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Reactions to Food Safety Recalls among Food Insecure and Food Secure Households

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Abstract

Behavioral reactions to food safety concerns among food-insecure persons are understudied. The study of the intersection of food insecurity and food safety challenges is vital to provide more nuanced guidance on policy measures related to food safety. We use a vignette approach to examine the reactions of food-insecure individuals to a hypothetical food safety recall. Food-insecure persons are likelier to seek refunds for eggs, while Supplemental Nutrition Assistance Program (SNAP) recipients are more likely to consume romaine lettuce. We recommend policy makers use multiple channels to target food-insecure groups and to better reach consumers with information aimed at reducing the risk of illnesses in the event of a food safety recall.

Keywords: food safety, recalls, romaine lettuce, eggs, food insecurity

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Introduction

Food safety remains a paramount concern due to its significant economic impacts across entire food supply chains and on consumers globally. In 2021, the Food and Drug Administration (FDA) in the United States issued more than 500 recalls for various food and beverage products, including critical items like powdered infant formula and peanut butter (U.S. Food and Drug Administration, 2024). While food safety recalls are not uncommon, their effects can vary significantly across different populations. For instance, households experiencing food insecurity may respond differently to recalls compared to food-secure households, as they often prioritize food purchases over other health-related activities (Berkowitz, Seligman, and Choudhry, 2014). However, such nuances in behavioral responses along the spectrum of food security are largely understudied.

Food recalls are crucial to mitigate risks associated with contaminated or unsafe food products. Recalls typically initiated by regulatory agencies like the FDA or food manufacturers involve removing potentially harmful products from distribution and consumption channels. The process often begins with identifying a safety issue through surveillance systems, consumer complaints, or routine testing. Upon confirming the presence of a hazard, authorities or companies issue public notifications detailing the affected products, reasons for the recall, and recommended actions for consumers, which may include disposal, return, or refund. Subsequently, investigators trace the distribution and sale of the recalled items to minimize consumer exposure and prevent further harm. Effective communication and cooperation among stakeholders, including producers, retailers, and consumers, are essential for successfully executing recall protocols (U.S. Food and Drug Administration, 2022). Despite these measures, challenges such as incomplete product traceability and delayed responses can hinder the effectiveness of recalls, underscoring the importance of continuous improvement and vigilance in food safety management.

Previous research at the intersection of food safety and food security has primarily focused on Supplemental Nutrition Assistance Program (SNAP) participants' perceptions of risks and the role of food safety in enhancing the welfare of food-insecure populations (Neill and Holcomb, 2019; Kinsey, 2005). While SNAP participation, food insecurity, and low income are interrelated, we examine these factors individually. There are high proportions of households that are poor but food secure, and also households that are food insecure with incomes above the poverty line (Gundersen, Kreider, and Pepper, 2011). We find similar results in our sample, demonstrating with a Venn diagram the overlap among SNAP benefit recipients, food-insecure, and/or low-income respondents in Figure 1. While studies have examined the impacts of food safety recalls on various food products, particularly meat, poultry, and eggs, due to data availability the emphasis has been mainly on consumer demand and price reactions (McKenzie and Thomsen, 2001; Lusk and Schroeder, 2002; Neill and Chen, 2022; Marsh, Schroeder, and Mintert, 2004; Thomsen, Shiptsova, and Hamm, 2006). Despite the apparent impacts of food safety recalls on prices and demand, the welfare effects are not always straightforward. Factors, such as willingness-to-pay (WTP) changes for affected food items, can vary depending on consumer knowledge and preferences (Richards and Nganje, 2014).

Moreover, the consequences of a food safety recall extend beyond economic considerations. Socioeconomic and demographic factors play a crucial role in determining the magnitude and distribution of these impacts. We believe that a better understanding of how consumers may react to food safety recalls has two main pathways: limited income/price sensitivity and risk preferences. Households near the poverty line, who are more likely to experience food insecurity, spend a significant proportion of their income on food compared to more affluent households (Coleman-Jensen et al., 2019). Thus, they may value the consumption of food products differently and react differently to food safety recalls, possibly prioritizing immediate food needs over health considerations, often referred to as patience. An individual's willingness to accept the risk of becoming ill may influence their response to food safety recalls. We expect some may be more risk averse and choose to avoid potentially contaminated products, instead electing to either dispose of them or seek a refund from the place of purchase.

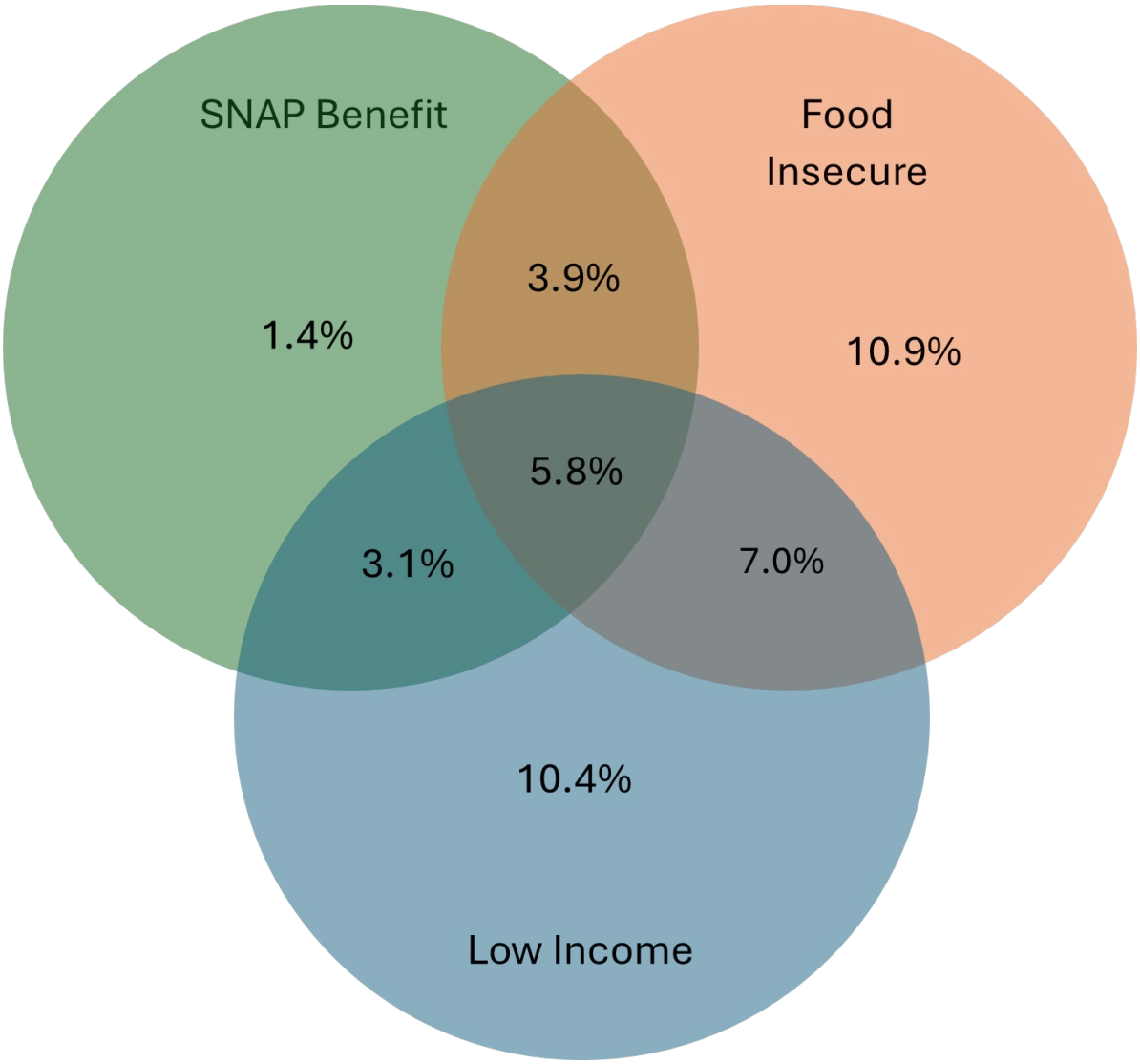

Figure 1. Percentage of SNAP Benefit Recipient, Food Insecure, and Low-Income Respondents

The specific effects of such pathways are likely to manifest most in food-insecure individuals as they are more likely to consume or return food items identified by a recall. Our work aims to directly observe the behavioral responses of food-insecure individuals to food safety recalls, shedding light on the factors influencing their decisions regarding recalled products. We do this by examining how time/patience and risk preferences interact with the choices of food-insecure individuals in a hypothetical experiment.

Our study contributes to the existing literature by employing a vignette approach to examine the reactions of food-insecure and food-secure individuals to hypothetical food safety recalls. Application of our results by companies and government agencies during a food recall event using targeted interventions that consider the food security status of households may reduce instances and severity of foodborne illnesses. Our findings suggest that attributes of specific food items, return policies, and demographic factors significantly influence consumers' responses to food safety recalls. We find that consumer reactions to recalls vary across demographics, food security status, and access to SNAP benefits. Food-insecure individuals appear more willing to accept the risk of becoming ill and choose to consume a recalled food. Nonwhite and relatively older respondents appear more likely to seek a refund for food purchased when a recall is announced. We recommend government and private sector entities use social media to distribute science-based information and risk-reducing actions available to vulnerable groups in the event of a food safety recall. Another option for SNAP recipients is to credit refunds to SNAP accounts, whether or not they used the funds to purchase the recalled food items.

In the remainder of this article, we discuss the survey data collected, the empirical model, study results, policy implications, and concluding remarks, and highlight avenues for future research.

Survey Design and Data Collection

We utilize stated preference methods to understand consumers' decisions to seek a refund, throw away, or consume eggs and romaine lettuce subject to a hypothetical food safety recall. The choice of food items for the study is not arbitrary. We identify eggs and romaine lettuce purchases based on participant consumption of each food and the representativeness of these two distinct food categories. Eggs must be cooked before consumption and are a relatively cheaper source of protein compared to meat and meat alternatives. Romaine lettuce is eaten in fresh form and is a vegetable households consume—albeit not the cheapest nor most expensive one. Both food items have been subject to several recalls over the past decade. By examining products with different dietary functions, we can determine how food attributes and demographic factors influence decision making in the case of a food safety recall. The primary contribution of our study to the existing literature is to improve understanding of behavioral reactions to food safety recalls between food-secure and food-insecure households.

The experimental design used for this study is the vignette method, which is a type of stated preference experiment where respondents make hypothetical decisions (regarding products, situations, etc.) with differing levels of attributes. Social psychology was the first field to use this methodology (Alexander and Becker, 1978) and has expanded to several fields, including

marketing and management (Aguinis and Bradley, 2014), as well as economics (Kapteyn, Smith, and van Soest, 2007; Epstein, Mason, and Manca, 2008; Ellison and Lusk, 2018). The vignette method has proven to recover the actual effects of attributes of interest in real-world scenarios (Hainmueller, Hangartner, and Yamamoto, 2015).

The vignette in our analysis has three attributes—price, risk of sickness, and travel time to store, each varied at three levels. From the 27 possible vignettes ($3^3 = 27$), we selected a subset of nine vignettes such that each variable was uncorrelated with the others (an orthogonal, fractional factorial design).

We recognize that one potential limitation to using data from an online survey analysis is stated preferences rather than revealed preference. However, the authors are not aware of data showing revealed preferences that also include observations on whether consumers returned a recalled food item for a refund or threw away the affected product. Therefore, we feel the online survey data used in this analysis that uses stated preferences is justified, given that we also collect observations about a consumer's response to a hypothetical food safety recall.

We elicit each participant's consumption pattern for each food item and then randomly assign them to evaluate one of the nine vignettes. Each respondent answered a vignette for romaine and egg food safety recalls if they consumed each food item at least once a month. If they responded by indicating that they never consumed one of the food items, they were not presented with the vignette for that food item. They were not included in the experiment if they never consumed either food item.

Below are examples of the basic vignette for romaine lettuce and eggs:

Romaine Vignette

Imagine you just found out about a food safety recall for romaine lettuce you recently purchased due to the risk of *E. coli*. The estimated risk of *E. coli* from the consumption of the lettuce is about **[1 in 3 (33%); 1 in 6 (17%); 1 in 9 (11%)]**. The lettuce cost you **[$2.00; $2.70; $3.30]** per pound. Assuming the grocery store where you can return the lettuce for a refund is a **[20; 30; 40]** minute round trip, what would you do?

Eggs Vignette

Imagine you just found out about a food safety recall for large, Grade A eggs you recently purchased due to the risk of salmonella. The estimated risk of salmonella from the consumption of eggs is about **[1 in 100 (1%); 1 in 200 (0.5%); 1 in 300 (0.33%)]**. The eggs cost you **[$1.60; $1.80; $2.00]** per dozen. Assuming the grocery store where you can return the eggs for a refund is a **[20; 30; 40]** minute round trip, what would you do? The respondent had three options: throw away the food item, return it to the store for a refund, or consume it.

We utilize data from Centers for Disease Control and Prevention (2022a,b) to create realistic probabilities of sickness from *E. coli* and salmonella. We first gather the total number of cases of foodborne illness of interest over 2017–2020, regardless of the source of contamination. Then, we gather the total number of illnesses for the foodborne illness of interest and the specific food that caused the illness. For example, the risk of illness from romaine facing a food safety recall for *E. coli* is calculated as follows:

$$\text{Risk of illness from romaine} = \frac{\text{\# of } \textit{E. coli} \text{ cases caused by consuming romaine lettuce contaminated by } \textit{E. coli}}{\text{\# of illnesses caused by } \textit{E. coli}}$$

To examine risk preference specifically related to foodborne illnesses, one of the choice attributes within the experiment is the risk of illness caused by consuming romaine and eggs. The specific calculation for the risk of illness caused by consuming romaine contaminated by *E. coli* to be $\frac{617}{3{,}588} \approx 17\%$ and the risk of illness caused by consuming eggs contaminated by salmonella to be $\frac{103}{13{,}472} \approx 0.7\%$. From these base calculations, we choose the three levels of risk to be 1 in 3, 1 in 6, and 1 in 9 for romaine lettuce and 1 in 100, 1 in 200, and 1 in 300 for shell eggs. We acknowledge that this risk estimation is the probability of eggs/romaine being the source of contamination given an illness due to the specified bacteria and not the risk of becoming ill. The likelihood of becoming sick is much smaller (i.e., $\leq 0.01\%$ for eggs). While our estimates exceed the documented infection rates, we argue that this approach is still worthwhile in understanding how different consumers respond to the recall. We suggest that future research focus on testing the hypothesis with smaller probabilities. Moreover, the average consumer likely has little or no frame of reference for the risk of illness from recalled food products, given the small probabilities associated with such rare events (Burns, Chiu, and Wu, 2010).

Before completing the choice experiment, we informed participants that food is occasionally recalled due to the risk of contamination of a foodborne illness, and that consumers who have purchased a recalled food item have three options: to return the product to the store from where it was purchased for a refund, dispose of the product properly so that people cannot eat it, or ignore the recall and consume the product. We did not inform them of the potential consequences of consuming contaminated foods as we were interested in extracting inherent risk perceptions. For SNAP benefit recipients, all refunds go directly to the recipients' Electronic Benefit Transfer (EBT) card. Cash refunds are not allowed for food items purchased with SNAP benefits.

To determine the price-level attributes, we gathered price data from the Federal Reserve Bank of Saint Louis and rounded to the nearest 10 cents. For romaine, we used the average price of romaine from February 2020 and December 2021 (this data range contained the lowest and highest price for romaine lettuce over the past five years) to determine a midpoint price point of $2.70 (U.S. Bureau of Labor Statistics, 2022b). We used the average price for shell eggs between February 2021 and February 2022 to determine a midpoint price point of $1.80 (U.S. Bureau of Labor Statistics, 2022a). Travel time to a store to obtain a refund for a food item facing a food safety recall is based on research showing the average time individuals in low-income areas spend

traveling to a grocery store, which is 19.5 minutes (Ver Ploeg et al., 2009; Hamrick and Hopkins, 2012).

Utilizing the 18 survey items from the U.S. Household Food Security Survey Module (USDA-ERS, 2012), we calculated the food insecurity status of respondents. Respondents who answer affirmatively to three or more questions in the survey meet the definition of food-insecure households.[1]

Given our interest in time preferences, we utilize survey questions and methods outlined in previous studies by Falk et al. (2023) and Falk et al. (2018). For the patience measure, each survey respondent was asked about their willingness to give up something beneficial today to gain something more valuable in the future and answered five questions about their choice between differing amounts of money today versus in the future.[2] We elicit a measure of personal risk preference using the methods above. Each survey respondent was asked about their willingness to take risks and answered five questions about their preference for a 50/50 chance of receiving different amounts of money as a sure payment. We normalized both scores to the average, where a negative value would indicate a lower-than-average risk/patience measure and vice versa for a positive measure.

We ask respondents questions about age, gender, race, education, political affiliation, income, whether children are present in the household, and whether they receive SNAP benefits. We collected a national sample of consumers in the United States via an online panel.[3] We incentivized respondents via payment to complete the survey and provided accurate responses through an online panel maintained by a third party (Qualtrics), resulting in 1,050 completed responses after removing inconsistent responses based on an inattention question.[4] The food insecurity rate in our sample is approximately 28% higher than the national average. Compared to the latest U.S. Census data, 24.7% of people in the United States identify as nonwhite, 50.5% are female, and the average age is 38.9. Fewer of our respondents identify as nonwhite (9.3%), 51.3% are female, and the average age is 41.9. We were left with 860 responses for analysis. Comparing food insecure (N = 238) and food secure (N = 622) individuals, we find several differences in characteristics. Notably, food-secure individuals in our study have lower measures of personal risk preference (indicating a person is more risk averse). Sociodemographic information about the sample can be viewed in Table 1.

[1]Note: While the food insecurity questions do produce a categorical measure of food insecurity, we follow how the USDA Economic Research Service (2012) typically report food insecurity in a binary measure for ease of interpretation.

[2]Others may download these survey questions for U.S. residents from https://www.briq-institute.org/global-preferences/downloads.

[3]We received appropriate university IRB approval before data collection.

[4]The inattention question was "I/my household ate at least once in the last 12 months. For this question, please select 'often true.'"

Table 1: Socio-Demographic Variables and Definitions

		Food Insecure	Food Secure	Full Sample
Variable	**Definition**	**Mean**	**Mean**	**Mean**
Personal risk preference	Measure of personal risk preference	0.145	-0.151	-0.068
Patience	Measure of patience	-0.246	0.103	0.007
Female	1 if female; 0 otherwise	0.643	0.463	0.513
SNAP	1 if current SNAP recipient; 0 otherwise	0.353	0.068	0.147
Age	Current age	35.042	44.506	41.887
Food budget > $100	1 if weekly food budget > $100; 0 otherwise	0.592	0.672	0.650
Nonwhite	1 if respondent identified as nonwhite; 0 otherwise	0.118	0.084	0.093
College	1 if obtained a college degree; 0 otherwise	0.462	0.641	0.592
Democrat	1 if identifies as a Democrat; 0 otherwise	0.378	0.342	0.352
Children in HH	1 if children under 18 are in household; 0 otherwise	0.424	0.172	0.242
Low income	1 if income is less than $40,000; 0 otherwise	0.471	0.190	0.267
Medium income	1 if income is between 40, 000−99,999; 0 otherwise	0.332	0.476	0.436
High income	1 if income is $100,000 or more; 0 otherwise	0.197	0.334	0.297
Number of observations		238	622	860

Note: This table presents means for the combined sample of respondents for both food safety recall food types.

Econometric Methods

Our analysis makes use of a multinomial logistic regression to determine how attributes, such as price, risk of illness, travel time to a store, and demographic variables, affect a person's decision to obtain a refund, dispose of, or consume a food facing a food safety recall. Given the three possible outcomes, the corresponding probability P that a person i chooses a specific outcome j (to obtain a refund, throw away, or consume a food item facing a food safety recall) are as follows (Greene, 2012):

$$P(Y_i = j) = \frac{\exp(X\beta^j)}{\sum_{j=1}^{3} \exp(X\beta^j)} \quad (1)$$

where X are explanatory variables and β^j is a set of estimated coefficients corresponding to each outcome j. To identify our model, we set the base outcome as the decision to throw away the food item. Therefore, all of the coefficient estimates are relative to the decision to discard the recalled food.

Specifically, we model each person's decision to obtain a refund, throw away, or consume a food item that has a food safety recall through a multinomial logistic regression with the following covariates:

$$X\beta^j = \beta_{0i} + \beta_1 Price_i + \beta_2 Store_i + \beta_3 Sick_i + \beta_4 FI_i \quad (2)$$

$$+ \beta_5 Patience_i + \beta_6 FIPatience_i + \beta_7 FISick_i + \alpha \mathbf{Z_i}$$

where we note the vignette variables by *Price, Store,* and *Sick*. *FI* is the food insecure dummy variable, and *Patience* measures the respondent's patience.

Given our hypotheses that food-insecure persons are likely more sensitive to their own time and risk preferences regarding foodborne illnesses, we utilize interaction terms. *FIPatience* and *FISick*, are the food insecurity binary variable and the respondent's patience measure and the risk of sickness attribute from the vignette, respectively. These terms directly test whether individuals are more concerned about how they spend their time dealing with food recalls, as they may be less willing to return the items for a refund. If food-insecure individuals are more concerned about the inherent risk of illness, they should be less likely to consume. Given that we consider a multinomial option in response, we expect the *FIPatience* variable to be positive in the Refund option and the *FISick* variable to be negative in the Consume option. Prior literature suggests that because food insecurity is so stressful (Laraia et al., 2017), individuals suffering from it may be unwilling to risk sickness that will possibly cause increased stress or expenditures from medical treatment. But, as previously mentioned, whether this manifests in terms of time or risk preferences (or both) has yet to be determined.

We denote the matrix of demographic variables as **Z**, which includes the following: *Child* is a dummy variable, indicating the presence of children in the household; *Female* is an indicator for

whether the respondent identifies as female; *SNAP* is an indicator for whether the respondent is a SNAP benefit recipient; *Age* is the age of the respondent; *Nonwhite, College, Dem, Medium Income, High Income* are the indicator variables for whether the respondent identifies as nonwhite, has a college degree, identifies with the Democratic party, has a medium level of income, or has a high level of income, respectively. We model the choice to obtain a refund, throw away, or consume each food item separately (i.e., eggs (N = 838) impacted by a food safety recall due to the risk of salmonella and a second model for romaine lettuce (N = 742) impacted by a food safety recall due to the risk of *E. coli.*) We tested the model for multicollinearity given the various types of risk controls and found these variables were uncorrelated.

Our study design has several assumptions. First, we assume consumers' reactions to food safety recalls are unaffected by attributes outside our experimental design, such as the recall timing relative to the purchase. For example, enough time may have lapsed between purchasing a food item and a food recall event that the consumer may have already consumed or disposed of the item due to spoilage. Our experiment also assumes the respondent is aware of the recall because we explicitly informed them. Consumers who have purchased a food item and are facing a food safety recall may have varying amounts of information regarding the recall.

Media coverage around the time of the recall event has impacted consumers' decisions (Neill and Chen, 2022). Also, we do not have a proper measure of respondents' time use, but rather a measure for patience, which, while not equivalent, is more straightforward to extract in a survey. Respondents with less leisure time may react differently to a food safety recall than those with ample leisure time. Our results may depend on the choice of food items in our analysis and may not be comparable outside of recalls for romaine lettuce or eggs. However, our analysis offers new insight to policy makers and researchers on the reactions to food safety recalls across groups of individuals. Finally, there are only 16 households that consume romaine lettuce after a recall in our sample. Thus, the results observed are driven by a small number of observations, which is a potential threat to proper identification.

Results

Of initial interest are the respondents' preferences of risk and time preferences. We find that food-insecure individuals are less patient and more willing to take risks than food-secure individuals, as shown in Figure 2. Our findings are similar to Neill and Holcomb (2019), where SNAP recipients had a lower perceived risk of the presence of *E. coli* in fresh produce from smaller farms. Given the challenges food-insecure people face and differences in risk preference and patience measures, we hypothesize that food-insecure individuals will react differently to food safety recalls than food-secure households.

We summarize the survey respondents' decisions by food recall type and food security status in Figure 3. Food-insecure respondents had a higher percentage of seeking a refund for both recalled eggs and romaine compared to food-secure respondents.

We present the multinomial logistic (MNL) regression results for romaine lettuce and shell eggs in Table 2. All regressions use the decision to throw away affected food items as the base outcome. We discuss results predominately via marginal effects for the MNL regressions in Table 3 for eggs and in Table 4 for romaine. In our MNL regressions, all three choice attributes (price, travel time to store, and risk of sickness) are significant factors in the decision to refund or consume food items facing a food safety recall. The price variable is significant for the decision to consume purchased eggs despite a recall event compared to disposal of the eggs. The price variable is significant for obtaining a refund and consuming recalled romaine relative to the disposal of the romaine. A one-dollar increase in the price of romaine results in a 29% increase in the log-odds of an individual choosing to seek a refund for the purchased romaine. The marginal effect of price presents similar findings. As price increases, a consumer's probability of throwing away eggs or romaine decreases by 19 percentage points.

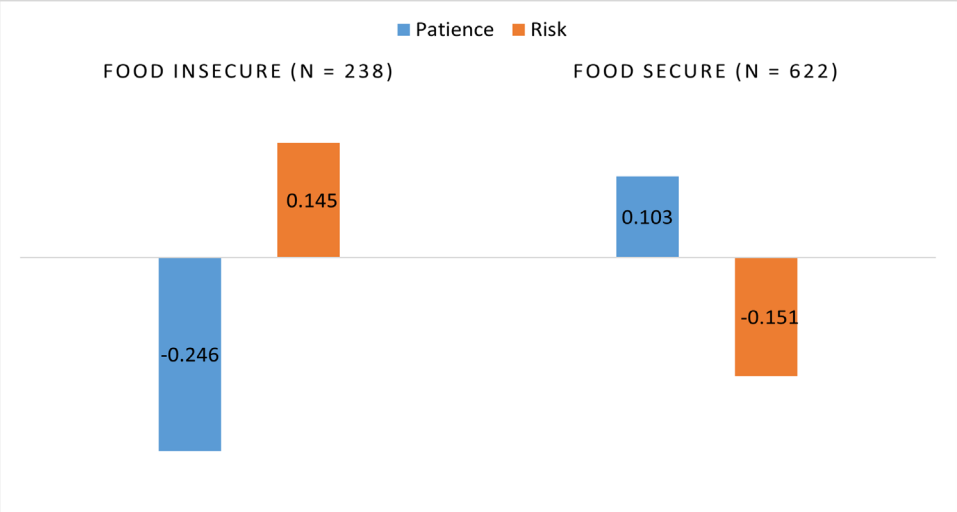

Figure 2. Risk and Patience among Food-Secure vs. Food-Insecure Households (Normalized Z-score Values)

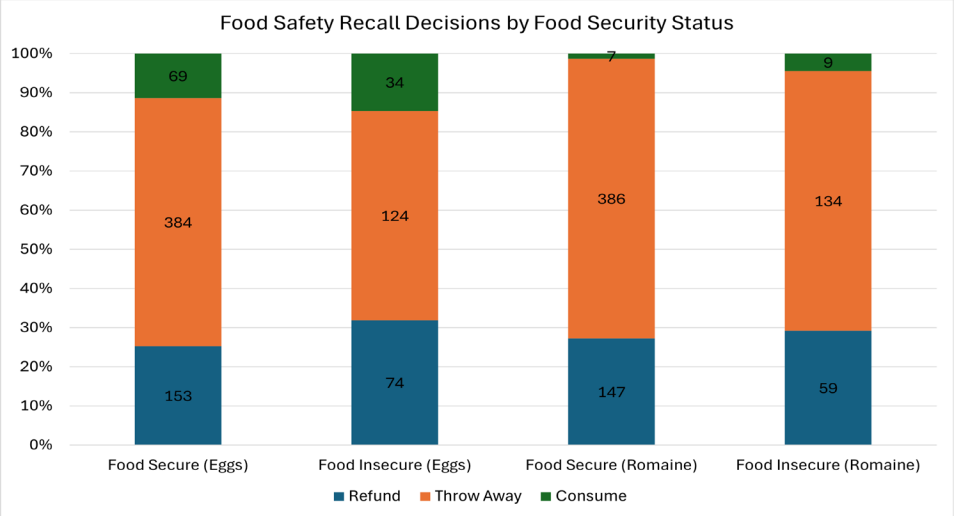

Figure 3. Survey Responses to Seek Refunds, Throw Away, or Consume Food Under a Food Safety Recall

Table 2. Multinomial Logistic Regression Results from Egg and Romaine Lettuce Vignette (Base = Throw Away Food Item)

	Eggs		Romaine	
Variables	**Refund**	**Consume**	**Refund**	**Consume**
Price	0.590	1.339*	0.288*	0.772*
	(0.514)	(0.743)	(0.160)	(0.436)
Travel time to store	-0.047***	0.015	-0.035***	-0.003
	(0.010)	(0.015)	(0.011)	(0.039)
Risk of sickness	0.338	1.077**	-0.001	-0.017
	(0.344)	(0.452)	(0.011)	(0.039)
Children in HH	0.155	0.588*	0.396	0.780
	(0.241)	(0.305)	(0.246)	(0.570)
Female	-0.167	-0.225	-0.407**	-0.807
	(0.184)	(0.249)	(0.193)	(0.581)
SNAP benefit recipient	0.228	0.503	0.204	1.847**
	(0.272)	(0.340)	(0.285)	(0.772)
Age	0.023***	0.006	0.028***	-0.015
	(0.008)	(0.011)	(0.008)	(0.032)
Nonwhite	0.553**	-1.587**	0.017	-13.747***
	(0.270)	(0.737)	(0.303)	(0.415)
College	-0.132	-0.134	0.107	0.118
	(0.186)	(0.249)	(0.190)	(0.691)
Democrat	0.280	0.207	0.398**	-0.157
	(0.176)	(0.235)	(0.178)	(0.649)
Medium income	-0.084	0.246	-0.324	0.728
	(0.231)	(0.349)	(0.245)	(0.863)
High income	-0.224	0.112	-0.334	0.880
	(0.277)	(0.382)	(0.283)	(1.025)
Food insecure	1.048**	2.079***	0.769	1.292
	(0.463)	(0.615)	(0.469)	(1.264)
Patience	0.012	0.281	-0.012	0.447
	(0.123)	(0.176)	(0.125)	(0.500)
Food insecure ×	0.579**	0.084	0.336	-0.060
patience	(0.251)	(0.312)	(0.258)	(0.653)
Food insecure ×	-0.701	-2.790***	-0.020	-0.035
risk of sickness	(0.642)	(0.903)	(0.022)	(0.061)
Constant	-1.747	-5.721***	-1.827**	-6.029**
	(1.150)	(1.527)	(0.781)	(2.634)
Observations	838		742	

Note: Robust standard errors presented in parentheses. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level.

Table 3. Average Marginal Effects for Eggs

	Refund		Throw Away		Consume	
	Avg. ME	**Std. Err.**	**Avg. M.E.**	**Std. Err.**	**Avg. M.E.**	**Std. Err.**
Price	0.068	0.092	-0.187*	0.104	0.119	0.074
Travel time to store	-0.009***	0.002	0.006***	0.002	0.003**	0.001
Risk of sickness	0.029	0.061	-0.129*	0.067	0.100**	0.045
Children in HH	0.011	0.043	-0.066	0.047	0.055*	0.030
Female	-0.024	0.033	0.042	0.036	-0.018	0.025
SNAP benefit recipient	0.027	0.048	-0.071	0.054	0.045	0.033
Age	0.004***	0.001	-0.004**	0.002	0.000	0.001
Nonwhite	0.150***	0.049	0.029	0.073	-0.179**	0.074
College	-0.020	0.033	0.030	0.037	-0.010	0.025
Democrat	0.045	0.031	-0.058*	0.035	0.013	0.023
Medium income	-0.023	0.042	-0.005	0.048	0.028	0.035
High income	-0.045	0.049	0.026	0.056	0.018	0.038
Food insecure	0.129	0.081	-0.310***	0.090	0.181***	0.060
Patience	-0.006	0.022	-0.022	0.025	0.028	0.018
Food insecure × patience	0.104**	0.044	-0.095*	0.050	-0.009	0.030
Food insecure × risk of sickness	-0.044	0.114	0.308**	0.128	-0.264***	0.090

Note: Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level.

Table 4. Average Marginal Effects for Romaine

	Refund		Throw Away		Consume	
	Avg. ME	**Std. Err.**	**Avg. M.E.**	**Std. Err.**	**Avg. M.E.**	**Std. Err.**
Price	0.050	0.030	-0.062**	0.030	0.013	0.009
Travel time to store	-0.007***	0.002	0.006***	0.002	0.000	0.001
Risk of sickness	0.000	0.002	0.000	0.002	0.000	0.001
Children in HH	0.070	0.046	-0.082*	0.046	0.012	0.011
Female	-0.072**	0.036	0.085**	0.036	-0.013	0.011
SNAP Benefit Recipient	0.027	0.053	-0.061	0.053	0.034**	0.016
Age	0.005***	0.001	-0.005***	0.002	0.000	0.001
Nonwhite	0.089	0.060	0.173**	0.070	-0.262***	0.062
College	0.019	0.036	-0.021	0.036	0.002	0.013
Democrat	0.076**	0.033	-0.071**	0.034	-0.005	0.012
Medium income	-0.066	0.046	0.050	0.046	0.016	0.017
High income	-0.069	0.053	0.050	0.054	0.019	0.020
Food insecure	0.137	0.088	-0.157*	0.088	0.020	0.024
Patience	-0.005	0.024	-0.004	0.024	0.009	0.010
Food insecure × patience	0.064	0.048	-0.061	0.049	-0.003	0.012
Food insecure × risk of sickness	-0.003	0.004	0.004	0.004	-0.001	0.001

Note: Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level.

Obtaining a refund for eggs and romaine lettuce requires significant travel time to the store. For eggs, we find that for each minute the travel time to the store increases, the probability a consumer seeks a refund decreases by approximately 1 percentage point. We also find that the probability the respondent disposes of or consumes the eggs increases by 0.6 percentage points and 0.3 percentage points, respectively. The marginal effect of travel time to the store for the food safety recall for romaine is similar. As travel time to the store increases, the consumer's probability of returning the affected romaine decreases by 0.7 percentage points. Respondents with children present in the household are more likely to consume eggs recalled due to a food safety issue than dispose of them. If children are present in the household, the probability of consuming the eggs despite the recall increases by 6%. The marginal effect of having children present in the household decreases the probability of throwing away the affected romaine by 8 percentage points. Eggs are relatively low cost compared to other protein sources (Farrell, 2013; Conrad et al., 2017) and are rich in nutrients, such as amino acids, choline, vitamins A, B, and D, and iron (FAO, 1985; Griffin, 2016; USDA-ARS, 2019). Given the reduced chance of getting sick from eggs cooked until the white and yolk are firm (CDC, 2022), parents may assume that cooking the eggs results in an acceptable reduction of the risk of using eggs under an active recall. Additionally, children do not often prefer vegetables (Skinner et al., 2002). It is possible that households with children may not be as concerned with a food safety recall for romaine lettuce because their children prefer not to eat vegetables, thus leading to a lower probability of throwing the romaine away due to the recall. Lastly, it is also possible that because romaine recalls are more prevalent than egg recalls, consumers may be more aware of romaine recalls in recent years.

For romaine lettuce facing a food safety recall, the MNL regression shows female consumers are less likely to seek a refund than they are to elect to dispose of the recalled romaine. For female romaine consumers, the probability of seeking a refund decreases by 7 percentage points, and the probability of disposal decreases by 9 percentage points compared to male consumers. This result is likely attributable to the fact that women have documented less leisure time than men given traditional gender roles and the overall differences in time use between men and women (Thrane, 2000; Sayer, 2005; Van der Lippe et al., 2011).

Being a SNAP benefit recipient is significant and increases the probability a consumer will choose to consume the romaine despite the food safety recall by 3 percentage points. SNAP recipients are the most price conscious and employ price-saving efforts soon after receiving their benefits (Zaki and Todd, 2021). This fact, coupled with the relatively short window of consumption before romaine lettuce spoils, likely drives SNAP recipients to consume rather than throw away recalled romaine lettuce.

As age increases, the probability of seeking a refund increases by 0.4 percentage points, whereas the probability of throwing away recalled eggs decreases by 0.4 percentage points. For romaine under a food safety recall, the probability of seeking a refund increases by 0.5 percentage points, and the probability of throwing away the romaine decreases by 0.5 percentage points. Our results are similar to Schafer et al. (1993), who found that age is related to food safety behavior. In addition, consumer expenditures vary by age (Foster, 2015). For example, the share of the food budget spent on food at home increases with age (Foster, 2015). It is likely that as age increases,

respondents are more likely to seek a refund relative to throwing away a food item or when facing a food safety recall due to spending habit differences among different age groups.

For nonwhite consumers, the probability of seeking a refund increases by 15 percentage points, and the probability of consuming the recalled eggs decreases by 18 percentage points. The likelihood of nonwhite respondents who choose to consume romaine under a food safety recall is 26 percentage points lower than the choice to dispose of the lettuce.

Democrats are more likely to seek a refund than to dispose of romaine lettuce. The probability of seeking a refund increases by 7.6 percentage points relative to disposing of romaine lettuce impacted by a food safety recall when the consumer identifies with the Democratic party. Identifying as a Democrat decreases the probability that the consumer throws away recalled eggs by 6% and recalled romaine by about 7 percentage points. This finding may be due to the link between personality and political choice (Capara, Barbaranelli, and Zimbardo, 1999; Caprara et al., 2006).

Our results indicate that food-insecure persons are more likely than food-secure persons to seek a refund of eggs or consume the eggs under a food safety recall. Being food insecure decreases the probability a consumer will throw away recalled eggs by 31 percentage points and increases the probability of choosing to consume the eggs despite the recall by 18 percentage points. Additionally, food insecurity decreases the probability of throwing away recalled romaine by 16 percentage points. Since food insecurity is stressful to individuals (Laraia et al., 2017), and food-insecure persons may focus all their efforts on finding food (Hadley and Crooks, 2012), it is plausible that food-insecure individuals are less likely to throw away food items or consume them despite the recall. When interpreting the effect of being food insecure on reactions to food safety recalls, patience and risk of sickness must also be considered as we included the interaction of these variables and food insecurity status. As a food-insecure person's patience measure increases, a food-insecure person is more likely to seek a refund and less likely to throw away recalled eggs. Additionally, as the risk of sickness increases for a food insecure person, the more likely they are to throw away recalled eggs and the less likely they are to consume recalled eggs.

Testing our empirical hypothesis about food-insecure persons, we find the interaction terms between food insecurity and patience significant in the egg model. Food-insecure individuals with higher patience measures have an increased probability of seeking a refund increase by 10 percentage points, and the probability of throwing away recalled eggs decreases by 9.5 percentage points. More patient, food-insecure individuals may have an inherent ability to devote time to seeking safe food options. As such, they are more likely to pursue a refund and are less likely to throw away contaminated eggs due to the opportunity to buy uncontaminated eggs or another cheap protein source with the refund given. Our second interaction term between food-insecure persons and the risk of sickness from the experiment is also statistically significant in the egg model. We find that food-insecure individuals have a lower probability (26.4 percentage points) of consuming recalled eggs than to dispose of them as the risk of sickness associated with the recall increases. Similarly, as the risk of illness increases during a food safety recall, the probability of a food-insecure person disposing of recalled eggs increases by 30.8 percentage points. However,

neither interaction term was significant in the romaine models, which supports our initial hypothesis that time and risk preferences are not universally important across all categories of products identified in food recalls.

A summary of our general findings for the vignette attributes, SNAP benefit recipients, and food insecure individuals are given in Table 5.

Table 5. Summary of Findings for Vignette Attributes, SNAP Recipients, and Food-Insecure Individuals

General Findings	Possible Explanation
As price increases, consumers are less likely to choose to throw away both eggs and romaine.	Consumers save money by reducing food waste, so they are less likely to choose to throw away food affected by a recall.
As travel time to the store increases, consumers are less likely to choose seeking a refund for recalled eggs and romaine and more likely to throw away recalled eggs and romaine.	Travel costs increase as travel time, discouraging consumers to seek a refund for recalled items and encouraging them to throw away recalled items.
SNAP benefit recipients are more likely to choose to consume recalled romaine lettuce.	SNAP benefit recipients are most price conscious after receiving their benefits and may be taking advantage of the short consumption window for romaine.
Food insecure individuals are less likely to choose to throw away and more likely to consume recalled eggs.	Food insecurity is stressful and those individuals may focus much of their effort into finding and keeping food.
As a patience score for a food insecure individual increases, the individual is more likely to choose seeking a refund and less likely to throw away recalled eggs.	Food insecure individuals with a higher patience score may be taking advantage of the opportunity to receive uncontaminated eggs or another cheap protein source with the refund.
As risk of sickness from a recall increases for a food insecure individual, they are more likely to choose to throw away recalled eggs and less likely to choose to consume recalled eggs.	Food insecure individuals may be unwilling to risk a sickness that could cause more stress or more health-related expenditures, given the increasing risk of sickness from a food safety recall.

Discussion and Implications

Our results offer several insights to researchers studying food safety recalls and policy makers seeking to implement effective strategies surrounding the consumer decision to heed food safety recalls. For researchers, we find several factors that should be considered when studying the

reactions to food safety recalls in the future. Because travel time to stores is a significant factor in deciding whether to obtain a refund, further studies should include this attribute to accurately model the decision-making process of consumers facing a food safety recall. Additionally, public messaging from retailers indicating that the recalled product itself need not be returned to the store; rather, they honor the refund based on a receipt showing purchases made within the time frame of the recall may improve accessibility to the food without costing more time and resources.

For policy makers, the goal of a food recall is ”to protect the public from products that may cause health problems or possible death” by removing ” food products from commerce when there is reason to believe the products may be adulterated or misbranded” (USDA Food Safety Inspection Service, 2015). Thus, a “successful” consumer reaction to a food safety recall would result in consumers who have purchased a potentially harmful food item throwing the item away or returning the item to the store for a refund. Our results indicate that not all consumers would be willing to throw away or obtain a refund for eggs or romaine if they face a food safety recall. Specifically, being a SNAP benefit recipient increases the probability of choosing to consume romaine under a food safety recall. As indicated previously, several explanations exist for this phenomenon, including that SNAP benefit recipients view risk differently than consumers who do not receive SNAP benefits.

Furthermore, we do not find that our hypotheses about SNAP recipients are universally true, given the non-statistically significant effects of a romaine lettuce recall. Policy makers can focus on targeting SNAP recipients during a food safety recall to discourage consumption instead of focusing on their time and risk preferences, which is unlikely to be ineffective.

Other notable demographic groups in our analysis include nonwhite respondents. Survey respondents who identified as nonwhite were more likely to react successfully to a food safety recall for eggs and romaine lettuce (i.e., they were more likely to seek a refund or throw away an item under a food safety recall and less likely to consume an impacted product). Additionally, food-insecure persons have a higher probability of consuming recalled eggs and a lower probability of choosing to throw away recalled eggs or romaine lettuce. Given the success of social media tools in disseminating public health messages (Mayer and Harrison, 2012), we recommend public and private sectors cooperate to circulate relevant information regarding food safety recalls to consumers using these channels. Communicating the importance of reporting and removing unsafe food items is critical to decreasing foodborne illnesses and costs. In addition, policy support for increasing traceability from food production to households that purchased unsafe foods will assist in tracking food safety recalls more accurately.

Conclusions

There are several nuances in the decision-making process when consumers face a hypothetical food safety recall of romaine lettuce and eggs. In our study, we attempted to determine how decision-making is similar or different across food-insecure and food-secure persons. Using the vignette method and multinomial logistic regression, we find the outcome depends on contextual factors, such as price, travel time to a store, and socioeconomic and demographic factors. We also

show that food-insecure individuals react to food safety recalls differently than food-secure individuals as the risk of sickness from consuming recalled eggs or romaine lettuce increases. Again, we acknowledge our limitation in using probabilities larger than the actual risk of illness. However, this approach can provide opportunities for further understanding of food-insecure consumers' reactions to food safety concerns. Also, many consumers likely have no frame of reference for the probability of illness from recalled products, so extracting such a measure may also prove worthwhile.

We add to the food insecurity and the food safety literature by determining attributes affecting a decision across individuals who have purchased items subject to a food safety recall. We show differences in how food-insecure persons react to recalls of shell eggs, and we find that other demographic groups respond differently to food safety recalls. Specifically, we find that being a SNAP benefit recipient increases the likelihood of choosing to consume romaine lettuce when facing a food safety recall. We also find that compared to white consumers, nonwhite consumers have a higher probability of seeking a refund for eggs affected by a food safety recall and a lower probability of consuming recalled eggs. Additionally, nonwhite consumers are more likely to decide to throw away and less likely to choose to consume romaine lettuce under a food safety recall compared to white consumers. Our findings are relevant to researchers and policy makers, as decisions on how best to react to a food safety recall differ based on demographics and product-specific factors.

Our findings set the stage for further research surrounding the factors that influence decision-making under a food safety recall. We demonstrate that attributes regarding a food safety recall are essential to how consumers react to food safety recalls. We determine that these decisions may differ based on demographic factors. Future work should focus on other variables not utilized in this analysis, such as the timing of the recall event relative to the purchase date or the amount of leisure time available to consumers. For example, policy analysis often fails to consider how SNAP benefit recipients use available time (Davis and You, 2011; You and Davis, 2019). Another option could elicit participants' actual travel times and frequency of visits to their preferred food stores and utilize this information within the experiment. Capturing these metrics in future work may provide a better understanding of the decision-making process consumers undergo when faced with a food safety recall and better inform policy makers on the best practices to reduce the risks of foodborne illness among consumers. Our research motivates the importance of incorporating the link between food safety and food waste in future research. Food waste is a natural part of the food system, predominately due to supply chain concerns, such as spoilage, that render it unfit for safe human consumption.

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