RESEARCH
Original Research

Urban Food Supply Chain Resilience for Crises Threatening Food Security: A Qualitative Study

Amelie A. Hecht; Erin Biehl, MSPH; Daniel J. Barnett, MD, MPH; Roni A. Neff, PhD

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ABSTRACT

Background Businesses and organizations involved in growing, distributing, and supplying food may face severe disruptions from natural and human-generated hazards, ranging from extreme weather to political unrest. Baltimore, Maryland, is developing policies to improve local food system organizations' ability to prepare for, respond to, and recover from disruptive events and ultimately to contribute to food system resilience.

Objectives To identify factors that may be associated with organization-level food system resilience, how these factors may play out in disaster response, and how they may relate to organizations' confidence in their ability to withstand disruptive events.

Design Semi-structured in-depth interviews with representatives of key food system businesses and organizations identified by means of stratified purposive sampling and snowball sampling.

Participants/setting Representatives of 26 food system businesses and organizations in Baltimore stratified by two informant categories: organizations focused on promoting food access, such as governmental offices and nonprofits, and businesses and organizations involved in supplying and distributing food in Baltimore City, such as retailers, wholesalers, and producers.

Analyses Interviews were analyzed using a phronetic iterative approach.

Results The following 10 factors that may contribute to organization-level resilience were identified: formal emergency planning; staff training; staff attendance; redundancy of food supply, food suppliers, infrastructure, location, and service providers; insurance; and post-event learning. Organizations that were larger, better resourced, and affiliated with national or government partners typically demonstrated more resilience factors compared with smaller, independent, and nonprofit organizations.

Conclusion To ensure reliable access to safe food for all people, food system organizations must strengthen their operations to safeguard against a variety of potential threats. This study's examination of factors that contribute to resilience can help food system organizations, researchers, and government officials identify priorities for investigating vulnerabilities in diverse operations and potential strategies to improve resilience in the face of ongoing and growing threats.
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BUSINESSES AND ORGANIZATIONS THAT GROW, distribute, and/or supply food (henceforth, organizations) may face severe disruptions from natural and human-generated hazards, ranging from extreme weather to political unrest. In Baltimore, MD, a mid-sized city in the eastern United States (US), diverse organizations located in or near the city play a role in providing food access for residents, including transportation and distribution hubs, supermarkets and corner stores, food assistance providers, school and hospital food service providers, urban and peri-urban farms, and resource hotlines. In the face of hazards, food security depends on the ability of these organizations to continue to operate and recover quickly.

Food systems must be able to withstand and rebound from acute disruptions such as civil unrest, cyber attacks, or hurricanes, as well as those with more gradual impact, such as drought, sea-level rise, or funding cuts.[1,2] As a result of climate change, extreme weather events such as winter storms, floods, and heat waves are expected to increase in

frequency and intensity in the coming years; longer-term threats to food supply are also forecasted.[3,4] Acute disruptions, the focus of this study, can affect the food system in myriad ways. For example, snowstorms can cause power outages that disable refrigeration and block roadways, hindering food shipments and impeding employees' ability to get to work. Civil unrest can close roads and threaten the safety of employees, vehicles, and buildings.

Populations with social and economic disadvantages are particularly vulnerable to the impact of food system disruptions.[5-7] In Baltimore, nearly one quarter of households experience food insecurity,[8] meaning that they have limited or uncertain access to adequate food.[9] The American Red Cross recommends that households have on hand enough emergency food and water to last 3 days,[10] but those experiencing food insecurity may be unable to meet this recommendation.[11] Thus in cities such as Baltimore with high levels of food insecurity, it is particularly important that food system organizations be prepared for diverse hazards.

Although there is a body of literature on agricultural resilience[12-14] and some literature addressing risks to food system infrastructure at the federal and international levels,[15-17] policymakers and researchers are in the early stages of considering ways to improve resilience across the food system. The need for this work is highlighted by high-profile events that have had devastating effects on food systems, such as Hurricane Harvey in Texas and Louisiana[18,19] and Hurricane Maria in Puerto Rico[20] in 2017 and the Great East Japan Earthquake in 2011.[21] Although definitions of resilience vary widely across disciplines, most focus on capacity to prepare for, respond to, and recover from disruptions.[21] Resilience literature also emphasizes the ability to transform and achieve a new "normal."[22,23]

Baltimore City is developing policies to improve food system resilience. The Baltimore Food Policy Initiative and Office of Sustainability partnered with researchers at the Johns Hopkins Center for a Livable Future to produce a report assessing the strengths and weaknesses of the current system and recommending strategies to reduce vulnerability.[2] Interviews with representatives of food system organizations serving Baltimore City (henceforth, food system actors) informed the report and also form the basis of the results presented in this study.

A better understanding of factors contributing to resilience is needed to guide resilience policy design. Researchers have employed quantitative and qualitative metrics to assess resilience at various levels, including city, community, and supply chain levels.[24] Cutter and colleagues[25] developed the Baseline Resilience Indicators for Communities, which measure community-level resilience before disaster by using indices of social, economic, institutional, infrastructural, community, and environmental capacities and assets. Similarly, the Resilience Community Index, developed by Foster and colleagues,[26] measures regional resilience using indicators encompassing regional economic, sociodemographic, and community connectivity attributes. At the city level, the Rockefeller Foundation City Resilience Index[27] includes 52 measurable indicators and highlights seven qualities of resilience in city systems: inclusiveness, integration, reflectiveness, resourcefulness, robustness, redundancy, and flexibility. The United Nations International Strategy for Disaster Risk Reduction Disaster Resilience Scorecard for Cities[28] lists 85 resilience evaluation criteria for resilience at the city level. At the supply chain level, Smith and colleagues[29] define four indicators with which to assess resilience: scale, diversity, responsiveness, and cohesion.

Limited research has explored organization-level resilience. In the field of business continuity management and planning, in which the majority of such research has occurred,[30] few studies have specifically focused on food industry businesses and nonprofits, which face distinct challenges during crises (eg, food perishability, need for large and constant supply). One notable exception is a 2006 report focused on the food and beverage supply chain in the United Kingdom (UK).[31]

Building on the UK report, the authors interviewed key Baltimore food system actors to identify factors that may be associated with food system organizations' abilities to prepare for, respond to, and recover from disruptions and ultimately contribute to resilience (Figure 1). This study qualitatively examines food system organization-level preparedness and its drivers, the ways in which these may play out in disaster response in Baltimore, and factors affecting organizations' confidence in their ability to withstand disruptive events.

RESEARCH SNAPSHOT

Research Question: What factors are associated with food system organizations' abilities to prepare for, respond to, and recover from disruption and ultimately contribute to resilience and food security?

Key Findings: In this qualitative study including 26 food system organization representatives in Baltimore, MD, the authors identified 10 factors that may contribute to organization-level resilience—formal emergency planning; staff training; staff attendance; redundancy of food supply, food suppliers, infrastructure, location, and service providers; insurance; and post-event learning. Organizations that were larger, better resourced, and affiliated with national or government partners typically demonstrated more resilience factors than smaller, independent, and nonprofit organizations.

METHODS

Approach

Qualitative interviews were selected as an approach because of the exploratory nature of the research and the aim of rich characterization of attitudes, perceptions, and practices.

Recruitment and Sampling

Semi-structured in-depth interviews (n=26) with Baltimore food system stakeholders were stratified by two informant categories: organizations focused on promoting food access, such as governmental offices and nonprofits (henceforth, food assistance providers), and businesses and organizations involved in supplying and distributing food in Baltimore City, such as retailers, wholesalers, and producers (henceforth, suppliers/distributors). The category of food assistance providers included employees and volunteers representing food

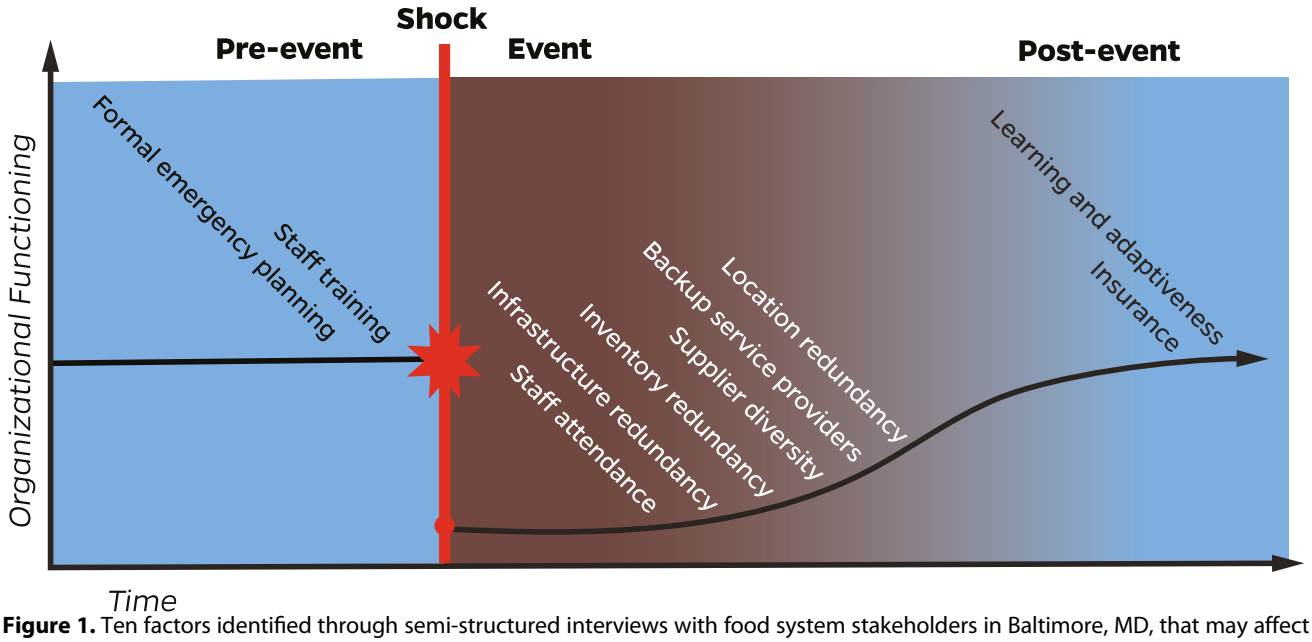

Figure 1. Ten factors identified through semi-structured interviews with food system stakeholders in Baltimore, MD, that may affect food system organizational resilience, mapped along the resilience curve.

assistance organizations (Figure 2). Participants were identified by researchers (EB and RN) and colleagues familiar with the Baltimore food system using stratified purposive sampling and snowball sampling. Sampling continued until theoretical saturation was reached and no new themes emerged. Organizations were purposively selected with the aim of identifying diverse nonprofit, for-profit, and government organizations from across the food system—from production to distribution to consumption. All but one sampled organization agreed to participate; the declining organization cited internal rules regarding research participation. All participants were 18 years or older and worked at organizations located in or serving Baltimore City; no additional exclusion criteria were employed.

Data Collection

Semi-structured interviews were conducted in person (n=21) or by phone (n=5) from June through September 2016. Interviews lasted 30 to 55 minutes, and each participant received a $25 gift card to either a movie theater or chain pharmacy/retail store after completion of the interview. Recordings were transcribed, and identifying information was redacted. During the consent process, participants were informed that their participation was voluntary and confidential, and their identities would not be revealed in the study results. All participants provided oral informed consent. The Johns Hopkins Bloomberg School of Public Health Institutional Review Board (IRB No. 7169) approved this study protocol.

All interviews were attended by at least two interviewers (E.B., R.N., and a third researcher), and several were attended by all three. To ensure consistency of administration, all interviewers were trained in qualitative research and practiced with the principal investigator (R.N.) before conducting interviews. RN administered three initial interviews accompanied by the other two researchers and administered or attended subsequent interviews when available.

During interviews, participants were asked about their organization's efforts to prevent or mitigate effects of hazards and to discuss their experiences during two past events that disrupted food access in Baltimore City (Baltimore Uprising in 2015, Winter Storm Jonas in 2016). Finally, participants were asked about their confidence in their organization's ability to operate during and recover from food system disruptions.

Semi-structured interview guides (Figures 3 and 4) were designed for food suppliers and food assistance providers. Separate from this analysis, the project also included questions for some volunteers representing food assistance organizations in their roles as community members. Interview questions were developed by researchers (E.B., R.N.) in consultation with research partners, based on study objectives and a literature review. Researchers reviewed a UK food and beverage supply chain report[31] and 31 food system plans developed in other cities,[2] then developed a preliminary list of questions by adapting interview questions used in 13 of those food system plans. Interview questions were refined by research staff to fit the Baltimore context and study aims and shared with colleagues for review. The interview guides were further refined after initial interviews, as is common in qualitative research.

Data Analysis

Data were analyzed using ATLAS.ti software.[32] Researchers used a phronetic iterative approach[33] to develop an analytic codebook comprising 10 coding families and 167 codes. Three researchers coded transcripts individually and met to discuss findings and reconcile differences. Then, guided by the list of possible factors related to organizational resilience by the research team, data related to each factor were entered into

	Food Assistance Provider	Supplier/Distributor
Large[b]	Coordinator of federal food assistance program[a]	Store manager of chain supermarket
	Regional officer at national disaster relief organization	Manager and director of college dining services
	Director of out-of-school meal provider organization	Deputy director of food distribution hub
	Director of meal delivery organization	Corporate manager of supermarket chain
	Manager at school food service provider	Manager at processing/distribution company[a]
	Director of resource helpline	Director of hospital food service
	Administrator of federal food assistance program[a]	Manager at maritime port
	Program administrator at food bank	
Small[b]	Director of food pantry	Representative of urban farm
	Director of a shelter/soup kitchen	Owner of independent grocery store chain
	Leader of a church food pantry	Owner of independent farm[a]
	Director of food recovery organization[a]	Owner of independent grocery store
	Administrative coordinator at church food pantry	
	Volunteer with food recovery organization	
	Volunteer with school food pantries	

[a]Denotes interview conducted via telephone.

[b]Perceived size is based on the research team's qualitative judgment using criteria including revenue, number of employees, number of clients served, and affiliation with governmental or national organizations.

Figure 2. A matrix of 26 respondents participating in a semi-structured interview qualitative study of urban food supply chain resilience for crises threatening food security in Baltimore, MD, 2016.

Microsoft Excel[34] for analysis. Quotations were selected to illustrate findings and provide depth.

After extraction, factors that may contribute to resilience were organized using the Haddon matrix, a framework that has been used for more than three decades to understand threats and potential solutions in injury prevention[35] and other fields, including assessment of public health disaster and emergency preparedness[36-38] (Figure 5). The Haddon matrix allows dissection of a problem using dimensions of time and contributing factors: rows represent three phases of time (pre-event, event, and post-event periods), and columns represent four influencing factors (organizational/human, agent/vector, physical environment, social environment/organizational culture).[35] The Haddon matrix provides a valuable framework with which to assess resilience of food system organizations and identify opportunities for policy intervention.

In this article, organizations are occasionally described as large or small. Although the authors considered various criteria to make these distinctions—including revenue, number of employees, number of clients served, and affiliation with governmental or national organizations—no singular definition made sense across organizations with such diversity in form and function. Thus designation of organizations as large (n=15) and small (n=11) is based on research team qualitative judgment using a combination of criteria mentioned previously.

RESULTS

Factors Contributing to Resilience

Respondents discussed diverse factors that may affect their organizations' abilities to prepare for, respond to, and recover from food system disruptions, both positively and negatively. These included formal emergency planning; staff training; staff attendance; redundancy of food supply, food suppliers, infrastructure, location, and service providers; insurance; and post-event learning. These factors are presented in the following sections according to the Haddon matrix stage in which they play the most significant role.

Pre-Event Factors

Formal Emergency Planning. More than half of respondents said their organizations had formal plans to address multiple types of disruptive events. Some were handed down by parent organizations; other organizations were required to develop plans by funders or accreditation boards. Every organization with a formal plan had designated employees to update the plan regularly.

A few organizations had developed formal plans to handle only the most common types of emergencies. One food distributor explained how her organization planned only for snowstorms:

> *We don't have any other major plans. [If] a disaster would happen, we will work directly immediately with*

everybody in the surrounding areas. And we do what we can at that point in time.—Supplier/distributor 1

Many smaller nonprofits and retailers said they lacked formal emergency plans altogether and instead adopted a "come what may" attitude, emphasizing they would do what it took in the moment to respond. A few respondents from organizations without formal plans discussed wanting plans but lacking the time or expertise to develop them. As one farm manager explained:

Within our group I guess we don't feel like we have the expertise or the knowledge to really know how to address these things.—Supplier/distributor 2

Staff Training. Effectiveness of emergency response may be influenced by the extent to which staff are trained and protocols communicated. Although many large organizations indicated that they conducted regular staff training sessions, most of the smaller nonprofits and retailers did not. One nonprofit director explained:

[Staff training] doesn't happen as frequently as I would like it to happen. If I had an HR person or department, it would definitely happen a lot more.—Food assistance provider 1

A few organizations indicated that they discuss components of emergency protocols during staff meetings or distribute written notices. A few also indicated that they conduct drills with all employees or tabletop exercises with senior management. Two large organizations explained that running through drills is time and resource intensive, however, and thus done rarely.

Although a few larger organizations reported that they had official command centers or incident response teams, at most organizations, an on-duty manager or senior-level employee was responsible for overseeing emergency response. As such, most organizations prioritize training for the senior managers responsible for overseeing emergency response. One food assistance provider estimated that approximately 20% of his staff are well acquainted with emergency procedures, and these employees would be responsible for managing their colleagues when a disaster strikes. Similarly, all respondents representing retail outlets explained that only senior store managers participated in training sessions. According to the director of a large chain retailer:

This type of stuff is done, and again, it's really the management level. You think the management level, and the assistant manager level, the department manager level. That's really where we spend the energy.—Supplier/distributor 3

Event Factors

Staff Attendance. Respondents mentioned that having enough staff available to work was critical to their organizations' abilities to operate. An organization's stated and unstated expectations may affect employees' willingness to respond and attendance during crises. Most organizations had high expectations for employee attendance but made exceptions for situations that might threaten employee safety. As summarized by one food distributor:

Our expectation is if they can come in safely without putting themselves at risk, we expect them to come in. If there is a risk, then we expect them to stay home.—Supplier/distributor 4

A few organizations reported having stricter attendance policies, which were discussed with new employees during the hiring process. One manager of a large meal service provider explained:

The expectation…is that we are open 365 days, 24 hours a day. When we know it's going to snow and stuff like that, you need to plan to be here. People need to have their own contingency plans in place.—Supplier/distributor 5

Other organizations said they also assigned designations to employees to make clear who was needed during emergencies. Several organizations affiliated with larger entities, including city government and a major university, reported following their parent organizations' closure policies (eg, if schools close, school-based food assistance providers also close).

More than half of participating organizations said they provided employees some support to get to work in a crisis. A few large organizations with critical functions, such as hospitals, university food service providers, and food distribution hubs, as well as one large chain retailer, said they pay for employees to stay in nearby hotels or provide housing on site. One small storeowner also said some employees, many of whom are family members, sleep in the office above his store overnight when a storm is forecasted. Nearly half of the organizations also reported informally sending employees with four-wheel drive vehicles to retrieve coworkers.

One large retailer with several city locations reported redistributing employees during emergencies, allowing employees to work from the location closest to home. Two other organizations said their operations were organized to allow employees to work remotely as needed.

Most of the nonprofit organizations included in the study depended heavily on volunteers. At one church food pantry, the manager estimated that nearly 90% of volunteers are retired seniors, many of whom experience mobility challenges. During events that make roads unsafe and shut down public transportation, many of these volunteers are unable to come in to serve.

If the volunteers can't get here then we can't do the pantry. That's really it.—Food assistance provider 2

An organization's mission may influence staff attendance. Many nonprofits are mission driven, motivated by a desire to serve vulnerable populations. At these organizations, respondents reported that staff often brave closed roads and extreme weather to continue to fulfill their duties, and community members who live within walking distance fill in when emergencies limit volunteer travel. As one food pantry director explained:

You have some community people that come in and they step up to the plate to help you out.—Food assistance provider 3

Organizations that were family run and operated also said they were likely to continue operations through emergencies, often because staff live on site.

Part 1: Introductory questions

1. Can you tell me briefly about your current role in your government agency/office?
   A. How long have you worked in that role?
   B. To what extent are you involved in planning for emergencies?

2. Please think for a moment about the types of hazards that could disrupt food access for the people of Baltimore. Can you name a few?
   A. Looking at this list, which would you say are the top three posing the greatest threat to your company/organization's ability to provide food to the people of Baltimore?

[SHOW ON PAPER: flood, snowstorm, damage to electrical lines, damage to cyber networks, drought in areas where food is produced, civil unrest, epidemic, rising costs of needed supplies like fuel, damage to key facilities, other (what)]

Please talk me through each of these in terms of how they could play out for your company/organization, your reasons for concern, and level of concern.

3. What was your organization's/agency's experience in Winter Storm Jonas in relation to assisting with food access? The Baltimore uprising?

4. Have you experienced an event where your organization lost power? If so, could you tell me about your experience then?

Part 2: Existing preparedness and roles

5. Please tell me about what, if anything, your organization/agency is currently doing to prepare for such threats, in as much detail as possible. Please share everything you can think of to tell me about it.

Prompts/follow-up questions:
   A. What hazards are you preparing for?
   B. What risk management processes/approaches/tools are in use to identify and assess threats/risks?
   C. How would you characterize the level of ongoing effort in preparedness?
   D. Do you record incidents and near misses or formally capture and share lessons learned?

6. Is there a formal plan or emergency protocols? What about informal planning?

IF YES TO EITHER:
   A. What do the plans entail?
   B. How often are they updated?
   C. How are plans communicated within the organization? Are they tested, such as in full-scale drills?
   D. To what extent do the plans you're describing involve other organizations, and if so, which?
   E. What motivated the organization to develop these plans, and when?
   F. How effective do you think you and the staff would be in carrying out the plan?
   G. How effective do you think the plan would be in controlling the risk in the event of one of these crises?

7. [For those who say their organization has done planning] Who has primary responsibility for emergency planning and response? (Individual/department/everyone? Site level vs centralized?)

8. Have you faced events that caused you to activate the plans?
   A. IF SO: How did that go?

9. Does your organization hold insurance coverage? If yes, what disruptive events does it cover?

10. What are the expectations for employee attendance and for volunteers during a disruptive event?
   A. What if transportation is disrupted, schools are out, or there is something else preventing workers from coming in?
   B. Is there any assistance provided to help workers or volunteers get there?

Part 3: Baltimore City Planning Effort

As we described, Baltimore City is working on a plan to help ensure residents, especially those who are already food insecure, can get food in the event of various crises.

11. What should other city agencies do to assist you in your preparedness?

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Figure 3. In-depth interview guide for those working to improve food access: government and nonprofit organizations.

12.	What should state and federal government agencies to do assist you in your preparedness?
13.	Do you have other recommendations for the planners to be thinking about?
14.	Is there anything else that you feel is important that has not been covered in this interview?
Part 4: Organizational background [research the answers to these questions and do not ask if information is available]	
15.	How large is your agency/organization?
16.	How many service sites do you have in the Baltimore area?
17.	Who are your clients? Where are your clients located (neighborhood)?

Figure 3. *(continued)* In-depth interview guide for those working to improve food access: government and nonprofit organizations.

Redundancy

Infrastructure Redundancy. Organizations had multiple tools that they could use to help them remain open through disruptive events. In particular, nearly half reported that they had backup generators, and a few had on-hand dry ice and refrigerated trucks that could hold perishables. One meal service provider said her organization had propane grills and butane burners that could be used to prepare food if kitchen power were out. Two farms and one large chain retailer said they had rain barrels and portable water pumps in case of water supply outage or, for farms, short-term drought. Several organizations also reported having their own snow plows or contracts with private plowing services so they did not have to rely on the city for plowing. One large chain retailer also had private security guards, which allowed it to stay open during the civil unrest.

Only a few organizations reliant on cyber communication had internal intranet servers that may be protected in a cyber outage and allow them to maintain internal operations and communication. Additionally, many had formal emergency plans available only in digital format and did not have hard-copy backup in case of outages. Only one organization had order and intake forms available in hard copy, which can be uploaded when a network connection is restored after an outage.

Organizations that were large or affiliated with a parent organization more frequently had one or more types of backup infrastructure compared with smaller and nonaffiliated organizations. Several nonprofits and small retailers discussed a desire for backup generators but lacked funds. One small grocery store owner explained the economics of why he chooses to rely on insurance to cover loss of products during a power outage as follows:

> *For you to have a generator that can actually run the refrigeration in the store costs about a half million dollars and then you've got to pay about $10,000 of your service contract, so I…generally buy insurance and try to cover my loss with insurance instead of trying to plan around it with the generator side.*—Supplier/distributor 6

A few organizations that could not afford generators or refrigerated trucks reported relying on help from suppliers during some emergencies. The same store owner explained that his primary supplier occasionally provides a refrigerated truck during power outages.

> *Generally, if it's an isolated problem, Baltimore City, local thunderstorm or anything, they'll give me a truck with a [refrigerator] within three or four hours, six hours. It's kind of an understanding, I guess…they want me to be successful.*—Supplier/distributor 6

Inventory Redundancy and Supplier Diversity. The amount of food that an organization has on hand in advance of an event and the organization's ability to quickly restock may determine how successfully it withstands a disruptive event. Under normal circumstances, food retailers engage in careful inventory management to control the ordering, storage, and stocking of items and minimize waste. In advance of weather events that can be predicted, such as snowstorms, all retailer respondents said they increase their stock of "essentials," such as bread, milk, and bottled water. Some, however, said they found stockpiling food challenging because of space limitations and perishability. One small retailer said:

> *This is a small store and it's hard to have extra produce laying around…When that truck [delivering produce] got here…it was going right to the shelf.*—Supplier/distributor 7

Several of the food assistance and meal service providers said they stockpile shelf-stable or frozen meals at the beginning of winter to have on hand when storms hit. When winter storms are predicted, many food assistance providers said they use phone trees and word of mouth to encourage clients to come stock up, and a few meal service providers deliver shelf-stable or frozen meals to clients in advance. A representative from one organization that provides free meals at community sites throughout the city explained:

> *So [sites] have two days' worth of supplies, and then the hope is that, in those two days, we could clear out some of the major arteries of the city, and then we would be able to replenish those meals.*—Food assistance provider 4

Having diverse suppliers may also influence an organization's degree of resilience. For example, if a food retailer relies exclusively on one out-of-state supplier, and that supplier is unable to make deliveries because of road closures, the retailer may be forced to close.

All organizations reported having more than one supplier, although the number varied widely. Some organizations said they recognized the value in having multiple suppliers and worked to diversify. As one representative explained:

Part 1: Introductory questions

1. Can you tell me briefly about your current role in your company/organization?
   A. How long have you worked in that role?
   B. To what extent are you involved in planning for emergencies?

Part 2: Threats to operations

2. When faced with events or threats that may disrupt normal operations, businesses may engage in preparations to minimize a threat's effects. What term would you use to describe this process of planning or preparing? *[Use person's term for the rest of the interview.]*

3. Please think for a moment about the types of hazards that could disrupt your company/organization's operations and ability to provide food to the people of Baltimore. Can you name a few?

Here is a list of other possible hazards we're thinking about, just so you have them in mind as we go through the rest of the questions.

[SHOW ON PAPER: flood, snowstorm, damage to electrical lines, damage to cyber-networks, drought in areas where food is produced, civil unrest, epidemic, rising costs of needed supplies like fuel, damage to key facilities, other (what)]

4. We'd like to learn more about some potential threats. What would you say are the top three food system threats to your company/organization's ability to provide food to the people of Baltimore?

Please talk me through each of these in terms of how they could play out for your company/organization, your reasons for concern, and level of concern.

Prompts:

   A. How likely do you think it is that this event will occur?
   B. What parts of your company/organization face the greatest risk?
   C. Would the loss/failure of any class of supplier(s) operations halt yours? If so, which ones?
   D. How long might it take your company/organization to get back on its feet?

5. [If not already covered above] What was your organization's/agency's experience in Winter Storm Jonas in relation to its ability to provide food? The Baltimore uprising?

Part 3: Existing preparedness and roles

6. Please tell me about what, if anything, your company/organization is currently doing to prepare for such threats, in as much detail as possible. Please share everything you can think of.

Prompts/follow-up questions:

   A. What hazards are you preparing for?
   B. What risk management processes/approaches/tools are in use to identify and assess threats/risks?
   C. How would you characterize the level of ongoing effort in preparedness?
   D. Does the organization record incidents and near misses or formally capture and share lessons learned?
   E. Is there insurance, and if so, for what?

7. Is there a formal plan or emergency protocols? What about informal planning?

IF YES TO EITHER:

   A. What do the plans entail?
   B. How often are they updated?
   C. How are plans communicated within the organization? Are they tested, such as in full-scale drills?
   D. To what extent do the plans you're describing involve other organizations, and if so, which?
   E. What motivated the organization to develop these plans, and when?
   F. How effective do you think you and the staff would be in carrying out the plan?
   G. How effective do you think the plan would be in controlling the risk in the event of one of these crises?
   H. Do you know how much your suppliers have planned for supply chain disruptions?

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Figure 4. In-depth interview guide for businesses and organizations involved in supplying and distributing food.

8. [For those who say their organization has done planning] Who has primary responsibility for emergency planning and response (Individual/department/everyone? Site level vs centralized?) A. Who decides the protocols? [If organization is part of a larger chain, probe to find out if policies are set at store level or higher up.] B. To what extent are supply chain specialists (eg, purchasing, logistics, operations) formally involved in planning?
9. Besides your own plans, are there any other voluntary or mandatory government requirements for emergency preparedness that you follow?
10. Have you faced events that caused you to activate (any of) the plans? A. IF YES: How did that go? B. After a disruptive event, has your organization been offered or sought support from government or other nonprofit entities? If yes, describe that support.
11. What are the expectations for employee attendance during a disruptive event? A. What if transportation is disrupted, schools are out, or there is something else preventing workers from coming in? B. Is there any assistance provided to help workers get there? [If larger chain says YES, ask who pays for the assistance.]
Part 4: Capacity assessment Thinking about the threats we've just discussed, we'd like to know more about your capacity to supply food in the event of a threat. Specifically…
12. How long could the company/organization maintain operations if movement of goods between sites were stopped or seriously impaired?
13. What is the shelf life of your stocks? (How many days could you continue providing food if supply was cut off?) A. What would run out first? B. What would be the recovery time/replenishment lead time for stocks? C. Would storage of finished goods or waste disposal problems halt operations?
14. [Don't ask emergency providers] Does the company/organization have data on panic buying patterns for key categories of product? (Under normal circumstances and after surge, eg, panic buying?)
Part 5: Baltimore City Planning Effort As we described, Baltimore City is working on a plan to help ensure people can get food in the event of various crises and to help the city's food system bounce back as well and as quickly as possible.
15. What would be valuable for the city to do to assist you in your preparedness?
16. Do you have other recommendations for the planners to be thinking about?
17. Is there anything else that you feel is important that has not been covered in this interview?
Part 6: Organizational background [Research the answers to these questions and do not ask if information is available.]
18. How large is your company/organization? How many sites do you have in the Baltimore area?
19. Who are your customers? What is the breakdown of your customers in food retail, food service, schools, other public/nonprofit institutions? Where are your customers located (neighborhood)?

Figure 4. *(continued)* In-depth interview guide for businesses and organizations involved in supplying and distributing food.

> *We get [food] from so many sources. So, at all different times of the days, all different days of the week, including weekends sometimes, we have everything from grocery stores to farms, to farmers' markets to everyone bringing us tons and tons of food, so if one source would shut down, it wouldn't hurt us.*—Food assistance provider 1

Backup Service Providers and Location Redundancy. Organizations that work closely with other institutions that provide similar services or that have multiple locations may be more resilient. A few of the multisite organizations explained that if one site were closed, clients could be diverted to another. For example, when discussing how a flood might affect her organization's operations, one food assistance provider said:

> *Because we have, as I said, sites all across the city, even if it flooded, it would be unusual for the whole city to flood, so we could still provide services. If a client wanted to come to one of our other locations and could get there, we could do that…If they could get on a subway, bus—there's public transportation available.*—Food assistance provider 5

Several of the food assistance providers also reported working together during disruptive events. One food pantry manager described a partnership among four neighboring pantries and the steps they take to accommodate each other's clients.

> *We're working together. We'll have some kind of sustainability for our clients in this general area if something happened to one of the pantries. For an example, when we go on vacation for a week then we link up with our pantry partners, and we send our clients to them so they can have resources while we're down.*—Food assistance provider 6

Post-Event Factors

Insurance. An organization's ability to recover after an emergency may be affected by the extent of its insurance coverage. All but one organization reported having at least one form of insurance, including insurance plans for loss of business, property, vehicles, crops, and workers' compensation. Most organizations were self-insured, but a few had insurance through a parent organization. Most organizations reported never or very rarely filing claims.

The representatives of the two urban farms interviewed found acquiring sufficient insurance challenging. One farm reported being uninsured, and the other reported being underinsured. One urban farm representative explained:

> *A traditional farm will have crop insurance that can protect against weather disasters, and that is something we've thought about, but again, because of our [small] scale it's just not even really worth it. You're paying this insurance premium, and that in and of itself might put you out of business.*—Supplier/distributor 2

Learning and Adaptiveness. An organization's desire and ability to reflect on and learn from past disruptive events and adapt its practices may have an impact on resilience. Reflectiveness is the use of previous experience to inform future decisions and modify standards and behaviors.[27]

Several organizations indicated that after a disruption, they assembled key staff to debrief and discuss lessons learned. Most had a team that met regularly to review and update emergency plans as needed. One food distributor described the protocol his organization follows after all disruptive events as follows:

> *We go back over what we did and what we could have done better and what we did totally wrong…We review [emergency plans] every year and then revise them as we need.*—Supplier/distributor 8

A few organizations indicated that they followed a less formal reflection process and did not have an established protocol for updating emergency plans (if they had emergency plans at all). One small retailer said that while he had personally reflected on how his store could respond more effectively during power outages, he had not conveyed those reflections to his staff.

Confidence in Ability to Respond

When asked about their confidence in their organization's ability to effectively execute an emergency response, nearly all respondents reported a high degree of confidence. They cited reasons including their success in handling past disruptive events, the steps they had taken to prepare, and the commitment of their staff. One food assistance provider explained:

> *Very effective, for many of the reasons that we've already stated. One is that we're deeply engaged at the city and county levels and statewide in the standing emergency groups that exist…We also have other partners that we can pivot to. We have our own inventory of items that we can deploy.*—Food assistance provider 7

A few organizations indicated a high degree of confidence in managing more routine or small-scale disruptions, such as power outages and snowstorms, but not more unusual or far-reaching events, such as earthquakes or terrorist attacks. Several respondents also explained that although their official plan may be sound, effective response would depend on the experience and training of the employees implementing it. As one distributor explained:

> *I think any plan is only as good as the people that know it and implement it…I don't care how many times you read it, until you live it, you are not going to be very effective at it. But, after you have done it for like twenty years, you know who to call and what to do and how to act.*—Supplier/distributor 8

DISCUSSION

The ability of local food system organizations to prepare for, respond to, and recover from threats to operations is critical to public health and food security. This study builds on the research presented in the UK report[31] to consider the unique risk profile of local food system organizations in a mid-sized US city and identify and describe factors that may contribute to their resilience. Improved understanding of these factors should guide policymaking.

The resilience factors suggested by this study overlap with and build on many factors highlighted in existing resilience indices in other sectors and at the city and supply-chain levels.[27-29] For example, the World Health Organization's Safe Hospitals Index identifies many of the same contributors to resilience during the pre-event and event stages, such as formal emergency planning and redundancy, but does not include consideration of post-event stage factors such as insurance or adaptiveness.[39] Although other existing frameworks do not focus on the food system, most similarly place emphasis on the importance of relationships and communication between parts of the system, diversity and redundancy of infrastructure and organizations, and post-event learning.

In this study, food system organizations demonstrated a range of capacity for factors potentially associated with resilience. A few organizations demonstrated all or nearly all factors, whereas others demonstrated only one or two. Overall, findings indicate that organizations that are larger, better resourced, and affiliated with national or government partners typically demonstrate more resilience factors compared with smaller, independent, and nonprofit organizations. Smaller and independent organizations often engage less in formal preparation and often lack backup

Phase	Organizational/human	Agent/vector	Physical environment	Social environment/ organization culture
Pre-event	• Risk assessment • Development of emergency plan[a] • Staff emergency response training[a] • Monitoring for potential disruptions • Pre-event communication with consumers	• Efforts to mitigate risk or magnitude of event (eg, GHG[b] reduction initiatives)	• Stockpiled food[a] • Private backup infrastructure[a] • Public infrastructure (eg, transportation, power lines) • Protected storage developed for food and water supplies, trucks, etc • Communication systems • Infrastructure constructed for resilience	• Relationships with diverse suppliers[a] • Staff knowing functional role(s) in emergency response • Staff participation in readiness training, exercises, and drills[a] • Organizational culture facilitating effective response • Relationships and communication strategies with communities
Event	• Intra-agency communications and collaboration[a] • Staff response execution • Support to enable staff/volunteers to work (eg, child care, transportation)[a] • Monitoring system to identify areas of greatest need	• Efforts to reduce disruption caused by the disruptive event, where feasible (eg, trying to quell violence in civil unrest)	• Command center setup and operations[a] • Accessibility of transportation • Stockpiled food[a] • Access to backup infrastructure, protected storage[a] • Functional communication system	• Expectations for staff attendance[a] • Organization mission[a] • Willingness of other volunteers and organizations to provide backup support[a]
Post-event	• Post-event restocking and repair of infrastructure • Use of insurance[a] • Application of lessons learned to improve response systems[a] • Funding, other support provided to enable organizational recovery and long-term planning	• Efforts to reduce long-term effects of the shock (eg, quickly rebuilding damaged supplies and infrastructure)	• Application of lessons learned to better safeguard vulnerable infrastructure • Funding, other support to enable recovery of physical infrastructure	• Willingness of staff to embrace lessons learned • Post-event community trust in organization • Flexibility in developing new relationships if some organizations close

[a]Indicates item assessed in this study.

[b]GHG=greenhouse gas.

Figure 5. Haddon matrix[32] applied to food system resilience.

infrastructure. The mission-driven and family-run nature of many smaller, independent organizations, however, may compensate in part for their lack of formal preparation, with more dedicated staff and thus better attendance.

These qualitative findings are consistent with results of other studies in the field of supply chain management that have examined organization-level emergency preparedness.[30,40-42] The UK report similarly indicated that resource constraints—including lack of funding, personpower, and expertise—were impeding preparedness efforts for many organizations.[31] Additionally, several studies that have examined the differences between organizations of different sizes and affiliations also showed that larger businesses and businesses that are part of chains are typically more prepared for emergencies than smaller and independent businesses.[30,31,40] Recent events also underscore the remarkable recovery capacity of large US retailers. After Hurricane Harvey, which dropped 40 to 52 inches of rain on southeast Texas and southwest Louisiana in August 2017, many large grocers were able to swiftly rebuild their supply chains and reopen.[18,19]

Despite wide variation in preparedness across organizations, nearly all respondents reported high confidence in their organizations' abilities to respond to disruptions. This confidence largely stemmed from past success in handling disruptions that occur regularly in Baltimore, such as power outages and snowstorms. If climate change projections are on target, however, extreme weather events such as hurricanes are likely to become more severe and common. Most respondents said their organizations had given little thought to preparing for these less common disruptions and were unequipped to handle them. Similarly, few had considered strategies to prepare for cybersecurity threats.

In this study, the Haddon matrix was used as a lens to highlight potential areas for targeted intervention by local, state, and federal governments. In the pre-event stage, local governments can facilitate relationships among key organizations and support information sharing, pooling of limited resources, coordination of backup providers, and city-wide planning, using Baltimore's planning efforts[2] as a guide. Local government can also lead training sessions to provide food system organizations with more information about preparing for disruptive events. One of the greatest barriers to preparedness identified is a lack of funds. In the pre-event phase, federal, state, and local government can offer grant funding for nonprofits to support staff time for emergency planning and subsidize or provide tax incentives to encourage purchase of backup infrastructure.

During the event and post-event stages, local government should consider strategies to improve interoperability of communication systems to enable organizations to interface successfully and thus support information sharing and coordination of services. To facilitate recovery in the post-event stage, federal and state government agencies could help small and urban farms protect their assets by making affordable insurance policies available. Local government can also convene food system actors for debriefing, discussion of lessons learned, and identification of opportunities to improve future resilience.

Furthermore, although this article is primarily concerned with supply chain *adaptation* to climate change and other emerging threats, the food system itself contributes in myriad ways to climate change.[4] Local governments can support activities that have dual benefits for climate change mitigation and long-term resilience, such as supporting local and regional agriculture or procurement of foods with lower greenhouse gas footprints. These activities can also serve to create jobs and stimulate regional economies. For example, Baltimore uses a land leasing initiative to encourage urban farmers to repurpose vacant plots,[43] and other cities have encouraged farming practices that use innovative techniques to minimize energy, water, and space needed to grow food.[44] To support these efforts, cities should foster collaboration across government agencies with expertise in urban planning,[45] public health, and food systems.

Implications for Nutrition and Dietetics Professionals

Although food insecurity is a major concern in the fields of nutrition and dietetics, to date, little attention has been paid to the threats to food security posed by acute disruptions to the food system. Nutrition and dietetics professionals can help prepare their communities to weather acute food system disruptions by educating individuals about the importance of keeping a 3-day supply of food and water at home.[10] Furthermore, nutrition and dietetics professionals can play an important role in advocating for interventions to make the food system more resilient, working either through their local food policy councils (a list is available from Food Policy Networks[46]) or local professional associations.

Strengths and Limitations

This study has several limitations. Although it includes perspectives from a wide variety of food system actors, it is small in scope, and a purposive sampling approach was used. Second, because definitions of large and small organizations are based on the qualitative judgment of the research team, it may be challenging to compare results with those of other studies. As in all qualitative research, it is also possible that researchers unconsciously influenced results through the way interviews were conducted or analyzed. Additionally, findings may not be generalizable to rural and suburban settings, cities that are considerably smaller or larger, or areas outside the US. Food system resilience in small cities and rural areas is particularly important, given that in the wake of disasters, these areas often receive less attention and fewer resources for recovery compared with larger cities. More research involving a broader array of actors, use of mixed methods, and different geographic scales is needed to develop indicators of organization-level resilience that can be measured, tracked, and compared across studies. The Haddon matrix should be further applied in subsequent food system analyses in other types of communities to identify generalizable insights and opportunities for policy intervention.

CONCLUSION

Hazards that disrupt the local and nonlocal food systems are likely to increase in severity and frequency in the coming years. To ensure reliable access to safe food for all people, food system organizations must strengthen their operations to safeguard against diverse potential threats. This study's

examination of factors that may contribute to organizational resilience can help organizations, researchers, and government officials identify priorities for investigating operational vulnerabilities and possible strategies to improve resilience in the face of growing threats.

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For more information on the subject discussed in this article, see Sites in Review on page 353.

AUTHOR INFORMATION

A. A. Hecht is a doctoral candidate, Center for a Livable Future, Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD. E. Biehl is senior program coordinator, Center for a Livable Future, Department of Environmental Health & Engineering, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD. D. J. Barnett is an associate professor, Department of Environmental Health & Engineering, Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD. R. A. Neff is an assistant professor, Center for a Livable Future, Department of Environmental Health & Engineering, Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD.

Address correspondence to: Roni A. Neff, PhD, Center for a Livable Future, Johns Hopkins Bloomberg School of Public Health, 111 Market Place, Suite 840, Baltimore, MD 21202. E-mail: RNeff1@jhu.edu

STATEMENT OF POTENTIAL CONFLICT OF INTEREST

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A. A. Hecht coded and analyzed data and drafted the manuscript. E. Biehl helped conceptualize the research study, collected and analyzed data, and edited the manuscript. D. J. Barnett helped conceptualize the analysis and edited the manuscript. R. A. Neff initiated the project; oversaw and participated in research design, data collection, and data analysis; and edited the manuscript.