems (Béné, 2020; Béné et al., 2021), especially the urban food systems (CCSA, 2020). Given that over 90% of new COVID-19 cases occurred in urban areas because of the high population density, risk of infection during routine food supply and purchasing activities increased (COLL, 2020). Therefore, prevention and control measures were more frequently enforced in urban areas than rural regions.

Shanghai, China's largest city, was severely affected by lockdown measures that obstructed its entire food system. Since early March 2022, as the number of infections increased, the scope of control strategies in Shanghai gradually expanded. Notably, from March 27th to June 1st, 2022, Shanghai implemented stringent measures to block the entire city with 2,500 residents (Figure 1) (Shanghai Statistics Bureau, 2022). The lockdown measures were continually adjusted according to the severity of virus transmission, indicating dynamic food system adjustment. During the earlier stages of the Shanghai lockdown, rapid lockdown initiation



caused food system disruptions. Food supply and food distribution was insufficient because of road closures and quarantine inspections limiting the flow of food logistics. Most food retail and catering entities were forced to close, severely restricting resident access to food channels, while the residents' scope of activities was also greatly reduced, further exacerbating their channels of obtaining food. In response, from April 1, the food system was adjusted to address the food needs of the majority of the population during the mid-term of the lockdown. As the virus spread was under control (On April 20, Jinshan and Chongming Districts in Shanghai reached zero infections on a societal level; by April 30, the entire city reported zero infections on a societal level). Lockdown measures began to moderate, and food system channels cautiously expanded. Until June 1st, when the virus was effectively controlled, all food system channels were restored. The urban food system stagnated from the supply side to the demand side, resulting in food insecurity issues at the household level. Furthermore, the rapid initiation of the lockdown in Shanghai resulted in a significant increase in depression and anxiety due to household food insecurity (Hall et al., 2023). Therefore, it is crucial for the government to ensure city-wide food supply to prevent food security issues resulting from shortages in food supply and insufficient access channels.

## 2 Literature review

Local food systems in various countries faced the same challenges during the pandemic. Complex urban food systems revealed the vulnerabilities and structural weaknesses. The unsustainability, inequity diminished the urban resilience to maintain food and nutritional status (Jensen and Orfila, 2021). Numerous issues surfaced during the pandemic, such as the disarray in coordinating responses across multiple departments, inflexibility in local food supply system policies, and the cascading effects resulting from the pressure on social and public sector services, all of which led to inadequacies in the operation of urban food systems (Hecht et al., 2019; Newell et al., 2022). Weaknesses in the areas of labor, processing, transport and logistics were highlighted (Béné, 2020). The unequal impact of food

security and services exacerbated conflicts among populations (Cattivelli, 2022). The relationship between metropolitan areas and nearby rural areas was characterized by a number of issues that need to be addressed, such as the role of peri-urban agricultural zones in ensuring food supply and land conservation, and the need to develop cooperation and mutual assistance activities among the different agents involved in the food system (Callau-Berenguer et al., 2022; Cattivelli, 2022). Although these issues reflect barriers to the transformation of urban food systems, they also represent opportunities for reform.

The COVID-19 pandemic exposed weaknesses in our emergency food distribution plans, emphasizing the importance of actively fostering adaptability in such plans. The adaptability was reflected in the actions of stakeholders at all levels. The vulnerability of the food system resulting from a high reliance on long-distance transport and cold-chain logistics was recognized, and the alternative was a more decentralized and localized short food supply chains (SFSCs) (Chi Ffoleau and Dourian, 2020; Shariatmadary et al., 2023). In government management, studies demonstrated the coordination of governmental activities alongside strategic alignment of policy initiatives. Examples include the government's management of partnerships and coordination among the public, private, and third sectors, as well as policies and initiatives implemented at the local level (Kroll and Adelle, 2022; Parsons and Barling, 2022; Turcu and Rotolo, 2022). However, due to the fast-paced and highly uncertainty of pandemics, this required a rapid response from all actors. This further exposed the existence of a disconnection between the national level and the city level of urban food governance, and fragmentation at the level of urban management (Turcu and Rotolo, 2022). Therefore, in situations where mainstream actors and institutions in the food system were slow or inadequate in their actions, local grassroots initiatives played a crucial role in ensuring food access, supply, and distribution. During the pandemic, local grass-roots actions addressed food security primarily through a people-centered approach, supplemented by third sector and community-led initiatives, revealing a new structure of food governance in the city (Turcu and Rotolo, 2022). These measures were considered innovative during the pandemic, as they are flexible and based on local characteristics, and are considered effective in

enhancing the resilience of local food systems. For example, non-governmental organizations, community groups, and residents' associations utilized existing resources to establish networks with both public and private organizations (Mockshell and Nielsen Ritter, 2024; Rut and Davies, 2024). They also coordinated with other regional food distribution centers to facilitate food sharing, mutual aid, and assistance activities, maximizing their impact in bridging the gaps in the local food distribution chain (Lofton et al., 2022; Mockshell and Nielsen Ritter, 2024). In addition, the flexible utilization and adaptive transformation of existing facilities and strategies alleviated pressure on the urban food system. For example, repurposing existing infrastructure (such as converting grocery stores into emergency food warehouses). Urban agriculture, community gardens, household gardens, and roadside vendors played important roles in providing food emergency buffer functions (Lal, 2020; Iida et al., 2023; Underhill et al., 2023). It is worth noting that e-commerce platforms, ensuring smooth information flow and contactless communication features, have also been proven effective in reducing the risk of infection and meeting urban food demand (Guo et al., 2021; Wang et al., 2022).

China, the world's most populous country, particularly experiences denser populations in its large cities, with more complex and diverse food systems. Faced with the rapid spread of the pandemic, the challenges confronting the food system are more formidable compared to other regions. Urban systems also implemented various measures to address this challenge. Existing research explored the overall urban governance and resilience measures of urban systems in China during pandemics (Xue et al., 2023). Research also addressed the exploration of methods and frameworks for future urban emergency response based on existing development concepts and policies in cities (Blay-Palmer et al., 2021; Fei et al., 2023). Additionally, study summarized food security governance in some cities and reviewed emergency food policies and their impact on urban household food security (Zhong et al., 2022; Chang et al., 2023).

In summary, from our understanding of existing literature, the research addressed the challenges faced by local food systems during pandemics on one hand, while also evaluated the measures taken by local food systems to respond to these challenges on the other hand. However, there is a lack of dynamic discussion regarding the challenges and solutions encountered by a city during a pandemic. Because the fast pace and high degree of uncertainty during a pandemic make it difficult to track and assess changes in the food system and related policy responses (Ilieva et al., 2023). Additionally, current research exhibited a deficiency in systematically coordinating stakeholder response cases across all levels. Given the rapid implementation of strict regulations, it becomes imperative to explain how the Shanghai government effectively coordinates the collaboration of diverse stakeholders to promptly sustain the functionality of the food system within a mega-city housing 25 million residents. This demonstration is essential for sharing useful practices to the global urban area. Therefore, we propose the first research objective RO1: based on the dynamics of the pandemic in Shanghai, we demonstrate the challenges that emerged at various stages of the city's food system. The study also identifies the systemic and structural deficiencies exposed by the city in light of these challenges and suggests improvements. However, collective behavior also exhibited confusion and discourse distortion at different stages of the pandemic (Xue et al., 2023), some response measures only focused on short-term crisis management and maintaining the status (López Cifuentes and Fiala, 2022). In response to these shortcomings, we propose the second

research objective RO2: enumerate the response measures taken by governments and stakeholders in various stages of the pandemic in light of the main challenges and evaluate the sustainability of these measures. The increase in resilience is most effective when multiple institutions, organizations, and individual citizens collaborate under a common strategy toward shared goals (Borrelli et al., 2023). The key aspect of this process is the development of a more comprehensive approach. Therefore, we propose the third research objective RO3: based on the listed challenges and response measures, combined with current technology and science, discuss how to build a more resilient urban food system to cope with future uncertainties.

Based on the outlined research objectives, our study holds significant implications: firstly, by identifying and analyzing the challenges that emerged in Shanghai's food system during the pandemic, our research provides valuable insights into the vulnerabilities and deficiencies of urban food systems in the face of crises. This understanding is crucial for policymakers, urban planners, and stakeholders to develop effective strategies and policies to enhance the resilience of food systems in similar contexts. Secondly, through an evaluation of the response measures implemented by governments and stakeholders in response to pandemic challenges, our study offers a critical assessment of the effectiveness and sustainability of these measures. This evaluation could inform future crisis management strategies and guide decision-making processes to ensure more adaptive and resilient responses in the future. Lastly, by discussing how to build a more resilient urban food system based on identified challenges, response measures, and current technology and science, our research contributes to the development of practical solutions for mitigating future uncertainties. This discussion provides actionable recommendations for enhancing the resilience of urban food systems, ultimately contributing to the long-term sustainability of cities in the face of global challenges. In summary, our study provides valuable insights, evaluations, and recommendations for policymakers, practitioners, and researchers to enhance the resilience of urban food systems and effectively manage future crises.

## 3 Methods

### 3.1 Data source

We conducted data collection according to the logic depicted in Figure 2. Owing to the scattered and transient characteristics of the event, we gathered information from diverse sources to describe the situation. To ensure accuracy, we compared information from both official and unofficial sources. The information utilized for analyses from publications, government-released reports, official information as well as blogs and media articles. The study was compliance with standard reporting guidelines. Ethics approval was deemed unnecessary for this study, as the research protocol did not involve any interventions or compromise privacy and anonymity. All data utilized in this study underwent thorough de-identification measures.

### 3.2 Analysis method

This study employed a qualitative analytical approach to describe and analyze disruptions and challenges to the urban food system in

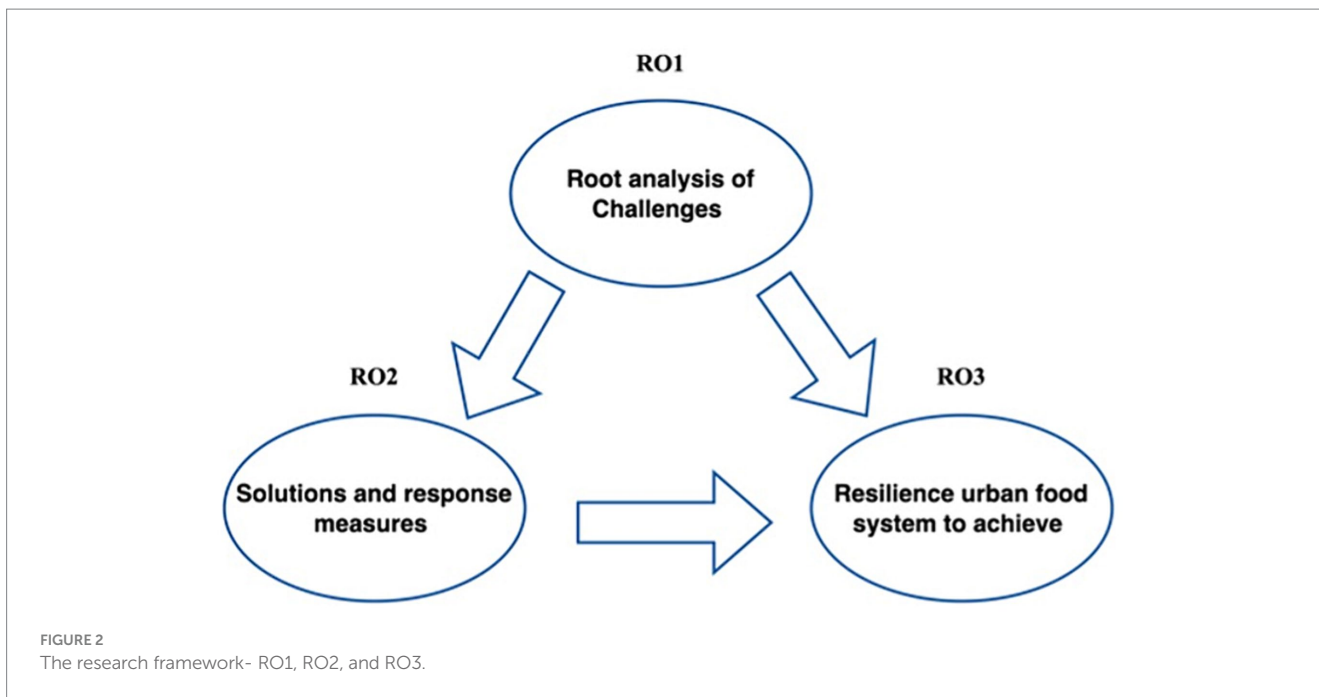


FIGURE 2 The research framework- RO1, RO2, and RO3.

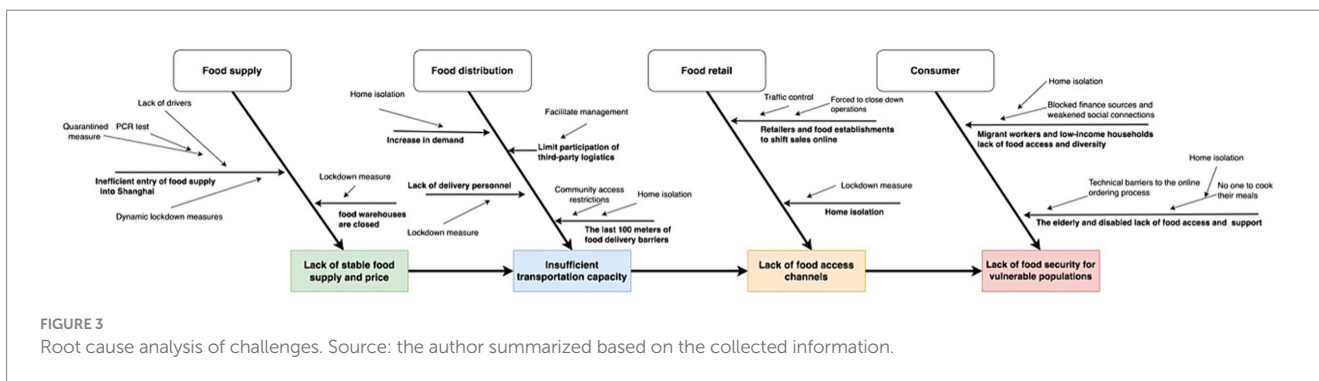


FIGURE 3 Root cause analysis of challenges. Source: the author summarized based on the collected information.

Shanghai during the COVID-19 lockdown from the March 27 to the June 1, 2022, along with corresponding mitigation solutions. Root cause analysis (RCA) is a systematic method of identifying the underlying causes of problems or incidents, rather than simply addressing their immediate symptoms. Using this method, we identified the reasons for the challenges in the Shanghai food system (Figure 3), why these challenges occurred. Based on root cause analysis result, we also summarized that how Shanghai responded to these challenges, how sustainable are these measures for the urban resilience food system building, and what we should do to avoid the recurrence of these challenges.

## 4 Results

### 4.1 Impact of lockdown on Shanghai’s food system and challenge

#### 4.1.1 Overview impact of lockdown on Shanghai

The impact of *food production* in Shanghai’s food supply chain faced minimal disruption. To address the short-term urgent needs,

perishable foods such as milk and leafy greens experienced minimal impacts because of support from the surrounding regions. In 2022, Shanghai’s surrounding areas dedicated a total of 803,200 mu to grain production, 490,700 mu to vegetable production protection zones, and 71,000 mu to specialty agricultural product advantage zones (Gu, 2022). Overall grain production remained stable at over 900,000 tons, with perennial vegetable acreage consistently at around 500,000 mu (Gu, 2022). Approximately 80% of the city’s leafy greens could be supplied by these surrounding areas (Gu and Wang, 2020). In addition, the collaboration between the government and major corporations provided essential food support. Guangming, a state-owned food company in Shanghai, demonstrated a dominant market presence in 2022, particularly in the dairy and meat sectors. The company’s market share exceeded 80, and 40% in dairy products and meat, respectively (Zhong, 2022). Moreover, the government collaborated with these companies to enhance food security by utilizing their storage facilities for grain reserves. For example: Guangming had an annual grain reserve throughput exceeding 10 million tons (Zhong, 2022). This company is also a significant player in Shanghai’s wholesale agricultural market, holding 60% market share in packaged rice and accounting for 70, 60, and 50% of the city’s



total wholesale volume of vegetables, meats, and fruits, respectively (Zhong, 2022). These solutions played a pivotal role in diminishing short-term overall emergency food supply pressures in Shanghai.

In the long term, to compensate for local supply shortages, areas outside Shanghai provided essential support. Because 85% of the grains, 75% of the vegetables and meats, and 65% of the eggs and dairy products in the entire city rely on supplies from other provinces and cities (Shanghai Municipal People's Government, 2022a,b). According to the State Council regulations, agricultural production could be resumed in low-risk areas (The State Council of the People's Republic of China, 2020). These areas were identified based on the COVID-19 pandemic and demographic data, where people were less likely to infect each other (Cheng et al., 2021). The Shanghai Municipal Commission of Commerce, in collaboration with wholesale markets, developed emergency plans. These plans involved reserving vegetables in low-risk areas such as Jiangsu and Shandong provinces to address shortages (Shanghai Municipal Commission of Commerce, 2022a). To ensure smooth supply, green channels for inter-provincial food transportation ensure the efficient delivery of food to Shanghai (The State Council of the People's Republic of China, 2022). These policies guaranteed food production continuity in agricultural areas and food logistics efficacy between provinces. Thus, provinces and cities located in low-risk areas could provide substantial food aid supplies and fulfill food demand orders for Shanghai. Similarly, *food processing and packaging* faced minimal disruption. As most food-processing factories are located in areas with low resident densities, they were less likely to become high-risk areas for viral transmission, thereby protecting continuous production activities.

Although there was an ample food supply available to Shanghai, stringent traffic control and pandemic prevention checks in Shanghai hindered the transportation of food into the city, resulting in ineffective distribution and lack of food access channels. Therefore, the most significant impact on Shanghai's food supply chain stemmed from interruptions in the *food distribution and retail channels* (Figure 3). The main challenges as follows.

#### 4.1.2 Challenge 1: lack of stable food supply and price

Although the overall food supply was adequate, inner city food supply faced the uncertainty regarding viral transmission led to frequent changes in lockdown measures. As most food items were transported by road using trucks owned by manufacturers, distributors, or third-party transportation companies, external personnel and vehicles faced challenges when entering Shanghai City (Figure 3). They were required to obtain permits and PCR test report before being allowed to proceed. This reduced the efficiency of food supplies entering the city. Once an incident of infection was detected in the transportation staff, they were quarantined for 14 days. This caused some drivers to fear quarantine and refuse to transport goods to Shanghai, resulting in driver shortage. At the beginning of April 2022, the number of vehicles transporting fresh agricultural products into Shanghai plummeted from 3,000 per day to 600 (Shanghai Municipal People's Government, 2022a). Besides, dynamic lockdown measures interrupted planned transportation routes at any time. After food supply entered the city, most food warehouses were closed due to pandemic prevention policies, resulting in a short-term shortage of food reserves within the urban area. Correspondingly, the imbalance between decreased food supply and increased demand led to

significant price increases during this period. Some businesses also engaged in illegal price gouging practices (Shanghai Municipal Administration for Market Regulation, 2022).

#### 4.1.3 Challenge 2: insufficient transportation capacity

As the number of infections rose sharply, the movement of couriers had a high potential for cross-infection. To facilitate management, the government limited participation of third-party logistics, permitting a limited number of transportation companies to operate within Shanghai. During normal periods, third-party logistics companies handled 70% of the logistics tasks in Shanghai. However, with the restrictions imposed on the involvement of third-party logistics, it is equivalent to a reduction in an equal amount of logistics transportation capacity. In 2022, the volume of local express delivery services reached 600 million parcels, representing a year-on-year decrease of 27.5% (Shanghai Statistics Bureau, 2023). Given the remaining transportation companies focused on essential government operations and the transportation of critical supplies, the logistics capabilities were further constrained. To meet the urgent food needs of residents, couriers who passed pandemic prevention checks were being issued city permits. Their numbers still could not meet the needs of the entire city. They were tasked with delivering food ordered by residents through e-commerce platforms to residential communities. However, due to the limitations of the lockdown policy, couriers were not allowed to enter the community and residents were not allowed to go out of the community, which made the last 100 m of food delivery become challenging (Figure 3).

#### 4.1.4 Challenge 3: lack of food access channels

Mobility restrictions forced retailers and food establishments to shift sales online, making online grocery the sole grocery channel in Shanghai. The residents were also restricted from going out. Those led to a lack of food access channels, resulting in insufficient food diversity, limited proximity, and inconvenient food access environments. Moreover, due to the shortage of delivery personnel, the high transportation costs and insufficient distribution effectiveness also hindered households from relying on the only way (online grocery) to obtain food (Figure 3).

#### 4.1.5 Challenge 4: lack of food security for vulnerable populations

Vulnerable populations in Shanghai also encountered challenges in food distribution. Due to lacking food access channels, people were starting to seek informal channels to obtain food, relying on personal connections or social networks. Migrant workers and low-income households earned income through part-time jobs, small businesses, and labor-intensive industries, had lower social resources and well-being than normal residents. This placed them at a disadvantage in securing food resources. Besides, due to lockdown mobility limitations, blocked finance sources and weakened social connections, further diminishing their food diversity. The food security of the elderly population is also a challenge. Among Shanghai's 14 0.7 million registered residents, there are 5.33 million people aged 60 or above, accounting for 36.1% of the population (Shanghai Hongkou District Government, 2023). Especially those without family or social support faced technical barriers to the online ordering process or no one to cook their meals. There were also more than 20,000 registered families

with serious illnesses in Shanghai (Wang et al., 2022). They required specialized support in their daily lives, and obtaining essential medicines and food could become even more challenging during the lockdown period (Figure 3).

## 4.2 Solutions and countermeasure of food supply in Shanghai

### 4.2.1 Overview of Shanghai's solutions

An overview of the emergency food supply system in Shanghai during the pandemic is shown in Figure 4. It was established by the government, in collaboration with several stakeholders. To face the challenges during the early stages of lockdown, this system addressed the issue of unstable food supply inside the city, mitigated logistical pressures, and established a robust and equitable food access channel to meet the overall food supply needs (Figure 5). The system primarily relied on guaranteed supply companies cooperating with collective purchasing as the primary supply channel, supplemented by government food relief and individual online grocery. Third-party logistics companies were responsible for filling up transportation gaps, while local communities and volunteers were responsible for the final food delivery. The emergency food supply system process included the following steps: (1) Demand collection: resident demands were

collected from three main sources (Figures 4B,C). Firstly, the district government collected residents' basic information through community committees to meet their basic food needs. Secondly, collective purchasing organizers regularly collected information about the types and quantities of food demanded by each household in the community, and then transmitted this information to guaranteed supply companies for centralized delivery. Thirdly, residents placed orders through e-commerce applications to satisfy specific requirements. (2) Food distribution: government food relief and collective purchasing were primarily handled by guaranteed supply companies for city centralized delivery with third-party logistics companies assisting in reducing transportation pressures. Online individual orders were delivered by individual delivery drivers (Figures 4B,C). (3) Last 100 meters of food delivery: after the community committee received the collective food supply, volunteers delivered food packages to the residents (Figure 4C).

### 4.2.2 Solutions to challenge 1

To ensure the smooth supply of food into the urban areas, Shanghai established food transfer stations on the outskirts of the city (Figure 4A). These stations facilitated the transfer of goods without direct contact, thereby minimizing the risk of infection for drivers from other regions (Shanghai Municipal People's Government, 2022a,b). This setup also ensured that external drivers, as indicated by

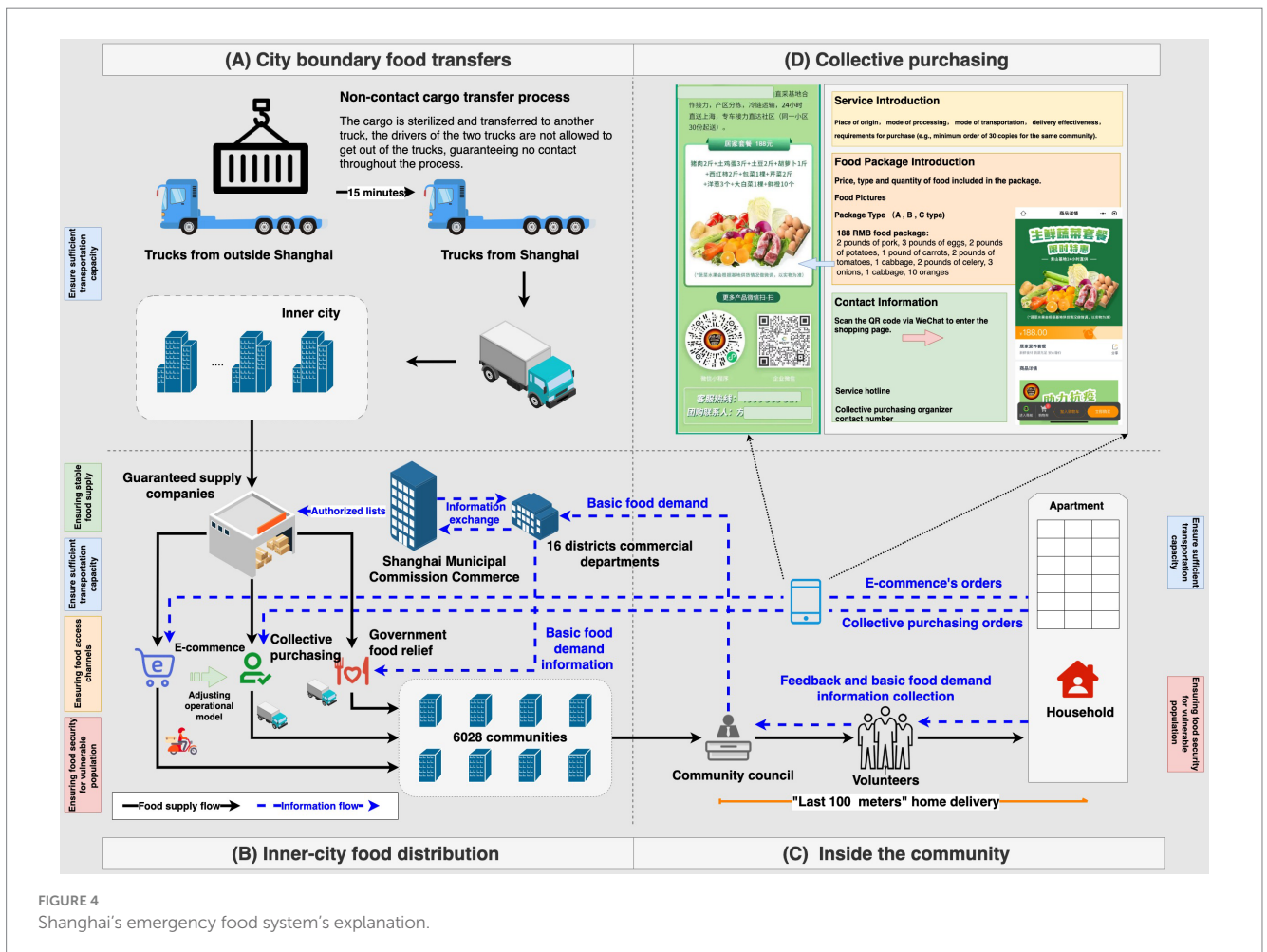
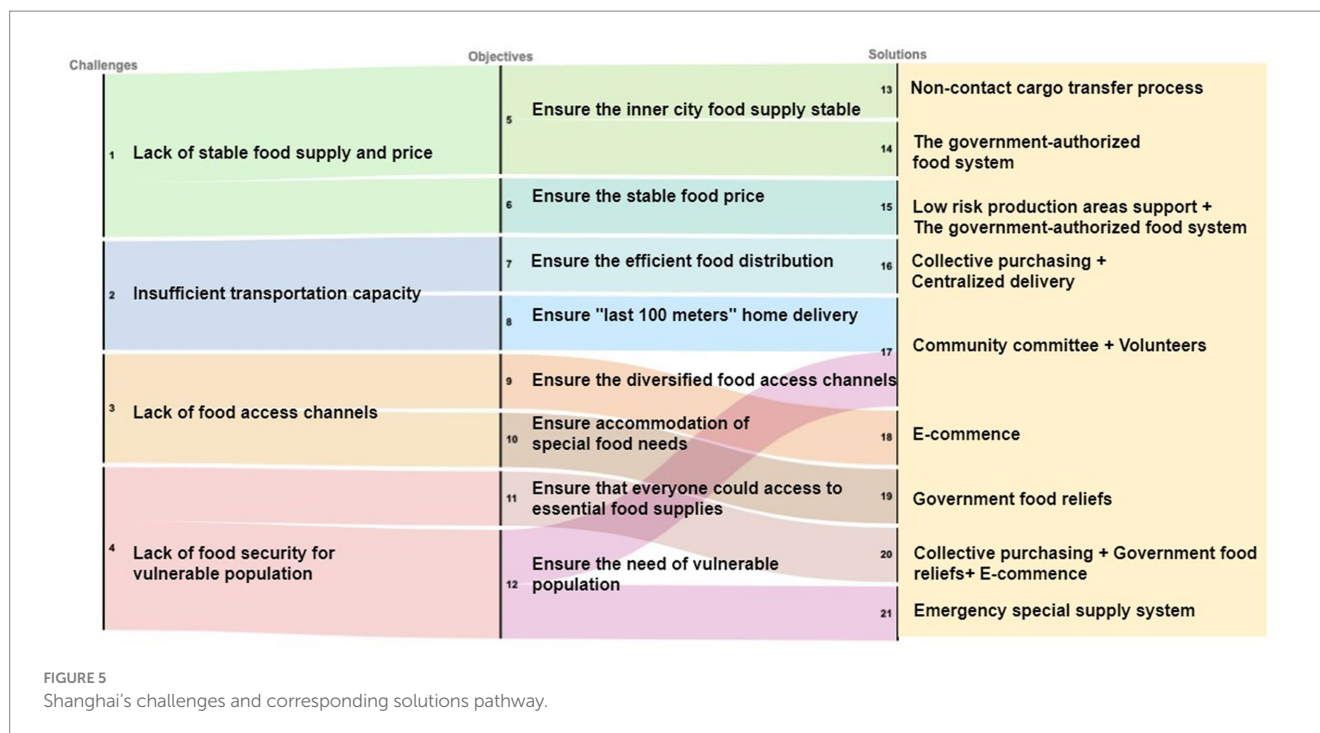


FIGURE 4 Shanghai's emergency food system's explanation.



the comprehensive data system, were not entered high-risk areas, alleviating concerns about potential infection and quarantine.

To ensure smooth food distribution within the urban areas, a government-authorized food system was established, ensuring food supply remains unaffected by lockdown policies. Entities participating in the food supply received Shanghai Municipal Commission Commerce's authorization. This protected them from interference by the lockdown control measures. These companies on the Shanghai Ministry of Commerce's authorized list were also announced to the Shanghai district governments to facilitate the establishment of cooperation between the district governments and these companies. This enhanced the efficiency of food distribution at the district level. In addition, Shanghai's Jing'an and Qingpu districts took the initiative to establish cooperation with agricultural cooperatives and places of origin to simplify the channels of urban food supply (Shanghai Municipal Commission of Commerce, 2022a). With food supply stabilizing, the overall market prices in Shanghai were also stabilizing. However, there were still some businesses engaging in price gouging. To address this issue, the Shanghai Market Supervision Administration stipulated profit margin regulations during the pandemic, specifying that the profit margin rate during the pandemic should not exceed the highest rate within the 7 days preceding March 19, 2022 (General Office of Shanghai Municipal People's Government, 2022).

#### 4.2.3 Solutions to challenge 2

To address insufficient transportation capacity, a collaborative model was implemented in which guaranteed supply companies cooperated through collective purchasing to effectively mitigate logistical pressures (Figure 4B). Each household reported the type and quantity of food needed for a certain period to the collective purchasing organizers through a WeChat application or phone calls (Figure 4D). Organizers collected this information and submitted collective orders to guaranteed supply enterprises. According to order

demands, guaranteed supply enterprises arranged for collective food demand delivery. Fewer trucks that made a single delivery were sufficient to meet the food demands of an entire community for a specific duration. For example: Pudong New Area with its population of 6.5 million residents, 2.6 million households, if each household receives a 5-kg food package, it only requires over 600 trucks (Shanghai Municipal People's Government, 2022a,b). This model ensured that despite the number of drivers and logistics staff was limited, it was possible to guarantee a large quantity of food and met the personalized food needs of each family. In addition, to address the logistical shortage caused by a further surge in food delivery demand, some third-party logistics were granted the permission to collaborated with guaranteed supply companies for food delivery as well (Shanghai Municipal Commission of Commerce, 2022b). To complete the last 100 meters of food delivery, the community committee organized resident volunteers to collaborate on the task. These volunteers were responsible for receiving food supplies (including collective purchasing, government food relief, and online grocery). After external packaging and disinfection, the community volunteers arranged food distribution tasks based on order information, volunteers delivered food packages to the residents' doorsteps, where they could pick them up, thereby ensuring a contactless food delivery process. The community-driven approach ensured efficient and safe delivery of essential food items to households (Figure 4C).

#### 4.2.4 Solutions to challenge 3

To increase the number of purchasing channels that are multiple and meet the food needs of most of the population, Shanghai established three food access channels in its food supply system (Figures 4B,C). (1) The food reliefs were funded by the government and designed to ensure that all residents could access the most basic food needs. The government obtained demographic information from every community and distributed free food packages including fresh



vegetables and meat products. (2) Collective purchasing ensured that the majority of the population had a stable and personalized food access channel. (3) Compared to the early stages of the lockdown, the role of online grocery undergone a fundamental shift, transitioning from a primary acquisition channel to a supplementary one. Individual online orders via a supplementary channel covered the special needs of a small group with items not available through the first two channels.

#### 4.2.5 Solutions to challenge 4

To address the lack of food security for vulnerable populations, Shanghai adopted food reliefs to guarantee basic food needs for all residents. Also, the mechanism of collective purchasing in combination with guaranteed supply enterprises greatly improved the efficiency of food distribution and provided a stable food supply for all residents. Particularly, for the needs of the elderly, pregnant women, infants and young children, and people with disabilities, the Shanghai Municipal Commission of Commerce established an emergency special supply system with guaranteed supply companies (e-commerce platforms and large supermarkets) (The Shanghai Municipal Health Commission, 2022). Companies provided special purchasing channels for these individuals. Residents only need to input their personal information and medical history into the system, and staff contacted with them to provide food and medication. To ensure the effectiveness of these emergency needs, supplies were transported by dedicated vehicles. For those who faced difficulty using the internet, the community committee posted information about food resources on community bulletin boards or made household interviews so that people with no internet technical proficiency could inform the community committee of their food needs.

#### 4.2.6 The practical effects of the Shanghai solution on the food system

In the initial stages of the lockdown in mid-March, the supply system provided Shanghai with a daily average of 10,204 tons of vegetables and 1,305 tons of pork (Shanghai Municipal People's Government, 2022a,b). As the number of supply guarantee enterprises continued to increase, by May 1st, the number had grown from the initial 4 to 1,400, ensuring an increase in both the quantity and variety of food. From May 1st to the 19th, a total of 390,000 portions of meat meals and 410,000 vegetable meals were supplied through the supply guarantee system (Shanghai Municipal People's Government, 2022a,b). To ensure the smooth operation of food logistics, 10 third-party cold chain logistics companies were incorporated into the supply system (Shanghai Municipal Commission of Commerce, 2022b). From the early stages of the pandemic to May 15th, the government provided free food channels, distributing a total of 7.658 million sets of living supplies to elderly people (Shanghai Municipal People's Government, 2022b).

## 5 Discussion

### 5.1 Reflection on the challenges within the food system

The 2-month lockdown in Shanghai posed four main challenges to the food system, prompting a reflection on the underlying reasons for these issues. Due to the coherence of the food system, these challenges collectively indicate a lack of a well-developed food emergency mechanism to address crises. The formulation of lockdown policies

hindered the operation of the food system, highlighting a disconnect between the functioning of the food system and the formulation of emergency policies. Therefore, a systemic approach to understanding the complexity of actors, activities, driving factors, and their interrelationships is crucial (Moragues-Faus and Battersby, 2021). This helps to clearly illustrate how urban food system planning and policies should consistently consider the entire food supply chain, highlighting disparities and disconnects to guide effective action on the ground (Clark et al., 2021; Moragues-Faus and Battersby, 2021). It is worth noting that this systemic thinking becomes even more crucial for urban governance during emergencies to avoid food system breakdowns caused by haphazard emergency planning. For instance, research proposes the design of Emergency Regional Food Supply Chains (ERFSC) under government intervention. The model considers regional food chain dynamics and labor demand forecasts under government intervention. This aids in alleviating efficiency losses in the food supply chain due to restricted labor during lockdowns (Tian and Mei, 2023). Therefore, expertise and foresight are essential. This necessitates greater involvement of scholars or professionals in urban policy formulation to avoid the disconnect between policies and actions within the food system.

Although food supply in Shanghai was generally adequate during this lockdown, thanks to the continued modernization of China's food warehousing facilities, there was a significant increase in logistics capacity and functioning road facilities. However, the inefficiency of food supply across city borders leads to instability in internal supply within the city. This reveals structural deficiencies in Shanghai's urban food system, characterized by excessive reliance on external food supply. Therefore, it is necessary to break down the spatial isolation of the city (Havewala, 2021) and ensure smooth food supply channels. The City Region Food Systems (CRFS) emphasizes the connectivity between urban areas and their surrounding regions, including rural areas. It proposes that urban-rural partnerships and intercity cooperation should transcend traditional administrative boundaries, reflecting an integrated food system between cities and their surrounding areas (Food and Agriculture Organization of the United Nations, 2024). Similar to the CRFS concept, Short Food Supply Chains (SFSC) and Local and Regional Food Systems (LRFS) are considered to have stronger resilience compared to long-distance transportation during pandemics. This is because they are closer to urban areas and less susceptible to disruptions, thus effectively supporting urban food security during the pandemic (Thilmany et al., 2021; Vicente-Vicente et al., 2021; Maas et al., 2022). Therefore, a more decentralized and localized food system needs to be established. Urban agriculture offers the potential for localized food systems. Vegetable gardens, home gardening, community gardens, and vertical farming have been proven to effectively enhance the food resilience within cities, reducing the vulnerability to sudden disruptions in food supply (Lal, 2020; Phooi et al., 2022; Elton and Cole, 2024). The social and public benefits of urban agriculture, including its potential to provide nutritional sustenance in post-disaster situations and serving as a contingent food source, should not be ignored (Sioen et al., 2017).

### 5.2 Advantages and sustainability of Shanghai solutions

#### 5.2.1 Advantage of Shanghai's solutions

To address the four challenges faced by the food system, Shanghai has implemented a series of measures: our study highlights the



following three advantages of Shanghai's measures that ensure the efficiency and applicability of its food system.

### 5.2.1.1 Systemic coherence and efficiency

Shanghai's solutions avoided confusion, duplication of efforts, mismanagement, and general inefficiency by establishing a government-led emergency food system. Firstly, the use of big data facilitated productive activities to be conducted in low-risk areas, enabling Shanghai to obtain food from other regions, and guaranteed overall food availability. Secondly, because the appointed guaranteed suppliers were directly available to the government, inefficiencies related to outsourced suppliers are avoided. The cooperation model between the collective purchasing and guaranteed supply companies improves logistics efficiency and overcomes challenges arising from insufficient logistics staff. Collective purchases and guaranteed supply companies based on e-commerce platforms also ensured the traceability and visibility of the food supply. Furthermore, implementing transportation policies and establishing joint supply emergency systems in major production and consumption areas have been proven to play a significant positive role in stabilizing food prices (Cui et al., 2023). Lastly, the collaborative efforts between communities and volunteers ensure minimal contact and efficient food delivery.

### 5.2.1.2 Smooth information exchange channels

The communication channels established by the community councils between the residents and the district governments have been effective in ensuring the availability of food to all residents and mitigating food concerns. On one hand, the community reported basic information about the demographic situation and livelihood demands to the district government, thus ensuring efficient distribution of government's food reliefs and collective supply. On the other hand, the latest policy measures and food supply information were disseminated to the residents through the community committees. This ensured that residents remained informed about the policy implementation and reduced their food shortage concerns which could be effective in reducing psychological panic among residents (Zhang et al., 2022). Besides, community committees routinely collected feedback from residents regarding issues related to food quality and quantity to district government.

### 5.2.1.3 Accurate meeting everyone's food needs

Collective purchasing provides Shanghai residents with diverse food supplies, ensuring that everyone can access food according to their needs. To complement collective purchasing, individual online shopping also offers additional choices for specific needs. Specifically, for vulnerable households (elderly, disabled individuals, pregnant women, and infants), the government collaborates with supply guarantee enterprises to establish a special supply system, accurately collecting information on vulnerable populations. The community committees also regularly collected their demands, and then the special group emergency supply delivery channel promptly provided them with assistance.

## 5.2.2 Sustainability of Shanghai's solutions

The emergency governance and actions toward resilient urban food systems need to maintain sustainability to address the growing natural and man-made disasters caused by climate change. In the solutions proposed in Shanghai, we believe that certain actions, such

as collective action, community governance, and innovative food business models, enhance the resilience of the city's food system and are sustainable. These measures are based on the local policy environment, social structure, and lifestyle habits. For instance, the strong policy coherence between the central government and local governments enhances the responsiveness of implementing collective action. While the effectiveness of these measures remains to be verified in other social contexts, collective purchasing behavior has been proven in Rome to contribute to the resilience of metropolitan food systems during lockdowns (Tarra et al., 2021). Additionally, collective purchasing or online shopping for fresh food are based on existing shopping habits of residents, which are likely to continue post-pandemic. These behaviors not only serve as crucial channels for food emergencies but also remain a primary way for residents to access affordable food sources in their daily lives.

While these solutions have established a more equitable and efficient urban food system during the lockdown, many actions appear to focus on short-term crisis management and maintaining the status quo. This hinders the sustainable transformation of urban food systems toward greater resilience. Firstly, government intervention is perceived as conflicting with market forces. Government-led system has limited market participation, resulting in market monopolization by guaranteed supply companies. This has led these companies to suppress other food supply channels to maximize their profits. For example, food assistance from other areas conflicted with the interests of guaranteed supply companies, resulting in delayed distribution and food spoilage. Furthermore, due to the fact that supply guarantee enterprises are simultaneously responsible for government food relief and centralized supply distribution, some of these enterprises, in order to maximize their profits, may provide low-quality food to the government, thus avoiding responsibility for food safety concerns. These issues arise from an unbalanced relationship between government leadership and market regulations. Under the government franchising system, where competition is minimal or severely limited, ensuring quality becomes challenging. In the market environment, competition is always the main driver of continuous improvements in product quality, with consumers, acting as a primary regulator, creating positive feedback for the market. Government regulation can only play a supplementary supervisory role. Therefore, the formulation of pandemic prevention policies and the market should not be in opposition to each other. Pandemic prevention policies and intervention measures should be based on and built upon the market. Delegating the remaining responsibilities to the market once the government establishes its role as a regulator in times of emergency is advisable. For instance, in contrast to governments, retailers possess distribution network visibility, efficient and autonomous transport capabilities, sturdy distribution networks, and coordinated management (Manners-Bell, 2014). Hence, unless there is a comprehensive breakdown in the physical distribution system, the intricate supply chains established over time are poised to demonstrate optimal efficacy in the dissemination of various products (Manners-Bell, 2014).

Secondly, during emergency periods, legal frameworks and food safety systems may be incomplete. Due to the government confirming the list of supply guarantee enterprises based on Article 85 of the Chinese Procurement Law. This has led to several companies not qualified in the food services entering the food supply system. They did not have qualifications in food transportation and preservation. In food logistics, it is important to keep products moving in a safe, tamper-free environment while maintaining their quality (Dani, 2015).

However, they lack the necessary facilities for food quality control, such as temperature-controlled vehicles and specialized food storage containers. Food also must be stored in appropriate areas to prevent cross-contamination (Dani, 2015). Moreover, community committees and volunteers responsible for food distribution are not professionally trained in regulations, and their practices, thereby posing potential food safety hazards. Simultaneously, multiple food distribution procedures in the Shanghai food system might expose the food to environmental temperature changes, resulting in decreased food quality. To address this issue, firstly, it is essential to enhance emergency food safety laws and mechanisms by integrating food chain safety standards. This can ensure the safety qualifications of food suppliers. Secondly, utilizing existing technologies such as blockchain can be beneficial. Blockchain has proven effective in addressing issues of information opacity, lack of trust, and traceability in fresh food supply chains. It ensures the integrity and authenticity of supply chain information, enhancing overall transparency. Furthermore, it facilitates coordination with legislative bodies by providing the necessary documentation and data for importing cold chain products, thereby demonstrating the quality of the final products.

### 5.3 Urban food system resilience building

This study focuses on the challenges encountered by Shanghai and the measures taken to address them during the lockdown period. Firstly, Shanghai's ability to swiftly respond and ensure food supply for all individuals in a short timeframe despite the disruptions caused by the lockdown policy highlights its disaster resilience. The coherence of the system, smooth flow of information channels, and precise dissemination of information ensure that it can quickly connect various aspects within the system to form an emergency network. Furthermore, based on the challenges faced by Shanghai, we have identified two fundamental issues within the urban food system. Additionally, we have reflected on the shortcomings encountered in the solutions. These issues and deficiencies precisely highlight the areas where improvements are needed to enhance the resilience of the urban food system. Cities should strive for self-sufficiency as much as possible by enhancing internal spatial layout and planning, increasing urban agricultural production, and developing the disaster-resistant attributes of urban green spaces and gardens. They should also diversify food sourcing and shorten supply chains and establish emergency food networks rather than single chains. Emergency policies should be tailored to match the characteristics and functions of the food system. This requires greater involvement of experts in decision-making bodies and coordination with policymakers to establish more scientifically informed emergency policies. It can help avoid disruptions in the food chain caused by policy interference, resulting in prolonged transit times for food from the food chain to consumers. Government intervention should be based on market principles; although strong intervention may be effective in the short term, the emergence of monopolistic markets increasingly highlights issues of food quality. Emergency legislation should be further refined. While swift action during emergencies can provide immediate food sources for victims, if it overrides food safety regulations, it can lead to food safety issues and secondary harm to victims, such as the occurrence of foodborne diseases. With the rapid development of

artificial intelligence, big data, and blockchain, the dissemination and transmission of information will become faster and more accurate. Integrating these cutting-edge technologies into the construction of food system resilience will be more conducive to food safety supervision and clear accountability.

However, this study has some limitations. Firstly, it provides a macroscopic overview of the food supply solutions in Shanghai, neglecting the household dimensions of satisfaction and feedback on specific solutions. Future studies should examine residents to gain a deeper understanding of the practical effects of the solutions detailed and their opinions. Secondly, the data and information collected for this study were mainly obtained from the working records of government staff and some secondary information, potentially introducing subjective issues related to memory bias and descriptive accuracy.

## 6 Conclusion

In this study, we systematically present the challenges faced by Shanghai's food system during the lockdown, along with a series of solutions to address these challenges according to a food system framework. Our research initially conducted a Root Cause Analysis to identify four challenges faced by the food system in Shanghai during the lockdown period: lack of stable food supply and price, insufficient transportation capacity, lack of food access channels, and inadequate food security for vulnerable populations. Based on these challenges, we identified two fundamental causes of Shanghai's urban food system as (1) a disconnect between the functioning of the food system and the formulation of emergency policies and (2) reliance on external food supplies and low food self-sufficiency.

To address these challenges, Shanghai implemented a series of solutions, including contactless food delivery by trucks, a franchised food supply system to ensure uninterrupted food distribution, franchise systems coupled with collective purchasing to increase transportation efficiency and stabilize prices, opening up multiple purchasing channels to ensure food security for vulnerable populations, and the last-mile food delivery by community committees and volunteers. These measures were swiftly coordinated by the Shanghai government, linking community as the basic governance unit, and ensured food supply for 25 million people. This can be attributed to (1) systemic coherence and efficiency; (2) smooth information exchange channels; (3) accurate meeting of everyone's food needs. Furthermore, these measures are established within and aligned with the local culture and lifestyle, which contributes to their sustainability. However, these measures have also exposed two problems: (1) government intervention conflicting with the market, and (2) incomplete emergency legal frameworks and food safety systems. By addressing these two problems, we can improve the coordination between the government and the market, as well as the robustness of the food security system, thereby better preparing to effectively respond to various potential future shocks.

Although the implementation of policies and measures varies according to the cultural and political environment of each region, the goal of building resilient disaster food systems remains consistent. We expect that the challenges and solutions identified in Shanghai will

provide valuable lessons for urban food system development in other regions. These lessons are also important for strengthening the long-term resilience of food systems.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

SH: Visualization, Funding acquisition, Resources, Investigation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Methodology, Conceptualization. LJ: Supervision, Writing – review & editing, Resources, Investigation, Formal analysis, Data curation. ZL: Validation, Methodology, Writing – review & editing, Supervision, Resources. KF: Formal analysis, Writing – review & editing, Supervision, Methodology. TI: Project administration, Writing – review & editing, Methodology. XZ: Writing – original draft, Supervision, Funding acquisition, Conceptualization, Writing – review & editing, Methodology.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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