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Online Food Purchase Behavior: COVID-19 and Community Group Effect

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Abstract: Online food community purchases contributed to urban residents' food security during the COVID-19 pandemic in Shanghai. The influence of the outbreak on the purchasing behavior of an online food community was examined. An innovative e-commerce model describes how the online community purchases facilitate integration of local food and agri-product resources, and provide consumers, especially residents of densely populated agglomerations, with convenient short-distance distribution. The survey data collected from 1168 residents show that the lockdown severity and food security concerns increased the frequency of residents' online food purchases. Heterogeneity analysis indicated that the Omicron outbreak effected the online food purchases of those born before the 1990s, males, the less educated, and low-income earners through a community group effect. The internet provides a convenient means of disseminating information, promoting access to local foods, and assuring food access during public health emergencies. Purchasing food online can be further enhanced through standardized management of online communities.

Keywords: online-to-offline sales; Omicron mutation; lockdown; food access; risk perception; community group effect

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1. Introduction

With the outbreak of the COVID-19 epidemic, food security has become a global concern. In 2021, 828 million people were affected by hunger, an increase of 150 million since the outbreak [1]. Trade restrictions, supply chain disruptions, and logistics disturbances following the onset of the COVID-19 pandemic resulted in an unstable food supply [2]. In-country lockdowns and measures attempting to control the COVID-19 virus have also adversely affected food access, shopping habits, and consumption [3,4]. The threats to food security due to the COVID-19 pandemic made assuring the supply of staple foods a top priority for governments [5]. For example, consumers made the transition to online community food purchases because of the pandemic [6].

An innovative online-to-offline (O2O) channel enabled direct online community purchase of fresh food by a particular community [7]. Compared with the traditional e-commerce model that relies on long-distance transportation, the online community purchase is based on a model which provides consumers with convenient distribution services over a short distance by integrating local food and agricultural product sources [8]. To safeguard the food security of vulnerable groups, numerous countries have assistance programs [9,10]. However, public health opportunities and innovations can emerge from digital food retail services to support healthy eating and the needs of vulnerable populations [11]. Ultimately, digital food retail selling will persist. During the Omicron outbreak, a COVID-19 variant, 92.81% of the surveyed respondents bought food, especially vegetables,

through online community purchases between March and May 2022. The group is a key to online community food purchases. A distinguishing characteristic is that consumers must first join an online group. Within the group, members actively interact and share information to decide what to purchase. Online community purchases combine discounted pricing for group members with a personalized shopping experience [12]. The following research questions have important academic and practical significance: Did the COVID-19 pandemic indirectly affect online community purchases? What role did the community group effect play in online community purchases during the COVID-19 pandemic, especially the Omicron outbreak?

Although online community food purchasing has become a realistic choice for urban residents during the pandemic, its mechanism has not been thoroughly examined. Using the Omicron outbreak in Shanghai between March and May 2022, the current study empirically analyzes the influence of the COVID-19 pandemic on urban residents' online community food purchases. This study examines the mechanism of the community group effect using survey data collected from 1168 residents. This paper makes several contributions to the existing literature. First, this paper extends empirical research by examining the emergence of an O2O business model effectively applied in situations of abnormal conditions such as a public epidemiological emergency. Knowledge from the current study complements earlier insights (for example, Gordon Wilson [3]) regarding the benefit to food distributors and, in particular, local food suppliers who may have lost market access due to the disruption of logistics. The gained insights will help in planning for future outbreaks. Second, this study defines the "community group effect" that lacked a clear explanation in the literature but is an essential attribute of online community purchases. This study also illustrates the change in consumer shopping behavior under conditions that limit mobility. Third, this study applies the community group effect as a mechanism variable using a conceptual framework for research on online community purchases. Online food sales have been growing and the pandemic appears to have accelerated their growth, possibly permanently shifting some food purchases. Fourth, this study explores the influence of lockdown severity, food availability, and resident risk perception on online community purchases through the community group effect during the outbreak of the Omicron variant, a mutation of the COVID-19 virus.

The results are of practical significance to assure the food security of community residents during outbreaks in the future. Online community purchases had become a topic of online e-commerce research prior to the COVID-19 pandemic. Research addressed purchase intention, convenience, satisfaction, trust, and other factors of online community purchases [13,14]. Liang et al. [15] showed that, during the COVID-19 pandemic, the online food purchases of urban residents became an important distribution format. Global retail e-commerce sales reached USD5.2 trillion in 2021, and are forecast to grow by 56%, reaching USD8.1 trillion by 2026 [16]. About 260 million consumers in the United States alone generated USD8.62 billion in sales in 2021 [17], while the transaction value of China's online community purchases was expected to reach CNY120.51 billion with 646 million users in 2021 [18], proving the online community purchase phenomenon is increasing in popularity.

2. Literature Review and Research Hypotheses

2.1. The Definition of Community Group Effect and Online Community Purchase

The online community purchase follows a novel online e-commerce model that focuses on integrating local and foreign food supply to facilitate access to staples during emergencies such as the COVID-19 pandemic. The approach combines the characteristics of community and online purchases. The interactivity, proximity, and familiarity of online community purchases can indirectly affect consumer purchase intention and behavior [14]. In 2010, the Meituan Company started an online community purchase business. Soon thereafter, WeChat and Pinduoduo followed [8].

The community group effect was originally applied to describe bacterial colony behavior. Extended to the social sciences, the community group effect restricts, affects, and changes the behavior of group members [19]. When studying the relationship between individual and group behavior, Charness et al. [20] found that individual behavior is affected by behavior of others in the group, causing a reaction. Sutter [21] found that the group effect can significantly affect its members' individual behavior. Ratner et al. [22] indicated that when one member's consumption behavior changes, other members are also affected. Once individuals are affected by internal pressure, they tend to make the same decisions as others to reduce the risk of information asymmetry. Consumers believe that others have more information and they make the same purchase decision [23].

The group is a distinctive feature of online community purchases compared with other types of online e-commerce. A widely recognized definition of the term "group" has not yet been agreed upon because of the varying nature of group composition. From the social relations perspective, a group is guided by social norms, its composition is relatively stable, members abide by consistent codes of conduct and values, and they decide about collective action [24]. From the perspective of network relationships, the concept of group integrates the characteristics of socialization. From the perspective of social relations, there are obvious social characteristics in the definition of group. From the perspective of social networking, Siemens [25] determined that online social behavior is interaction and sharing within a group, and, in an online group, members develop a sense of community. It is difficult to distinguish between a group and an online group, and the two terms are used interchangeably [26].

This paper defines a "group" as an entity where information is exchanged and transmitted through online social networking, and the organization forms a stable network. Furthermore, the "community group effect" in this paper refers to the active searching for and exchanging of information to influence other group members and induce purchase decisions. In an online community purchase, the group effect occurs before the purchase decision. An individual joins the group to overcome information asymmetry, in hopes of obtaining information shared by others to facilitate subsequent purchase decisions. Ultimately, group membership facilitates access to a variety of foods and the search for the best deals [27]. A cell phone connected to the internet is the typical tool used by the group members.

2.2. The COVID-19 Pandemic and Online Community Purchase

Since the outbreak of COVID-19, many scholars have attempted to measure its impact. Existing studies have used lockdown severity [28] and the number of confirmed cases [29] to measure pandemic effects. In terms of food security and consumption, the impact of the COVID-19 pandemic has been associated with food shortages and risk perception. For example, Mardones et al. [30] found that the pandemic had a major impact on the global food security system while affecting public health. Hakim et al. [31] found that consumer risk perception gradually eased with increasing information about the epidemic.

Governments at all levels have taken a series of prevention and control measures to attempt to prevent the spread of COVID-19 [32]. Liu et al. [28] distinguished between mild and severe COVID-19 effects and found that residents in different regions were affected differently. At the regional level, Wen et al. [33] differentiated the impact of the epidemic in high-, medium-high-, medium-, and low-risk areas and found that regions differed in their adoption of epidemic prevention and control measures. In severely affected areas, travel was limited and online purchases became an important source of food.

The current study considered the influence of food shortages during the pandemic on urban resident online food purchases. As food shortages have become a major concern for residents, online community purchases have become popular [34]. Food supply disruptions caused by the pandemic could induce food panic and food hoarding. Online community purchases effectively alleviated hoarding behavior [35,36]. Chenarides et al. [37] reached a similar conclusion. The current study also considered the impact of resident risk perception

on online community food purchases. Risk perception during the COVID-19 pandemic affected consumer consumption behavior, and perceived risk was a key factor in decision making [38]. The spread of COVID-19 caused consumer concerns about safety, contributing to the popularity of online community purchases [39]. Online community food purchases provide convenient and safe shopping during lockdowns, eliminating visits to stores and the risk of infection by other store customers [35]. However, opinions about the influence of risk perception on online food purchase vary. For example, in their studies prior to the COVID-19 pandemic, Dash et al. and Kuhlmeier et al. [40,41] found that risk perception was negatively correlated with consumer purchase intentions, but in a recent study, Omar et al. [42] arrived at the opposite conclusion. Therefore, this study proposes the following research hypothesis:

H1. *Lockdown severity, food shortage threats, and risk perception during COVID-19 significantly affect online community food purchases.*

2.3. The Omicron Outbreak and Community Group Effect

The COVID-19 pandemic restricted the consumer's ability to obtain information about food, but the emergence of the online group has reversed that effect, enabling access to information. Obtaining information to purchase food motivated group participation. The interactivity within the group distinguishes the online community purchase from the traditional online shopping mode. The mutual trust within the group helps to fulfill member consumption needs [43]. Chan et al. [44] applied the theory of resource exchange to study how interactivity affects reciprocity and thus consumer purchase intentions. In addition to the actual expenditure and opportunity costs, residents tend to ignore the cost of collecting information. The provision and exchange of information within the group greatly reduces its cost and informs purchase decisions.

During the COVID-19 pandemic, online groups have become the chief participants in the production, transmission, and dissemination of information by virtue of information technology. The early-emerging groups accounted for insignificant sales values, but as information technology matured and transactions were not constrained by traditional geographical boundaries, the groups produced greater sales values [45]. Continuous information production and transmission within the group attract additional urban residents to join because of the convenience and easy access to information [26]. This study proposes the following research hypothesis:

H2. *The Omicron outbreak significantly affected the community group effect on participation in online group food purchases.*

2.4. The Omicron Outbreak, Community Group Effects, and Online Community Food Purchases

Compared with the traditional e-commerce model, the online community purchase has both retail food purchase and social attributes [46]. Such attributes did not originally describe online purchase behavior. In response to the COVID-19 pandemic and the induced food shortages and increased risk perception, urban residents organized groups, collected information, and collectively undertook online food purchases.

The community group effect is an important motivation for consumers to make online community food purchases [47]. Loxton et al. [48] found that the severity of the pandemic curbed not only traditional social behavior, but also consumer purchase behavior. The willingness to consume is affected by others' purchasing decisions [21]. Therefore, it can be inferred that the more residents in a group, the more willing they will be to make online community food purchases.

During the COVID-19 pandemic lockdowns, the community group effect could only be expressed in online purchases. Ben et al. [49] found that because of policy measures, such as maintaining a certain social distance, consumers choose online community food purchases using cell phones. After exchanging information within the group, group members can assure their food security through an online community food purchase.

Therefore, we believe that the argument flow is "COVID-19 mutation → community group effect → online community food purchase", and we propose the following:

H3. *The Omicron outbreak indirectly affected group member online community food purchases through the community group effect.*

Figure 1 illustrates the conceptual framework. The three hypotheses link the COVID-19 pandemic represented by the Omicron mutation and the three induced phenomena with the functioning of the groups in the community and online food purchases.

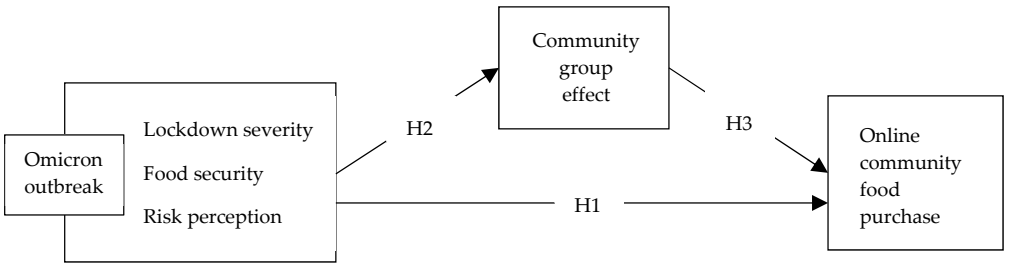

Figure 1. The conceptual framework for exploring urban residents' online community food purchases.

3. Survey, Data, Variables, and Model

3.1. Survey and Data Collection

The data were collected using an online survey and the posted questionnaire. This study used data from an online community purchase survey conducted in 16 districts of Shanghai between March and May 2022. During this period, Shanghai was under lockdown measures. Survey links were posted through the author's survey company account to attract the widest possible group of respondents. As an incentive, respondents were able to enter a cash draw once. Furthermore, participation was voluntary and participants were informed about the purpose of the study. Informed consent was obtained from all participants. The survey applied the stratified sampling method and the sampling was conducted in proportion to the population in each district.

To ensure the quality of gathered data, the questionnaire design involved three stages: preliminary design, pilot and modification, and final questionnaire release. In the questionnaire design stage, the authors learned about online community food purchases during the lockdown and selected the appropriate topics for individual questions. The survey questions explored the effect of the Omicron outbreak on changes in respondent online community food purchases. Furthermore, demographic variables such as gender, age, and current employment status were queried. The final part of the survey contained an open-ended question to offer participants the opportunity to add any comments or thoughts they had about food security during COVID-19.

The preliminary questionnaire was tested and modified before being distributed to community residents. The questionnaire was pre-tested on 120 test subjects beforehand to ensure comprehensibility. A total of 1476 questionnaires were distributed. The final selection involved screening for short completion times or contradictory responses and 308 questionnaires were eliminated. The final sample consisted of a total of 1168 observations, a return rate of 79.1%.

3.2. Characteristics of Online Community Food Purchases

Figure 2 shows the online community food purchase sources used by the Shanghai residents during the Omicron pandemic from March to May 2022. The sources included neighborhood committees, community leaders, local businesses, local governments, and cooperatives. The most frequent purchases were from the neighborhood committee, 69.60%, followed by purchases from community leaders, 57.53%. The community group leaders were organizers distributing information to consumers and organizing joint food purchases.

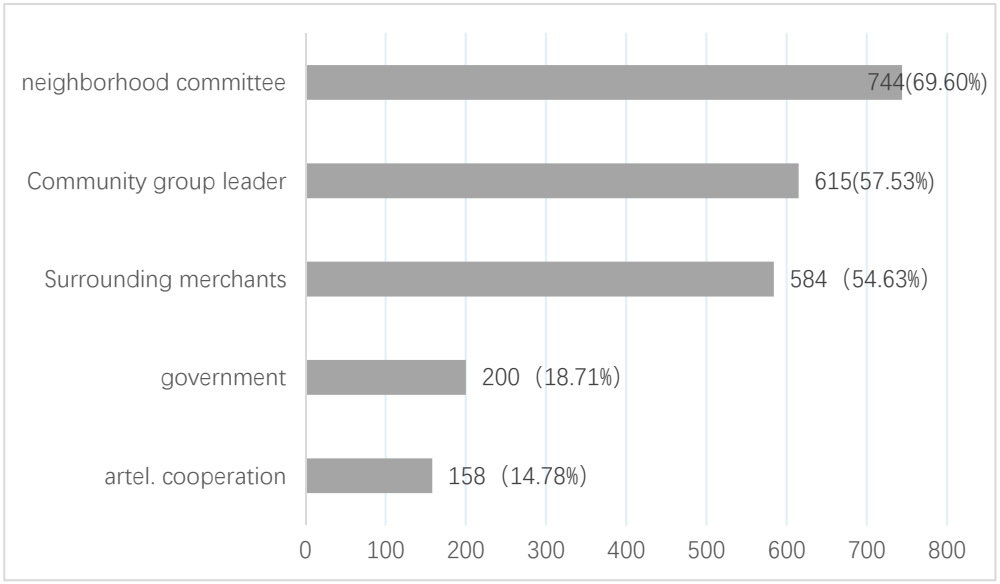

Figure 2. Shanghai resident choices in making online community food purchases during the Omicron outbreak, March–May 2022.

Figure 3 shows the main food categories of online community purchases. Vegetables dominated the purchases, followed by eggs and milk. Fruits and meats were also purchased by more than half of respondents, while rice, flour, and oil were purchased less often. Aquatic products and seafood were purchased least often.

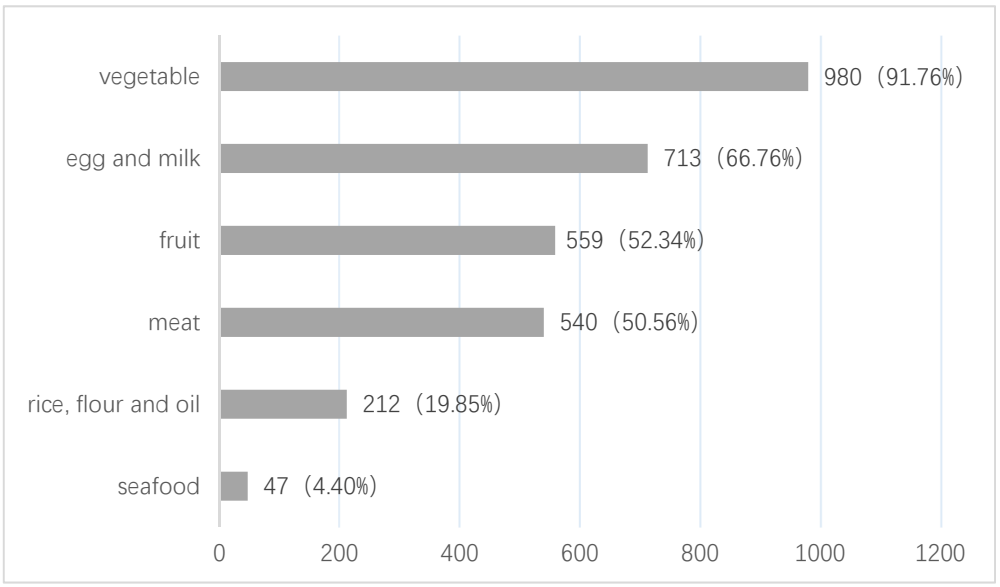

Figure 3. Online community purchases by food categories in Shanghai during the Omicron outbreak, March–May 2022.

3.3. Variable Selection

3.3.1. Dependent Variable

Following Janssen et al. [50], the "online community food purchase frequency" is the dependent variable in the current study. The frequency refers to the number of purchases made through the online community. The dependent variable was based on the question, "How many times have you or your family bought food in the WeChat online community last month?" Residents chose among five options: "0 times", "1–3 times", "4–6 times",

"7–9 times", and "more than 10 times". Table 1 shows the distribution of responses across frequency categories.

Table 1. Online community food purchase frequency distribution across five categories.

Frequency	0 Times	1–3 Times	4–6 Times	7–9 Times	More than 10 Times	Total
Number	84	309	396	177	202	1168
Percent	7.19	26.46	33.9	15.15	17.29	100

3.3.2. The Omicron Effect as the Explanatory Variable

The core variables reflected the Omicron presence. The effect of Omicron was measured by three variables: lockdown severity, food shortage, and risk perception.

Lockdown severity. The lockdown severity was based on the question "What kind of area does your community belong to?" Respondents could choose among five options: "lockdown area", "control area", "prevention area", "unpublished", and "unclear". Because the options of "unpublished" and "unclear" reflected insignificant Omicron occurrence, those two options were combined. The most severe effect, "lockdown area", accounted for about 50% of responses.

Food security and risk perception. Following Janssen et al. and Hesham et al. [50,51], the current study employed food security and risk perception as variables measuring the Omicron effect. The question "What is the impact of the current epidemic on your food security?" served as the basis for the explanatory variable specification. The response options included "no impact at all", "some impact", "neutral", "large impact", and "very large impact". The share of respondents indicating a large effect of Omicron on food security accounted for 87.5% of all responses.

The question regarding risk perception was "Are you worried about the Omicron presence in the dishes or packages the online community purchased through WeChat?" The response options included "very worried", "somewhat worried", "neutral", "not too worried", and "not at all worried". In terms of the risk perception, the share of those "very worried" accounted for 70.2% of responses.

3.3.3. Mechanism Variable

Community group effect. The community group effect refers to group members actively searching and exchanging purchase information within the group, thereby influencing others and this leading to purchases. The community group effect was quantified by the number of times community residents joined the group, and the corresponding question was "In the last month, how many times have you or your family joined online community WeChat groups through your cell phone?" Residents chose from five options: "0", "1–3", "4–6", "7–9" and "more than 10 times". The community group effect was the mechanism variable accounting for the indirect effect of Omicron outbreaks on urban residents' online community food purchases.

3.3.4. Control Variable

To accurately reflect the Omicron outbreak effect on online community food purchases and avoid the problem of missing variables, this study follows [6]. Several control variables have been selected, including the socio-demographic attributes of gender, age, education, family size, marital status, and the presence of children and/or the elderly in the family. Also, family income was added to the control variable set.

3.4. Descriptive Statistics

Table 2 shows the descriptive statistics of the sample. Among the demographic features, respondents in the 19–40 years old age range accounted for 81%. The proportion of females was somewhat higher than males, 57.8%. About 60% of respondents were married and the average household included 3.18 persons. In terms of the educational

attainment level, the majority carried at least an undergraduate degree (76.6%). The majority of respondents reported that their household included 3 individuals (46.06%). Families with elderly and children accounted for 21.83% and 42.04%, respectively. The average per capita monthly income fell in the range of CNY8001–12,000 (28.42%). A detailed overview of the online food purchase behavior can be obtained from Table 2.

Table 2. Variable definitions and selected descriptive statistics.

Variable	Sample Size	Variable Definition and Assignment	Mean	Standard Deviation	Min	Max
Dependent variable						
Purchase frequency	1168	Number of food purchases one month after Omicron outbreak: 0 = 0 times, 1 = 1–3 times, 2 = 4–6 times, 3 = 7–9 times, 4 = more than 10 times	2.089	1.178	0	4
Change in purchase frequency (robustness check)	1084	Change in frequency of online community food purchases compared with before the epidemic: 1 = basically unchanged or decreased, 2 = slightly increased, 3 = significantly increased	2.738	0.522	1	3
Omicron effect						
Lockdown level	1109	Lockdown level: 1 = prevention area/no lockdown, 2 = control area/can move within the community, 3 = lockdown/shelter in place	2.271	0.842	1	3
Food security	1168	Effect on family food security: 1 = no effect at all, 2 = some effect, 3 = general, 4 = large effect, 5 = very large effect	4.447	0.843	1	5
Risk perception	1084	Concern that food purchased online contains the Omicron virus: 1 = not worried at all, 2 = basically not worried, 3 = generally, 4 = relatively worried, 5 = very worried	3.81	0.902	1	5
Mechanism variable						
Community group effect	1168	Number of people joining the group to buy through WeChat within one month after the Omicron outbreak: 0 = 0, 1 = 1–3, 2 = 4–6, 3 = 7–9, 4 = more than 10	1.852	1.054	0	4
Control variable						
Gender	1168	1 = Male, 2 = female	1.578	0.494	1	2
Age	1168	1 =< 18, 2 = 19–22, 3 = 23–30, 4 = 31–40, 5 = 41–50, 6 = 51–60, 7 = >61	3.481	1.119	1	7
Education level	1168	1 = High school and below, 2 = junior college, 3 = undergraduate, 4 = master, 5 = doctor	2.832	0.845	1	5
Family income	1168	Per capita monthly after-tax income: 1 = Below CNY2000, 2 = 2001–4000, 3 = 4001–6000, 4 = 6001–8000, 5 = 8001–12,000, 6 = 12,001–20,000, 7 = above 20,001	4.721	1.467	1	7
Family population	1168	Number of household members: 1 = 1, 2 = 2, 3 = 3, 4 = 4, 5 = 5 or more	3.183	1.03	1	5
Marital status	1168	1 = Married, 0 = not married	0.604	0.489	0	1
Children	1168	Children under 12 years of age: 1 = yes, 0 = no	0.42	0.494	0	1
Elderly	1168	Elderly, 60 years old or older: 1 = yes, 0 = no	0.218	0.413	0	1

3.5. Model

3.5.1. Purchase Frequency Model

The dependent variable is an ordered discrete variable making the ordered logit regression suitable for analysis. The vector expression of the model is

$$Y_i = \alpha_1 + \beta_1 OMICRON_i + \lambda_1 Z_i + \varepsilon_i (i = 1, 2, \ldots, n) \quad (1)$$

where Y_i is the online community food purchase frequency; $OMICRON_i$ is the key event, which was measured by three variables. Level_i stands for the lockdown severity; Security_i indicates food security issue, and Risk_i stands for risk perception; Z_i is the control variable, ε_i is the random error term, and α, β, γ, and λ are parameters to be estimated.

3.5.2. Mediation Effect Model

To explore the mechanism of the indirect effect of Omicron outbreaks on online community food purchases through the community group effect, Equation (2) has been specified. To test the mediating effect of the community group effect, the intermediary effect test follows [52]:

$$Group_i = \alpha_2 + \beta_2 OMICRON_i + \lambda_2 Z_i + \varepsilon_i, (i = 1, 2, \ldots, n) \quad (2)$$

$$Y_i = \alpha_3 + \beta_3 OMICRON_i + \gamma_1 \text{Group}_i + \lambda_3 Z_i + \varepsilon_i, (i = 1, 2, \ldots, n) \quad (3)$$

$Group_i$ stands for the mediated variable community group effect, with the other variables defined as in Equation (1).

4. Results

4.1. Purchase Frequency

The ordered logit model was estimated using Stata15.0. Table 3 shows the estimation results for three levels of purchase frequency as compared to the omitted purchase frequency category. The results are for three equations that differ in terms of the explanatory variable indicating the lockdown severity, threat to family food security, and the perception of risk of Omicron infection from purchases.

Table 3. Direct impact of the Omicron outbreak on online community food purchases.

Variable	Purchase Frequency		
	(1)	(2)	(3)
Lockdown	0.142 **	-	-
	(2.16)		
Food security	-	0.190 ***	-
		(2.91)	
Risk perception	-	-	−0.0619
			(−0.99)
Gender	0.299 ***	0.292 ***	0.135
	(2.65)	(2.67)	(1.18)
Age	0.0457	0.0540	0.0667
	(0.80)	(0.98)	(1.13)
Education	0.292 ***	0.290 ***	0.142 **
	(4.12)	(4.24)	(1.96)
Family income	0.180 ***	0.178 ***	0.137 ***
	(4.33)	(4.42)	(3.22)
Family size	0.120 *	0.127 **	0.125 **
	(1.94)	(2.12)	(1.97)
Marital status	−0.0221	0.00424	−0.104
	(−0.16)	(0.03)	(−0.75)
Children	0.318 **	0.317 **	0.245 *
	(2.51)	(2.57)	(1.92)
Elderly	0.00517	−0.0408	−0.0259
	(0.04)	(−0.29)	(−0.18)
N	1109	1168	1084
Pseudo R2	0.026	0.029	0.013

Note: Intercepts are statistically significant. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The results indicated that the lockdown had a significant positive effect on the frequency of online community food purchases (Table 3). As the lockdown severity increased, group members were more likely to purchase food online.

The results indicated a significant positive effect of the threat to household food security on the frequency of online food purchases. The results suggested that residents realized that the Omicron outbreak could cause food shortages and thus increased the frequency of their group online food purchases to safeguard their own food security.

Estimation results of Equation (3) showed that the respondents' risk perceptions lacked significant effect on the frequency of online food purchases. In contrast, Equations (1) and (2) showed the positive and significant Omicron outbreak effect on online group food purchases. Results confirmed H1 that the Omicron outbreak significantly affected the online group food purchases of urban residents.

4.2. Mechanism Analysis

4.2.1. Effects of Omicron Outbreak on the Community Group Effect

Table 4 shows the results of three equations focused on the lockdown severity, food security, and risk perception. Each key factor had a significant positive impact on the community group effect. The results tested H2 that the Omicron outbreak significantly influenced the community group effect and indicated that it increased the threat to household food security and the respondents' risk perception. The outbreak of the mutated virus made it difficult for residents to obtain information about food availability, and more information could be obtained by joining the community group.

Table 4. The effect of Omicron outbreak on the community group effect.

Variable	Community Group Effect		
	Equation (1)	Equation (2)	Equation (3)
Lockdown severity	0.229 ***	-	-
	(3.36)		
Food security	-	0.370 ***	-
		(5.41)	
Risk perception	-	-	0.157 **
			(2.45)
Control variable	YES	YES	YES
N	1109	1168	1084
Pseudo R2	0.038	0.046	0.023

Note: Intercepts are statistically significant. ** $p < 0.05$, *** $p < 0.01$.

4.2.2. The Effect of Omicron Outbreak on Online Community Food Purchases through the Community Group Effect

To analyze the impact mechanism, this study used the mediation effect model proposed by Rucker et al. [52]. The method has been applied to studies using a continuous dependent variable. The dependent variables in the current study were discrete and ordered. To avoid estimation bias, the method proposed by Karlson, Holm, and Breen [53] (KHB) was used.

The current study applied the community group effect as a mechanism variable to test whether the Omicron outbreak promoted online food purchases. The total effect was significant and positive in the lockdown level and food shortage equations (Table 5). The indirect effect of the community group effect had a similar influence. The indirect effect of the community group accounted for 79.52% and 98.77% of the total effect of the lockdown severity and food security on online community food purchases, respectively. In the case of risk perception, column (3), the direct effect was significant and negative, while the indirect effect was positive. H3 was confirmed. The Omicron outbreak indirectly affected online food purchases through the community group effect.

Table 5. Effects of Omicron outbreak and the community group effect on online food purchases.

Variable	Dependent Variable: Purchase Frequency		
	Lockdown Level (1)	Food Shortage (2)	Risk Perception (3)
Total effect	0.166 **	0.244 ***	−0.0744
	(2.44)	(3.66)	(−1.16)
Direct effect	0.0335	0.00292	−0.161 **
	(0.49)	(0.04)	(−2.49)
Indirect effect	0.132 ***	0.241 ***	0.0862 **
	(2.86)	(5.12)	(2.37)
Control variable	YES	YES	YES
N	1109	1168	1084

Note: Intercepts are statistically significant. ** $p < 0.05$, *** $p < 0.01$.

4.3. Robustness Analysis

To assure robustness of the results, the test for endogeneity was performed. As a result of the test, the empirical relationships were re-specified to ensure the reliability of results.

4.3.1. Endogeneity Test

Among the three key variables of interest in this study, the lockdown severity was exogenous. The variables of food security and risk perception were endogenous because they reflected the subjective responses of residents. Therefore, the lockdown severity was considered as an instrumental variable to deal with the endogeneity of the remaining two variables [54].

Table 6 shows the 2SLS regression results. The first stage 2SLS results (column (1) and column (3); Table 6) show that the lockdown severity positively influenced both food security and risk perception. Further tests of weak instrumental variables indicated that they met the correlation conditions. The Hausman test results indicated that food security and risk perception were endogenous variables, and the lockdown severity was exogenous.

Table 6. Results of the test for endogeneity.

Variable	Phase I (1) Food Security	Phase II (2) Purchase Frequency	Phase I (3) Risk Perception	Phase II (4) Purchase Frequency
Lockdown severity	0.093 ***		0.134 ***	
	(3.18)		(3093)	
Food security		0.931 *		
		(1.850)		
Risk perception				0.005
				(0.02)
Control variable	YES	YES	YES	YES
Wald Chi2(9)	64.67		32.92	
N	1109		1041	

Note: Intercepts are statistically significant. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The results in column (2) and column (4) (Table 6) indicated that food security positively influenced the frequency of online food purchases. This result is consistent with the previous estimation indicating that the empirical results are robust.

4.3.2. Testing for Result Consistency

To verify the results, the ordered logit model was replaced with the ordered probit model. The empirical results of the replacement model (Table 7) were consistent with those of the original model. The Omicron outbreak indirectly encouraged online food purchases

through the community group effect. The regression coefficient magnitude negligibly differed between the ordered logit and the ordered probit models.

Table 7. Robustness test: the revised model.

Variable	Community Group Effect (1)	Purchase Frequency (2)	Community Group Effect (3)	Purchase Frequency (4)	Community Group Effect (5)	Purchase Frequency (6)
Lockdown severity	0.134 *** (3.45)	0.0356 (0.91)				
Food security			0.206 *** (5.41)	0.0104 (0.27)		
Risk perception					0.0859 ** (2.28)	−0.101 *** (−2.65)
Community group effect		0.718 *** (19.35)		0.724 *** (20.11)		0.638 *** (16.80)
Control variable	YES	YES	YES	YES	YES	YES
N	1109	1109	1168	1168	1084	1084
Pseudo R2	0.039	0.150	0.047	0.154	0.021	0.115

Note: Intercepts are statistically significant. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.3.3. Dependent Variable Reconsidered

To further test the robustness of the results, the dependent variables were reconsidered and "change in purchase frequency compared with that before the epidemic" was replaced with "purchase frequency". The corresponding question was, "How often did you buy vegetables in the WeChat online community in the last month compared to before the epidemic?" The respondents chose among five options: "substantial increase", "small increase", "basically the same", "small decrease", and "substantial decrease". The choices of "basically the same", "slightly decreased", or "significantly decreased" accounted for only 3.97% of the total sample. The three were combined, and the variable was re-coded as "large increase" = 1, "small increase" = 2, and "basically the same" = 3 (Table 2). The estimation results are shown in Table 8. The results indicated that the Omicron outbreak indirectly increased online community food purchases through the community group effect.

Table 8. Robustness test following the revised dependent variable.

Variable	Community Group Effect (1)	Change in Purchase Frequency (2)	Community Group Effect (3)	Change in Purchase Frequency (4)	Community Group Effect (5)	Change in Purchase Frequency (6)
Lockdown severity	0.229 *** (3.36)	0.429 *** (4.70)	-	-	-	-
Food security	-	-	0.370 *** (5.41)	0.521 *** (6.13)	-	-
Risk perception	-	-	-	-	0.157 ** (2.45)	0.279 *** (3.42)
Community group effect	-	0.663 *** (6.61)	-	0.614 *** (6.28)	-	0.644 *** (6.66)
Control variable	YES	YES	YES	YES	YES	YES
N	1109	1041	1168	1084	1084	1084
Pseudo R2	0.038	0.069	0.046	0.077	0.023	0.059

Note: Intercepts are statistically significant. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.4. Heterogeneity Analysis

The Omicron outbreak indirectly increased the frequency of online community food purchases through the community group effect. The heterogeneity of the Omicron influence on online community food purchases through the community effect was not considered. To provide further insights, the current study conducted heterogeneity analysis and divided gender, age, education level, and family income into groups. This study used the three variables of lockdown severity, food security, and risk perception for heterogeneity analysis. Although the numerical results of the different variables slightly differed, they showed heterogeneity. (Because of the limited space, the details are not reported but interested

readers can receive them upon request.) The ordered logit model was used and the results are shown in Tables 9–12.

Table 9. Heterogeneity analysis: gender.

Variable	Male		Female	
	Community Group Effect (1)	Purchase Frequency (2)	Community Group Effect (3)	Purchase Frequency (4)
Lockdown level	0.216 **	0.00205	0.235 ***	0.0693
	(2.08)	(0.02)	(2.59)	(0.76)
Community group effect	-	1.456 ***	-	1.170 ***
		(13.15)		(13.10)
Control variable	YES	YES	YES	YES
N	468	468	641	641
Pseudo R2	0.044	0.180	0.028	0.127

Note: Intercepts are statistically significant. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 10. Heterogeneity analysis: age.

Variable	Post-1990s Generation		Pre-1990s Generation	
	Community Group Effect (1)	Purchase Frequency (2)	Community Group Effect (3)	Purchase Frequency (4)
Lockdown severity	0.306 ***	0.0303	0.158 *	0.0364
	(3.10)	(0.31)	(1.66)	(0.37)
Community group effect	-	1.213 ***	-	1.379 ***
		(12.47)		(13.85)
Control variable	YES	YES	YES	YES
N	577	577	532	532
Pseudo R2	0.044	0.133	0.026	0.170

Note: Intercepts are statistically significant. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 11. Heterogeneity analysis: education level.

Variable	Low Education		High Education	
	Community Group Effect (1)	Purchase Frequency (2)	Community Group Effect (3)	Purchase Frequency (4)
Lockdown severity	0.237 *	0.0473	0.242 ***	0.0140
	(1.69)	(0.33)	(3.09)	(0.18)
Community group effect	-	1.939 ***	-	1.144 ***
		(11.11)		(15.02)
Control variable	YES	YES	YES	YES
N	259	259	850	850
Pseudo R2	0.051	0.243	0.026	0.120

Note: Intercepts are statistically significant. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 12. Heterogeneity analysis: income.

Variable	Low-Income		High-Income	
	Community Group Effect (1)	Purchase Frequency (2)	Community Group Effect (3)	Purchase Frequency (4)
Lockdown severity	0.0664	0.0338	0.269 ***	0.0357
	(0.43)	(0.22)	(3.54)	(0.47)
Community group effect	-	1.401 ***	-	1.270 ***
		(8.55)		(16.55)
Control variable	YES	YES	YES	YES
N	219	219	890	890
Pseudo R2	0.049	0.164	0.032	0.142

Note: Intercepts are statistically significant. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.4.1. Gender

The sample was split into two subsamples according to gender. Table 9 shows that the Omicron outbreak had a greater impact on men's online community food purchases through the community group effect than it did on women's. A possible explanation is that, in Shanghai, women are also relatively independent within their families, and they

join more community groups. Compared with men, women had a strong risk perception regarding the possibility of infection while shopping and a smaller proportion reported purchases than men. The gender difference reflected the difference between gender levels of risk awareness, and that males were less risk averse.

4.4.2. Age

The sample data indicated that the proportion of residents 30 years old and younger was 52.24%. The sample age distribution resembled the average distribution in Shanghai. Therefore, residents were divided into the post-1990s generation and the pre-1990s generation. Table 10 shows the results suggesting that the Omicron outbreak had a greater impact on the pre-1990s generation's online community food purchases through the community group effect when compared with the post-1990s generation. A possible reason was that the majority of pre-1990s households included children and the elderly. Such households strive to assure that their members have adequate food to maintain their health and they joined more community groups to participate in online community food purchases. The influence of difference in age reflected differences in the protection of family health. Therefore, the coefficient associated with the online community food purchases of pre-1990s residents had a relatively larger magnitude.

4.4.3. Education Level

The education of respondents allowed splitting them into two categories: less than a bachelor's degree, and bachelor's degree or higher. The results are shown in Table 11. The results indicated that the Omicron outbreak had a greater impact on the online community food purchases of less-educated residents through the community group effect than on highly educated residents. Residents with a low educational attainment participated more frequently in the online community food purchases.

4.4.4. Income

The per capita monthly disposable income of Shanghai residents was about CNY6500 in 2021 [55]. The respondents were divided into the high-income and low-income categories based on whether they reported income of CNY6000 or more, or less than CNY6000, respectively. Table 12 shows the results indicating that, compared with its effect on high-income residents, the Omicron outbreak had a greater impact on low-income residents' online community food purchases through the community group effect. High-income residents were less affected by price increases. Low-income residents more vigorously pursued joining a community group, hoping to purchase plentiful food at a lower price. As noted earlier, information seeking played an important role in the decision to participate in online community food purchases.

5. Discussion

The survey data collected from 1168 residents showed that the COVID-19 pandemic increased and accelerated residents' participation in online food community shopping, as consumers had to adapt to new policies to respond to food security problems. The research findings revealed that the heightened severity of lockdowns and concerns about food security amplified the frequency of residents' online food purchases. Standardized management of online communities could further boost these purchases. The mechanism analysis showed that the Omicron outbreak influenced online food purchases through a community group effect.

The results indicated that the lockdowns and the threats to household food security had a significant positive effect on the frequency of online community food purchases. Estimation results of equation showed that a respondent's risk perception lacked significant effect on the frequency of online food purchases. In contrast, lockdowns and food shortages showed both positive and significant Omicron outbreak effects on online group food purchases. The results confirmed that the Omicron outbreak significantly

affected the online group food purchases of urban residents. Earlier, Qi et al. [56] and Marinkovićv et al. [57] arrived at similar conclusions. This was due to the fact that, by increasing the frequency of purchases, residents could obtain sufficient food to cope with the impact of COVID-19. However, risk perception failed to produce a significant effect of the Omicron outbreaks on online community food purchases. A possible reason for this outcome was the scope of the lockdowns, which covered the whole of Shanghai, limiting differences in resident risk perception.

This study indicated that the lockdowns, the threats to household food security, and the respondents' risk perception all had significant positive impacts on community effects. The results showed that the Omicron outbreak significantly influenced the community group effect and indicated that it increased the threats to household food security and the respondents' risk perception. These results are consistent with the findings of Liang et al., who found that most households purchased food with assistance from community-based grassroots organizations during the lockdown [58]. This is due to the fact that the outbreak of the mutated virus made it difficult for residents to obtain information about food availability, and more information could be obtained by joining community groups.

The results of the mediation effect model showed that the total effect was significant and positive in the lockdown level and food shortage equations. The indirect effect of the community group effect had a similar influence. In the case of risk perception, the direct effect was significant and negative, while the indirect effect was positive. The current study shows what Rucker et al. [52] called the "suppression effect", indicating that risk perception directly inhibited online community food purchases. However, the indirect effect of lockdowns and food security through the community group effect was greater than the indirect effect of risk perception. It is plausible that residents believed that online community food purchases increased their own safety, so they limited their purchase frequency. However, Shanghai was subject to a lockdown, and finding necessities was the most pressing need. Compared to food security, respondent risk perception was relatively weak. Risk perception seemed to increase the frequency of online food purchases through the community group effect. Overall, the Omicron outbreak encouraged residents to actively participate in information collection and exchange within the community group and to take collective action to ensure their own food security. Previous scholars have found that COVID-19 accelerated online food purchasing [39,59]. This research shows that the Omicron outbreak indirectly affected online food purchases through the community group effect. Therefore, the community group effect is recognized, and the research conclusions broaden the previous related studies.

There are a few limitations to this study. Firstly, the survey included only relevant samples of residents during the epidemic period, with a relatively simple data collection scope. Therefore, the findings are mainly applicable to the situation during the epidemic period. These findings will serve as basic information for comparing data from different regions after the end of the epidemic and will provide a reference for future studies. Secondly, regardless of the COVID closures, it is crucial to discuss the significance of online community purchasing in ensuring food security for vulnerable groups. The research mentioned offers some insights for possible research into vulnerable people's difficulties, but further empirical testing is required.

6. Conclusions and Policy Implications

6.1. Conclusions

The results allow drawing the following conclusions. First, the benchmark regression indicated that the lockdown severity and food security significantly encouraged urban residents' online community food purchases. Risk perception of becoming infected by shopping did not significantly affect the purchases. Second, the results determined that the direct effect of lockdown severity and food security indirectly encouraged urban residents' online community food purchases through the community group effect. Although risk

perception repressed the direct effect of online community purchases, the indirect effect was far greater. Following the model revision and the reformulation of the dependent variable, the results were still robust. Third, heterogeneity analysis found that the Omicron outbreak had particularly strong effects on online community food purchases by men, the pre-1990s generation, the less educated, and low-income urban residents through the community group effect.

6.2. Policy Implications

This study offers the following policy suggestions. The improvement of the online community food purchase supply system can be achieved through the standardized management of online communities, enhancing their efficiency. Government agencies should actively promote the construction of infrastructure supporting the logistics and distribution. The agencies must optimize the convenience of internet information dissemination to promote a market utilizing locally produced foods and forming a safe, stable, and efficient online community food purchase supply system. Standardized trading rules for the community group's operation could make the system transparent to those who consider joining a neighborhood group. The sustainable development of the online community should be supported. Monitoring the operation of online group functioning to prevent fraud should be considered to strengthen the food security of participants.

Differentiated food-supply-system guarantees should be provided for residents according to the lockdown severity in their area. The online community should enhance residents' sense of food security in order to enhance the role of online communities in securing the food safety of residents.

Regardless of the status of the COVID-19 situation, the level of food security among vulnerable populations has become more evident. Consequently, relevant organizations have started providing distinct food supply services to residents of the online community, taking into consideration their unique characteristics. At the same time, the online communities must pay attention to the needs of elderly, low-educated, low-income, and other vulnerable residents to improve their sense of food security. Online communities have certain advantages for the food security of vulnerable groups.

Finally, residents must be guided in understanding the risks of COVID-19 and its variants, and their food safety must be improved during any future epidemic. Relevant agencies should take the initiative to guide residents to information about the scientifically verified risks associated with the epidemic to weaken its negative impact.

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