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Food Insecurity and COVID-19 Food-Related Perceptions, Practices, and Problems: A 3-State Descriptive Study

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Original Research

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Abstract

Objective: To compare food insecurity (FI) risk and food-related COVID-19 infection risk perceptions, practices, and problems (3P) in Washington (WA), New York (NY), and Louisiana (LA).

Methods: Data from the RAPID Multi-Wave Risk Perception Study was collected via online surveys between May 19 to July 14, 2020 (N = 1260). Multivariable - adjusted logistic and ordinal regressions were performed for odds of FI risk and 3P during these early months of the pandemic.

Results: The determinants of FI risk in all states included income, age, and employment. Some determinants were state-specific: households with members at substantial risk for COVID-19 (WA and NY), ethnicity (NY), education, and relationship status (LA). The odds of FI risk were higher among those who perceived higher likelihood of COVID-19 infection *via* in-store shopping (OR = 1.34, 95% CI: 1.06, 1.70) and improperly cooked food (OR = 1.87, 95% CI: 1.46, 2.41). FI risk was associated with higher odds of problems related to food affordability (OR = 10.66, 95% CI: 7.87, 14.44), preference (OR = 2.51, 95% CI: 1.86, 3.39), sufficiency (OR = 2.63, 95% CI: 1.96, 3.54), food sources (OR = 7.68, 95% CI: 5.73, 10.31), food storage capacity (OR = 0.48, 95% CI: 0.36, 0.66), and knowing where to find help in obtaining food (OR= 7.68, 95% CI: 5.73, 10.31); most of which did not differ by state. No association was found between food insecurity risk and food-related practices.

Conclusion: Better food preparedness is needed to reduce FI risk during pandemics in specific groups in WA, NY, and LA. Specifically, food affordability, sufficiency, and storage, as well as sources, and increasing knowledge on food programs are limitations that need to be addressed for emergency situations.

Introduction

Food insecurity (FI) refers to limited or uncertain access to sufficient, safe, and nutritious food for an active and healthy life at all times and by all people.[1] It is critical to monitor and address FI during a pandemic because food is a key determinant of population and individual health. Inadequate food and diet are direct contributors of severity and/ or duration of diseases associated with SARS-CoV2 infection. In fact, the Food and Agriculture Organization (FAO) of the United Nations has stated that there will be no end to the pandemic without simultaneously addressing FI.[2] Indeed, because health is incumbent on sufficient and nutritious foods, there can be no maintenance of good health or improvement in poor health without ensuring adequate access to food for all.

Prior to the pandemic, 10.5% of US households were food insecure in 2019.[3] For example, the Census Household Pulse Survey (CHPS) carried out between April 23 and May 13, 2020 indicated that 23% of all American households were food insecure during that pandemic period, as compared to an earlier prediction of 17%.[1,4] Recent reports have highlighted the worsening of this problem, especially in racial, ethnic, and other minority groups.[5,6] This is not surprising, since the COVID-19 pandemic has caused millions of people to lose their jobs, thus limiting their ability to access food.[7,8] The food supply chain has also been substantially challenged; first through hoarding of household commodities including food,[9] then through mandatory lockdown orders, and take-out/ delivery-only options from food-service establishments, along with other social distancing guidelines.[10–13] These measures have resulted in food service interruptions from restaurants, bars, school feeding programs, and grocery shopping.[13,14] Thus, even households that were food secure prior to the pandemic may now be food insecure or at an increased risk for FI. Households that were already struggling with food access may now have

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even fewer resources to comply with COVID-19 mitigating measures due to economic and movement restrictions.

The protective measures and mitigating efforts to combat the spread of COVID-19, although essential, have had important consequences on food access in the US Those who are at risk for FI are also more vulnerable to COVID-19 infection and its consequences.[3] For instance, food insecure populations may have had to go to multiple grocery stores/ food banks to obtain sufficient food to adhere to quarantine or lock-downs, yet they were at a higher risk for homelessness or inadequate housing to allow for safe quarantine.[15] It is also worth noting that due to structural and systemic inequalities, people of color tend to be over represented in essential jobs (warehouses, food service, nursing, etc.) which were most affected during the pandemic, and which offer less reliable social distancing, paid leave, or continued health insurance in case of incapacitation due to COVID-19.[15] As a result, vulnerable groups end up being in public spaces more than others, which increases their exposure to infection risks.

Thus, to minimize the risk for FI during these disruptive times, it is crucial to understand how messages around grocery shopping and indoor-dining at bars/ restaurants are being perceived; whether the recommended practices such as avoiding indoor-dining at bars/ restaurants, and less frequent grocery shopping are being adopted; and the food access problems in terms of affordability, availability, nutrition, and quantity, as well as source, and food storage space in case of service and movement restrictions. As the pandemic persists, with the easy movement of people worldwide facilitating the spread of communicable diseases, it is critical to address the gap in empirical evidence on how FI progresses during a pandemic, and the factors that increase vulnerability to FI during those times, including whether the policies that were implemented are useful. Data from the RAPID: Multi-Wave Study of Risk Perception, Information Seeking, and Protective Action in COVID-19 (Multi-Wave Risk Perception Study) was used to describe FI risk across 3 states in different regions of the US: Washington (WA), New York (NY), and Louisiana (LA). These 3 states are in 3 different geographic regions of the US and have had different COVID onset time points. Thus, this study provides a unique opportunity to examine the risk of food insecurity, perceptions of COVID-related food messaging, COVID-related protective food practices adopted, and food access problems at various levels of COVID onset and with different policy responses across 3 states.

Materials and methods

Study design and population

The Multi-Wave Risk Perception Study collected data using a web-based survey administered by Qualtrics (Qualtrics, Provo, Utah, USA) with the aim to understand information seeking, risk perceptions, and protective behaviors among adults during the COVID-19 pandemic in the United States. The sample included 3 geographically distinct regions: 1 state with early onset of the disease (WA), 1 with later surge of the disease (NY), and 1 with later identification of cases (LA). Participants were recruited using a quota-based proportional sampling method to ensure the study sample mirrored the population on race, age, sex, and income.

Between May 19 and July 14, 2020, a total of 1555 participants, aged 18 years and older, participated in the online survey. The self-reported data from participants were reviewed for quality and those with inadequate quality responses (e.g., gibberish, speeding, etc.), missing demographic variables (sex, income, race, education), and having no response to the relevant food-related questions, were excluded from our analyses. This study was reviewed and approved as exempt by the Institutional Review Boards at [omitted for review].

Food insecurity (FI) risk

The Hunger Vital Signs (HVS) 2-item screening questionnaire was used to identify households at risk for FI.[16] The 2 questions in this screener measure were: (1) worry about running out of food, and (2) running out of food and being unable to obtain more. In this study, participants at risk for FI are defined as those who answered positively to either 1 or Hunger Vital Signs questions. This combination of questions provides a sensitivity of 97% and a specificity of 83% for detecting at risk households.[16] There exist other tools for measuring food insecurity in the US e.g., the Household Food Insecurity Access Scale (HFIAS),[17] or the Household Food Security Survey Module (HFSSM) which can be 18-, 10-, or 6-item questionnaires.[18] However, in public health emergencies when time is of the essence, the use of a simpler tool is often warranted. Therefore, the HVS, as a 2-item questionnaire, allowed a rapid but valid measure of at-risk populations in the US.

Perceptions, practices, and problems

Questions related to perceptions, practices, and problems were identified based on news reports, national guidance provided, and expert understanding of the aspects that were important to investigate. 3 questions were used to evaluate perceptions of the likelihood of COVID-19 infection by: (1) shopping at the local grocery store, (2) eating food that was not fully cooked or that was cold, and (3) going to a bar or restaurant for food. These were measured on a 5-point Likert scale that was collapsed to reflect answers as 'somewhat unlikely (extremely unlikely and somewhat unlikely),' 'neither likely nor unlikely,' and 'somewhat likely (extremely likely and somewhat likely).' 3 questions were also used to assess the adoption of recommended practices to reduce the risk of COVID-19 infection: (1) decreased or stopped going to bars/ restaurants, (2) purchased extra food and/ or commodities, and (3) reduced the usual number of grocery trips. The first 2 questions were coded as 'yes' or 'no.' The third question was measured on a frequency scale which was collapsed to reflect responses that were either positive (sometimes, usually, always) or negative (never). 7 questions were used to determine food-related problems experienced by participants: (1) receiving food assistance, (2) having sufficient space to store 14 days' worth of food, (3) food affordability, (4) ability to find enough food, (5) ability to obtain preferred foods, (6) lack of knowledge on where to find help to access food, and (7) having to go to multiple food source locations for food. The first question was assessed as 'yes' or 'no;' the second question was measured on a 5-point Likert scale that was collapsed to 'somewhat disagree,' 'neither agree nor disagree,' and 'somewhat agree;' and the remaining 5 questions were measured on a frequency scale that was collapsed to positive (sometimes, usually, always) and negative (never) responses.

Co-variates

Socio-demographic variables were also self-reported: age (years), sex (male, female), race (Black, White, Other: Asian, Pacific Islander, Native American, Native Alaskan, Aleutian), ethnicity (Hispanic, non-Hispanic), as well as education (any high school

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to GED, tech school to 2-year college, 4-year college, and above), COVID-19 effect on employment (no change, change: work from home or increased hours, change: furloughed, reduced hours, lost job), relationship status (partnered, not partnered), income (< $25,000; $25,000 - $49,999; $50,000 -$74,999; $75,000 - $99,999; ≥ $100K), and COVID-19 high-risk households (member(s) suffering from an acute or chronic health condition, and/ or aged ≥ 65yo).

Statistical analysis

Frequencies were used to describe the distribution of respondents' characteristics followed by chi-square tests to compare differences across states. Multivariable-adjusted binary logistic regressions were performed to examine the determinants of the risk for FI, overall and stratified by state. The multivariable models were adjusted for factors known to affect FI risk (i.e., race, sex, age, and income), and covariates that were significant at $P < 0.1$ in backward stepwise regressions. To compare the food-related perceptions, practices, and problems according to FI risk: binary logistic regressions for the dichotomous outcomes and ordinal regressions for the categorical outcomes were used. Odds ratios (OR) and 95% confidence intervals (CI) are reported for all regression results. All analyses were performed using Stata v16 (Stata Corp., College Station, TX, USA).

Results

Population characteristics

Table 1 summarizes characteristics of all participants included in this study. A higher proportion of all participants were women, white, non-Hispanic, and partnered. They were also from households at high-risk for COVID-19 and had at least a 4-year college education. Across the states; sex, relationship status, and COVID-19 high-risk households were not statistically different. However, NY respondents were older, WA respondents were more likely to be unpartnered, and LA respondents were less likely to be non-White, non-Hispanics, less educated, and earn lower income. Nearly 50% of all respondents were at risk for FI, with NY (50.4%) having the highest percentage, compared to WA (46.9%), and LA (42.3%).

Food insecurity risk and its determinants

In the overall sample, NY respondents were more likely to be at risk for FI compared to WA respondents (OR = 1.59, 95% CI: 1.15, 2.19), but there was no difference with LA (Table 2). The other determinants identified were income, COVID-19 effect on employment, age, and relationship status, as well as COVID-19 high-risk households. State-stratified analyses identified similarities and differences for determinants of FI risk. Income, COVID-19 effect on employment, and age were relevant in all states, while neither race nor sex were. Additionally, being part of a COVID-19 high-risk household was also a determinant of FI risk in WA (OR = 1.72, 95% CI: 1.07, 2.79) and NY (OR = 3.33, 95% CI: 1.94, 5.73), but not in LA. Risk for FI in NY was higher if respondents were Hispanic (OR = 2.16, 95% CI: 1.02, 4.56). LA respondents were at higher risk for FI if they were partnered (OR = 1.72, 95% CI: 1.05, 2.81), but at lower risk if they had at least a 4-year college degree (OR = 0.46, 95% CI: 0.25, 0.84).

Food-related perceptions, practices, and problems

For the overall sample, perceptions of the likelihood of COVID-19 infection for in-store grocery shopping (OR = 1.30, 95% CI: 1.06, 1.70), and eating cold/ improperly cooked food (OR = 1.87, 95% CI: 1.46, 2.41), but not going to bars or restaurants (OR = 0.91, 95% CI: 0.71, 1.18), were higher among those who were at risk for FI (Table 3). None of the practices: (1) decreasing bar/ restaurant dining, (2) purchasing extra food, and (3) reducing the number of grocery trips were different between those who were at risk for FI and those who were not. Respondents at risk for FI reported greater odds of food access problems. For instance, they were more likely to face affordability issues (OR = 10.66, 95% CI: 7.87, 14.44), to not find their preferred food options (OR = 2.51, 95% CI: 1.86, 3.39), to have insufficient food (OR = 2.63, 95% CI: 1.96, 3.54), to not know where to find help for obtaining food (OR = 7.68, 95% CI: 5.73, 10.31), having to go to more grocery locations to access food (OR= 3.05, 95% CI: 2.29, 4.06), and to have food storage limitations (OR = 2.07, 95% CI: 1.52, 2.81). Respondents at risk for FI were also more likely to receive food aid (OR = 2.33; 95% CI: 1.64, 3.29).

In state-stratified analyses, NY respondents at risk for FI were more likely to perceive in-store grocery shopping as an infection threat (OR = 1.57, 95% CI: 1.02, 2.42), but this perception was not shared by those in WA or LA. Food-related COVID-19 practices were not different by FI risk in WA, but NY respondents at risk for FI reported having reduced the number of grocery trips (OR = 2.09, 95% CI: 1.03, 4.24), while those in LA reported purchasing more food than usual (OR = 1.66, 95% CI: 1.05, 2.61). NY and LA respondents at risk for FI reported facing all the food access problems that were investigated in this study. However, WA respondents at risk for FI did not report statistically significant problems with food storage space, nor having to go to multiple grocery locations for food.

Discussion

This paper explores the determinants of the risk for FI during the COVID-19 pandemic in 3 states differing by geographic locations, onset of COVID-19, and COVID-19 policy implementation. It also examines the experiences of food-related COVID-19 infection risk perceptions, practices, and problems according to the risk of FI in WA, NY, and LA. The 3 states experienced different COVID-19 distribution during our study period: early onset (WA), later onset-quick surge (NY), and later onset-slower spread (LA). Due to the uneven onset and differing state-level responses to the pandemic, the impact on FI is not equal in all states. For instance, NY state respondents in this study had higher odds of being at risk for FI, compared to WA respondents (Table 2). This information is consistent with another report on the state of FI in the different U.S. states during COVID-19.[4] The prevalence of FI rose from 10.5% (pre-COVID) to 22.9% (during-COVID) in NY (Table 4). The prevalence of FI was significantly different between LA (30.1%) and WA (18.6%) in the period immediately preceding our study, between April 23 and May 19, 2020 (Table 4). However, the proportion of respondents at risk for FI were not found to be different between LA and WA in our study which took place between May 19 to July 14, 2020 (Table 2). Given that WA had an early onset of COVID-19 and LA had late identification of COVID-19 cases, this result is indicative that FI risk during the pandemic is long-lasting.

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Table 1. Characteristics of survey participants (N = 1260)

Characteristics[a]	WA	NY	LA	Total	*P**
State sample	428 (34.0)	393 (31.2)	439 (34.8)	1260	
Sex					0.10
Male	182 (42.5)	184 (46.8)	173 (39.4)	539 (42.8)	
Female	246 (57.5)	209 (53.2)	266 (60.6)	721 (57.2)	
Age (mean, SD)	64.01 (16.9)	66.92 (16.7)	63.86 (16.6)	64.86 (16.8)	0.04
Race					< 0.01
White	289 (67.5)	259 (65.9)	320 (72.9)	868 (68.9)	
Black	59 (13.8)	57 (14.5)	80 (18.2)	196 (15.6)	
Other	80 (18.7)	77 (19.6)	39 (8.9)	196 (15.6)	
Hispanic/ Latino					0.02
No	360 (84.1)	332 (84.5)	395 (90.0)	1087 (86.3)	
Yes	68 (15.9)	61 (15.5)	44 (10.0)	173 (13.7)	
Education					< 0.01
HS/ GED or less	103 (24.1)	83 (21.1)	134 (30.5)	320 (25.4)	
Tech to 2-yr college	164 (38.3)	114 (29.0)	150 (34.2)	428 (34.0)	
4-yr college and above	161 (37.6)	196 (49.9)	155 (35.3)	512 (40.6)	
COVID effect on employment					< 0.01
No change	216 (49.2)	155 (39.4)	218 (50.9)	589 (46.8)	
Change: Work from home/ Increased hours	75 (7.1)	91 (23.2)	59 (13.8)	225 (17.9)	
Change: Furloughed/ lost job/ reduced hours	148 (33.7)	147 (37.4)	148 (33.7)	443 (35.2)	
Relationship status					0.37
Not partnered	204 (47.7)	170 (43.3)	192 (43.7)	566 (44.9)	
Partnered	224 (52.3)	223 (56.7)	247 (56.3)	694 (55.1)	
Household income					0.04
< 25K	102 (23.8)	86 (21.9)	131 (29.8)	319 (25.3)	
25K to < 50K	97 (22.7)	76 (19.3)	88 (20.1)	261 (20.7)	
50K to < 75K	87 (20.3)	79 (20.1)	76 (17.3)	242 (19.2)	
75K to < 100K	49 (11.5)	52 (13.2)	66 (15.0)	167 (13.3)	
>= 100K	93 (21.7)	100 (25.5)	78 (17.8)	271 (21.5)	
COVID-19 high-risk households					0.19
No	144 (33.6)	109 (27.7)	134 (30.5)	387 (30.7)	
Yes	284 (66.4)	284 (72.3)	305 (69.5)	873 (69.3)	
At risk for food insecurity					0.07
No	233 (53.1)	195 (49.6)	247 (57.7)	675 (53.6)	
Yes	206 (46.9)	198 (50.4)	181 (42.3)	585 (46.4)	
Perceptions					
Likelihood of COVID-19 infection by:					
. . . Grocery shopping at local grocery store					0.74
Somewhat unlikely	165 (38.6)	148 (37.7)	158 (36.0)	471 (37.4)	
Neutral	92 (21.5)	95 (24.2)	96 (21.9)	283 (22.5)	
Somewhat likely	171(40.0)	150 (38.2)	185 (42.1)	506 (40.2)	
. . . Eating food that was not fully cooked or cold food					0.19
Somewhat unlikely	269 (62.9)	219 (55.7)	267 (60.8)	755 (59.9)	
Neutral	91 (21.3)	88 (22.4)	93 (21.2)	272 (21.6)	
Somewhat likely	68 (15.9)	86 (21.9)	79 (18.0)	233 (18.5)	
. . . Going to a bar or restaurant					0.03*
Somewhat unlikely	112 (26.2)	79 (20.1)	114 (26.0)	305 (24.2)	
Neutral	70 (16.4)	51 (13.0)	74 (16.9)	195 (15.5)	
Somewhat likely	246 (57.5)	263 (66.9)	251 (57.1)	760 (60.3)	
Practices					
Decreased or stopped going to bars or restaurants	283 (66.1)	245 (62.3)	255 (58.1)	783 (62.1)	0.05
Purchased extra food or commodities	168 (39.3)	180 (45.8)	173 (39.4)	521(41.4)	0.10
Reduced number of grocery trips	351 (82.0)	337 (85.8)	354 (80.6)	1042 (82.7)	0.14

(*Continued*)

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Table 1. (*Continued*)

Characteristics[a]	WA	NY	LA	Total	*P**
Problems					
Sufficient space to store 14 days' worth of food					0.92
Somewhat disagree	65 (15.2)	63 (16.0)	65 (14.8)	193 (15.3)	
Neutral	35 (8.2)	36 (9.2)	43 (9.8)	114 (9.1)	
Somewhat agree	328 (76.6)	294 (74.8)	331 (75.4)	953 (75.6)	
Could not afford amount or kind of food preferred	173 (40.4)	160 (40.7)	179 (40.8)	512 (40.6)	0.99
Could not find as much food	291 (68.0)	274 (69.7)	298 (67.9)	863 (68.5)	0.82
Could not find preferred food	292 (68.2)	289 (73.5)	315 (71.8)	896 (71.1)	0.23
Experienced challenges knowing where to find help for food	160 (37.4)	178 (45.3)	160 (36.5)	498 (39.5)	0.02*
Had to go to more places than usual to obtain food	265 (61.9)	255 (64.9)	289 (65.8)	809 (64.2)	0.46
Food assistance receipt	88 (20.6)	78 (19.9)	68 (15.5)	234 (18.6)	0.12

[a]All characteristics are presented as n(%), except when otherwise stated.
*Statistically significant difference between states.

Table 2. Determinants of FI risk by state (OR, 95% CI)*

Characteristics	Overall sample	Washington	New York	Louisiana
At risk of food insecurity, n/ N (%)	585/ 1260 (46.42)	181/ 428 (42.29)	198/ 393 (50.38)	206/ 439 (46.92)
State				
WA	ref	NA	NA	NA
NY	**1.59 [1.15, 2.19]**	NA	NA	NA
LA	1.17 [0.85, 1.60]	NA	NA	NA
Race				
White	ref	ref	ref	ref
Black	1.44 [0.98, 2.11]	1.59 [0.82, 3.09]	0.97 [0.45, 2.09]	1.66 [0.88, 3.12]
Other	1.24 [0.86, 1.79]	1.38 [0.76, 2.50]	1.08 [0.56, 2.08]	1.27 [0.58, 2.79]
Sex: Female	0.77 [0.59, 1.00]	0.66 [0.41, 1.06]	0.80 [0.49, 1.30]	1.00 [0.63, 1.59]
Household income				
< 25K	ref	ref	ref	ref
25K to < 50K	**0.41 [0.28, 0.60]**	**0.46 [0.24, 0.86]**	**0.25 [0.12, 0.55]**	**0.60 [0.31, 1.14]**
50K to < 75K	**0.23 [0.16, 0.35]**	**0.31 [0.16, 0.60]**	**0.20 [0.09, 0.44]**	**0.28 [0.13, 0.54]**
75K to < 100K	**0.16 [0.10, 0.26]**	**0.28 [0.13, 0.63]**	**0.16 [0.06, 0.38]**	**0.15 [0.07, 0.34]**
>= 100K	**0.16 [0.11, 0.25]**	**0.12 [0.06, 0.24]**	**0.22 [0.10, 0.49]**	**0.20 [0.09, 0.44]**
COVID-19 effect on employment				–
No change	ref	ref	ref	ref
Change: Work from home/ Increased hours	**1.81 [1.24, 2.65]**	**2.38 [1.21, 4.68]**	**2.38 [1.21, 4.68]**	**2.21 [1.11, 4.38]**
Change: Furloughed/ lost job/ reduced hours	**2.78 [2.07, 3.74]**	**2.56 [1.43, 4.55]**	**2.55 [1.43, 4.55]**	**3.01 [1.82, 4.99]**
Age	**0.96 [0.95, 0.97]**	**0.97 [0.96, 0.98]**	**0.95 [0.94, 0.97]**	**0.97 [0.95, 0.98]**
Hispanic/ Latino	1.46 [0.99, 2.14]	–	**2.16 [1.02, 4.56]**	–
Education				
HS/ GED or less	–	–	–	ref
Tech to 2-yr college	–	–	–	0.75 [0.44, 1.30]
4-yr college and above	–	–	–	**0.46 [0.25, 0.84]**
Partnered	**1.47 [1.10, 1.96]**	–	–	**1.72 [1.05, 2.81]**
COVID-19 high-risk households	**2.02 [1.53, 2.68]**	**1.72 [1.07, 2.79]**	**3.33 [1.94, 5.73]**	1.55 [0.96, 2.50]

*Values reported are odds ratios with 95% CI unless otherwise specified;
Bolded values indicate statistically significant associations.

Determinants of FI risk

In all 3 states, high income was associated with lower odds of being at risk for FI, while any change in employment during the pandemic was associated with higher odds of being at risk for FI. The results are not surprising since the risk for FI increases when money to buy food is unavailable, insufficient, or spent on other competing needs such as medical supplies or services, education, and/ or accommodation.[3,19] Unemployment is also associated with FI by making it more challenging for households to meet their basic needs.[20] During the COVID-19 pandemic, the US Department of

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Table 3. Food-related COVID-19 infection risk perceptions, practices, and problems (OR, 95% CI)*

Food-related COVID-19 infection risk	Overall	WA	NY	LA
At risk of food insecurity, n/ N	585/ 1260 (46.42)	181/ 428	198/ 393	206/ 439
Perceptions				
. . . Grocery shopping at local grocery store[1]	**1.30 [1.06, 1.70]**	1.20 [0.80, 1.82]	**1.57 [1.02, 2.42]**	1.32 [0.87, 1.99]
. . . Eating food that was not fully cooked or cold food[1]	**1.87 [1.46, 2.41]**	**1.80 [1.15, 2.83]**	**2.00 [1.27, 3.15]**	**1.92 [1.24, 2.96]**
. . . Going to a bar or restaurant[1]	0.91 [0.71, 1.18]	1.05 [0.68, 1.62]	0.77 [0.47, 1.27]	0.99 [0.64, 1.52]
Practices				
Decreased or stopped going to bars or restaurants	0.77 [0.59, 1.00]	0.75 [0.46, 1.21]	0.69 [0.42, 1.13]	0.92 [0.59, 1.43]
Purchased extra food or commodities	1.21 [0.93, 1.56]	0.90 [0.57, 1.42]	1.13 [0.71, 1.81]	**1.66 [1.05, 2.61]**
Reduced number of grocery trips	1.29 [0.92, 1.83]	1.04 [0.57, 1.89]	**2.09 [1.03, 4.24]**	1.24 [0.70, 2.18]
Problems				
Could not afford amount or kind of food preferred	**10.66 [7.87, 14.44]**	**8.69 [5.19, 14.58]**	**14.03 [7.71, 25.54]**	**12.34 [7.21, 21.12]**
Could not find preferred food	**2.51 [1.86, 3.39]**	**2.19 [1.32, 3.65]**	**2.49 [1.42, 4.37]**	**2.89 [1.71, 4.92]**
Could not find as much food	**2.63 [1.96, 3.54]**	**2.29 [1.36, 3.86]**	**3.05 [1.74, 5.32]**	**2.86 [1.72, 4.75]**
Did not know where to find help for food	**7.68 [5.73, 10.31]**	**6.97 [4.20, 11.56]**	**8.20 [4.80, 14.17]**	**9.45 [5.52, 16.18]**
Had to go to more places than usual to obtain food	**3.05 [2.29, 4.06]**	1.67 [1.00, 2.81]	**2.14 [1.22, 3.78]**	**2.67 [1.52, 4.70]**
Insufficient space to store 14 days' worth of food[1]	**2.07 [1.52, 2.81]**	1.68 [1.00, 2.81]	**2.14 [1.22, 3.78]**	**2.67 [1.52, 4.70]**
Food assistance receipt	**2.33 [1.64, 3.29]**	**2.39 [1.36, 4.23]**	**3.32 [1.68, 6.57]**	1.46 [0.78, 2.74]

All models were multivariable-adjusted binary logistic regression unless otherwise specified.
[1]Ordinal regression with models that meet the proportional odds assumption.
*All models were adjusted for: race, sex, income, Hispanic ethnicity, age, COVID-19 effect on employment, partnership status, COVID-19 high-risk household

Table 4. Prevalence of food insecurity and COVID-19 mitigation policies state in 2020

State	WA	NY	LA
Stage of pandemic	Early onset	Later surge	Late identification
FI prior to COVID[1]	9.80%	10.50%	13.60%
FI during COVID[2]	18.60%	22.90%	30.10%
Unemployment			
May-20	15.1%	14.5%	13.3%
Jun-20	9.8%	15.7%	9.7%
Preventive policies already in place[3]			
1. Stay-at-home/ Shelter-in-place			
Start	23-Mar	22-Mar	23-Mar
End	31-May	28-May	15-May
2. Restaurant delivery/ takeout only			
Took effect	16-Mar	16-Mar	17-Mar
Resumed dine-in	May 11-July 3[a]	22-Jun	May 15[c]
3. Non-essential business closure			
Took effect	25-Mar	22-Mar	23-Mar
Re-opening	May 11-July 3[a]	Variable[b]	15-May

[1]FI prevalence from USDA (2018).[1]
[2]FI prevalence from Schazenbach and Pitts (2020). Data from CHHPS between April 23 to May 19 2020.[4]
[3]Mandatory state-wide order.[27]
[a]Variable by county.[27]
[b]Variable by county and business type.[28]
[c]Restaurants allowed to have outdoor seating, but not table service since May 1.[29]

Labor reported over 700000 job losses by the end of March 2020, and high unemployment rates during both May and June of 2020 in all 3 states (Table 4). Additionally, more than 35% of study participants reported being furloughed, working reduced hours, or losing their jobs (Table 1). The loss of income associated with these negative changes in employment increases the vulnerability of households to FI.[20] About 17% of respondents also experienced other changes in their employment through increased hours or resulting work-from-home situations. Interestingly these changes also resulted in increased FI risk, potentially because of job-types (front-line or essential workers),[15] sick family members requiring increased healthcare spending, and higher childcare expenditures due to school closures,[3] among others. However, further research including qualitative studies are needed to understand this phenomenon.

Every yearly increase in age was associated with 3 - 5% lower odds of FI risk in our study. In another COVID-19 study among US adults, similar findings were reported.[19] It is likely that older

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adults have access to resources, such as monetary savings or family support, that act as buffers against the risk for FI.[5] Participants from COVID-19 high-risk households had higher odds of FI risk. Evidence from prior literature suggests that FI is associated with increased healthcare utilization and expenditures among adults.[21–24] This is in part due to the higher financial burden of chronic diseases among food insecure populations, and the trade-offs between medical and food expenditures.[22]

Some determinants of FI risk varied by state, indicating that state-specific policies on certain risk factors may be desirable. For example, higher education was associated with lower odds of FI risk in LA, potentially because higher education may be the gateway to employment and higher income.[21] This was different in WA and NY. Conversely, Hispanic ethnicity was associated with higher odds of FI risk compared to non-Hispanics only in NY. Prior research in the US has established that people of color and Hispanics are the most vulnerable to basic needs insecurities which is compounded during times of disruptions such as the COVID-19 pandemic.[3,4] While this study demonstrates significant consistencies across states, the differences illustrated in the data also indicate a need for state-specific initiatives to complement any nation-wide strategy.

Perceptions, practices, and problems

Among those at risk for FI, only NY residents were significantly more likely to believe that in-store grocery shopping would increase their risk of COVID-infection (Table 4). The higher odds may be due to the COVID-19 stage at the time of survey when NY state was experiencing the highest number of cases as compared to any other US state, as well as the fact that stay-at-home orders were being enforced.[25] Overall, those who were at risk for FI were also more likely to perceive higher likelihood of COVID-19 infection from cold/ improperly cooked food. This belief may have arisen due to unclear messaging about the spread of SARS-CoV2 during the initial stages of the pandemic.

The perceptions associated with the likelihood of COVID-19 infection may also affect FI by making people think more strongly about their dining and/ or grocery shopping practices. For instance, the 2020 Food and Health Survey reported that about 50% of all US adults are concerned about safety of food prepared outside the home during the pandemic.[26] Other studies show that during the pandemic, consumers did indeed reduce the number of grocery trips[27] and preferred curb-side pick-ups or home deliveries over in-store shopping.[11] In our study, when considering all 3 states together, the bivariate association suggested that those who perceived greater likelihood of COVID-19 infection by going to the grocery store were more likely to reduce the number of grocery trips $P < 0.01$, results not shown). Our state-stratified analyses showed reduced number of grocery trips in NY, but not in WA and LA. We did not observe a significant reduction in bar/restaurant dining between those who were at risk for FI and those who were not. These findings may be reflecting the outcome of preventive policies mandating business closure, shelter-in-place, and restaurant take-outs/ delivery-only services that were implemented around the same time in all 3 states (Table 4).

Crucial pandemic-specific food access problems were also identified in this study. First, those who were at risk for FI were more likely to need to go to more places than usual to find food during the pandemic. Going to multiple food locations increases the risk of exposure to the infectious agent,[28] thus making food insecure populations even more vulnerable to the disease. Second, although those at risk for FI were more likely to receive food assistance, they also had food access problems related to affordability, preference, and sufficiency. These are despite the CARES Act and the Families First Coronavirus Response Act that were both passed in March 2020, about 2 months prior to the distribution of this survey. Third, the group at risk for FI was also more likely to report not knowing where to get food aid. This is an opportunity for improved messaging about federal and state food assistance programs. Finally, insufficient food storage within the home for the 14-day quarantine period was found to increase FI risk. This information highlights the need for transdisciplinary interventions with cross-sectoral partners such as architects, developers, housing assistance, and nutrition assistance agencies to ensure that, in the future, emergency preparedness can efficiently support individuals and households with meeting their basic needs. Most of the problems faced by those at risk for FI did not differ by state, suggesting that the problems are widespread and consistent across different experiences of COVID-19. This offers an opportunity to gain experience from and collaborate across states to address FI.

Strengths and limitations

This work adds to the critical evidence needed on the risk of FI during different progression stages of the COVID-19 pandemic by considering different states in the US. This publication is both unique and essential because of all that we do not yet know or understand about the differences in FI risks, perceptions, practices, and problems as the pandemic continues to evolve in the US.

While this study has generated useful information about food-related issues during the pandemic, there are several limitations to note. The survey was only available online and in English, which gives rise to participation bias (i.e., only those who have access to internet, some knowledge of technology, and are fluent in English were included). The sample may therefore not be representative of the states' population, although census-matched quota sampling was used and 9 in 10 Americans reported using the internet in 2018 (89% of non-Hispanic whites, 88% of Hispanics, 87% of Black Americans, and 81% of people with < $30,000/ year in income earning).[29] The bias, if present in this study, will likely have produced underestimations because those with internet access tend to be of higher income. The surveys were also self-reported which leads to the potential for social desirability bias, wherein those who were at risk for FI did not report themselves as such. Nevertheless, because this survey was anonymous, we do not expect any misclassification to be significant. If response bias occurred, the associations observed would be underestimated. While a web survey has limitations, this was a safe mode of data collection early in the pandemic without contact for both study participants and researchers. Our analysis was cross-sectional, which does not allow for temporal determination. However, the RAPID: Multi-Wave Study of Risk Perception, Information Seeking, and Protective Action in COVID-19 study is in the process of collecting more waves of data as the COVID-19 pandemic progresses, and it is expected that longitudinal results will be made available in the future.

Conclusion and public health implication

The outcome of this study provides support for future research on the long-term impact of pandemics or other disruptive events on FI and COVID-19 driven FI in specific racial and ethnic groups; and targets food, nutrition, economic, and other basic-needs assistance

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programs. Although additional research is needed in this area, food access problems in our study did not differ by state, suggesting that country-wide advanced planning for emergencies may be a strategy to avoid widespread FI. Planning should carefully assess the effects of infection-mitigating policy actions on food access.

Data availability statement. TheRAPID: Multi-Wave Study of Risk Perception, Information Seeking, and Protective Action in COVID-19 (Multi-Wave Risk Perception Study), is based upon work supported by the National Science Foundation under Grant No. 2028412.

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