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Risk perception and emergency food preparedness in Germany

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ABSTRACT

Events that cause an interruption of the food-supply chain (e.g. blackout in the Münsterland in 2005) are thought to have a low probability but high impact on the German society. For this eventuality, public authorities want the public to be prepared for food shortages, but they perceive the public as not being receptive for emergency food-preparedness issues. Nevertheless, research shows that Germans actually store food to a certain extent. Furthermore, risk perception should not be understood as a unidimensional construct; instead it has various aspects. In this study, we investigate risk perception and emergency food preparedness in Germany to improve preparedness-education efforts. We conducted an online survey (n = 1979) and asked people how they would perceive and react to a hypothetical food-shortage scenario. Results show that people in Germany can be categorized into four different preparedness types (the self-confident all-rounders (31%), the unsure non-prepared (27%), the unconcerned optimists (24%) and the risk-oriented independents (18%)) and their storing behavior is mainly driven by reasons of convenience. Accordingly, efforts by public authorities to strengthen the food preparedness and resilience of the German society have to target these preparedness types and connect emergency food-preparedness issues to peoples' everyday lives.

1. Introduction

People in Germany live in an affluent society and most of them do not need to worry about food and water supplies in their everyday lives [1,2]. They are used to having a wide range of food products constantly available in supermarkets, gas stations, or even farmer markets. In most urban areas such as Berlin, people even have 24/7 access to supermarkets, eating-out options and/or delivery services.

Nevertheless, due to its complexity and interdependency, this system of food supply is vulnerable [3]: The food-supply chain, including production, processing, distribution, and consumption, is depends strongly on a functioning electricity supply. For example, in the case of dairy production, milking cows is mostly an automated and computer-controlled process that is dependent on electricity. The same applies to the ultra-pasteurization to make it durable. Trucks that deliver milk to retailers need fuel from power-operated gas stations. Finally, most grocery stores rely on power to open their doors, get their cash-register system functioning and cool their chilled products. The power supply can be affected by hacker attacks on SCADA-system power plants [4] or by the increasing impact of natural disasters as well as extreme weather events [5,6]. In 2005, for example, power lines broke due to heavy snowfall and frost in the Münsterland region and 250,000 people went without power for several days [7]. Additionally, most of the food-supply infrastructure and resources are owned by private companies that have "developed sophisticated mechanisms to deal with sudden shifts in demand and supply, react to commonplace impairing incidents (e.g. traffic congestions) smoothly and overcome the various hurdles of day-to-day business while relying on the small profits afforded by a crowded market" [3; p. 41]. A more significant interruption of these interdependent systems could quickly cause a food shortage.

Events like in the Münsterland in 2005 are thought to have a low probability but high impact on German society. Accordingly, the German Federal Ministry of the Interior considers the food supply for the German population as a part of the critical infrastructure "food" (Federal Ministry of the Interior, Building and Community [8,9]. Critical infrastructures are "organizations or institutions of special importance for general life whose failure could lead to severe supply bottlenecks, significant disruption to public safety or other dramatic consequences" [8, p. 11]. A food-supply crisis occurs when the provision of the food supply cannot be guaranteed for a major part of the people of the Federal Republic of Germany and the government has to intervene (e.g. by determining prices) to reestablish the food supply (Ernährungssicherstellungs- und -vorsorgegesetz [ESVG], 2017, §1).

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Nevertheless, there are no legal requirements for food retailers to stockpile food to be prepared for disaster events [3]. Living in an affluent society, most people in Germany have not suffered any major interruption of the food supply in the last decades. Also, the public does not seem to be aware the vulnerability of the German food-supply system itself. When civil-protection authorities in Germany discuss how to cope with possible food shortages, they transfer their responsibility for ensuring security to the public itself by continuing to view private households as being charged with this task. They want the public to be resilient by taking action to prepare for food shortages as the government cannot guarantee security for every single citizen in every crisis [58,10].

In this context, the Federal Ministry of the Interior published a strategic paper regarding civil-defense strategies in Germany in the summer of 2016 [59]. While the paper focuses on several aspects of civil defense, e.g. warning processes, CBRN protection, or technical relief, the recommendation in particular that the population should store food and drinking water for approximately ten days[1] received a lot of public attention. It was perceived by the media as unnecessary scaremongering and resulted in mainly satiric public reactions. Also, existing studies show that most people in Germany are currently not prepared to be independent from the food supply for about ten days [11]—not even if they have already suffered a small-scale blackout for several days [12].

Against this background, current efforts by public authorities to strengthen the preparedness and resilience of the German society against food-related uncertainties of the 21st century face challenges. According to public authorities, the public is particularly not receptive to emergency food-preparedness issues, because they do not perceive food shortages as a threat they need to be aware of. For example, a study by the German Federal Ministry of Food and Agriculture shows that the general population perceives the risk of a food shortage as low and most people feel able to cope at least with consequences of a longer blackout [9]. Furthermore, when disaster strikes, the public would expect not itself, but instead authorities or food retail to ensure their food supply. In Germany, a term called “Vollkaskomentalität”, which could be translated as “all-risks-insured mentality”, was used several times by representatives of public authorities saying that the German population is not facing the risks concerning a food shortage in the right manner [13,14].

However, this view of the public's perception of emergency food preparedness might not tell the whole story: Firstly, individual risk perception cannot only be understood as an unidimensional construct that differs merely between a high or low risk perception. Rather is has various qualitative aspects [15]. Secondly, research also shows that Germans actually do store food—at least to a certain extent [11,16]. These aspects lead to the assumption, that the public's view on preparing for food shortages is yet not fully understood. We thus ask in this study to what extent does the German public perceive emergency food preparedness as necessary and why? To answer this, we propose the following four research questions:

RQ1: Why does the public currently store food?

RQ2: Who does the public think is responsible for managing food shortages?

RQ3: In what way does the public perceive food shortages as a risk?

RQ4: Are there different types of preparedness?

A further examination of how people in Germany perceive food shortages as a possible threat as well as their storing behavior can help authorities improve their preparedness-education efforts. Acknowledging the possible diversity of “the” public in that regard could add a recipient-oriented perspective to current communication strategies and help increase resiliency. This is of relevance, because the population's self-help will stay a highly relevant component of food-emergency preparedness in Germany.

2. Theoretical background

For the purpose of this study, we focused on three main aspects to assess public's view on emergency food preparedness: First, we take into account behavioral aspects of food storage in Germany. Then we discuss in detail the concepts of trust and risk perception to understand who they deem responsible for coping with such situations and how people perceive food shortages as a risk.

2.1. Food-emergency preparedness and food-storing behavior

As already mentioned above, food shortages in Germany have not been a relevant scenario since the Cold War. The interest in food-emergency preparedness in Germany is based mainly on the experiences and suffering of the population during World War II and is anchored in the German state's duty of care. Due to geopolitical turbulences in 1965, a new law on preparing for a food emergency-the “Ernährungssicherungsstellungsgesetz [ESG]”-was passed. The ESG, and additionally in 1990 the Ernährungsvorsorgegesetz [EVG][2], aimed at securing the food supply of the German population. In this context, several large stockpiles (“Zivile Notfallreserve”, “Bundesreserve Getreide”) were built to store crops, rice, and condensed milk. Since 2010, an intense discussion about renewing the legal framework has arisen and led to the new law “Ernährungssicherstellungs-und -vorsorgegesetz [ESVG]” in April 2017.

Initiated by the Federal Office for Agriculture and Food, studies in food storage and food-crisis prevention were conducted. The Federal Office of Civil Protection and Disaster Assistance (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe (BBK)) [17] focused on the critical infrastructure of the food supply itself and drew attention to various hazards such as extreme weather events that might affect the provision of food to the German population. Further studies investigated how to store food for the long term or concentrated on aspects of food safety (e.g. Refs. [18–20]).

To our knowledge, there is only little research on the public's perception, attitude and behavior regarding food-emergency preparedness for crises in Germany: BBK [21] showed that awareness of possible crises is a relevant factor that influences whether people store food or other relevant materials such as candles or drugs. According to a representative survey conducted by Rasche et al. [16] in several German federal states,[3] 72% of participants stated that they store food[4]. Their main reason was to have food at home (31%), to avoid buying groceries every day (16%), or because they live in rural areas (13%). Disaster preparedness did not seem to be a popular motive, though. About 31% could not give any reason for storing food. Menski and Gardemann [12] conducted a survey in a small-scale rural area in Germany (“Münsterland”) that suffered from a blackout for up to five days [22]. They conclude that experiencing a power outage did not result in an increased preparedness or rather in an increased food-storing behavior. In 2016, a representative online survey in Germany [11] found that 88% of the population indicated that they have food stored for up to three days. About 17% are prepared for at least 14 days as recommended by

[1] The official recommendation to store food has existed for several years. In its brochure “How to be Prepared for an Emergency”, the Federal Office of Civil Protection and Disaster Assistance (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe, BBK) even suggests having food for 14 days at hand [32].

[2] It has to be noted that the ESG applies to a food shortage during a state of defense, whereas the EVG applies to disasters during peacetime, such as natural hazards, industrial accidents etc.

[3] The selected federal states were Schleswig-Holstein, Berlin, North Rhine-Westphalia, Free State of Saxony and Baden-Württemberg.

[4] [16] aimed to conduct 360 interviews, but the final number of participants is not clarified.

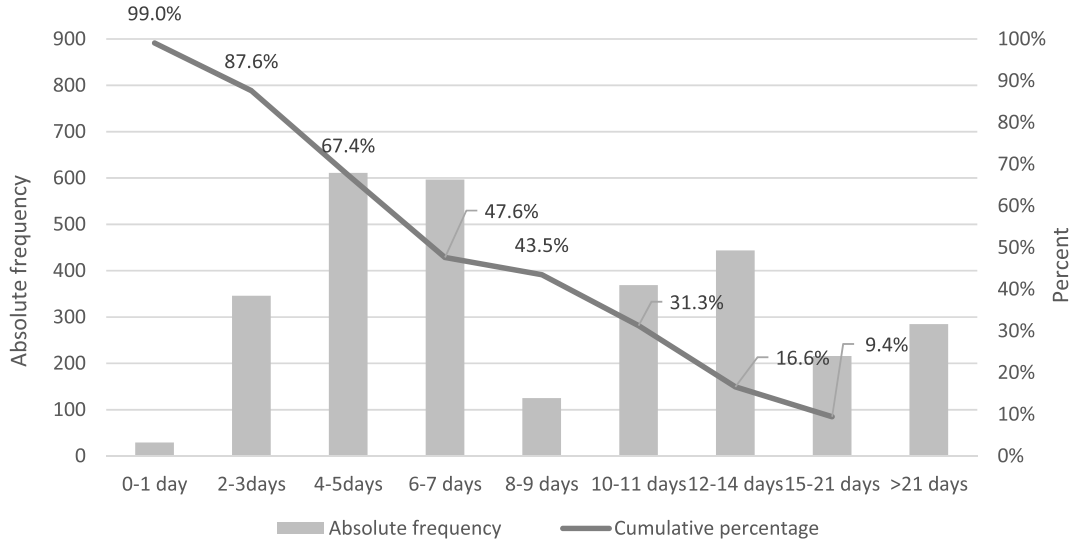

Fig. 1. Food supplies for all household members (n = 3022) [11]. The cumulative percentage refers to the particular upper class interval limit.

the authorities (see Fig. 1).

It appears that reasons of convenience and economy - and not preparedness for a food shortage -mainly drive food-storage behavior. This also holds true for several other OECD countries (Gerhold, Bauer & Brinkmann, in preparation). Thus, investigating why people store food contributes to a deeper understanding of Germans' preparedness patterns.

2.2. Trust and responsibility

Spada and Reisse [23] argue that trust in responsible authorities is also a relevant factor for the perception of risk. This is in line with Siegrist [24] who argues that the risk assessment of individuals in a crisis depends on how much they trust public authorities. He theorizes that if complexity exceeds a certain level and individuals feel unable to act, it is plausible to trust the organizations who (are supposed to) have the power to respond adequately to crises. Trust in authorities and food retailers in this case makes it possible to ignore the potential outcome of a risk for the individual, leading to the ability to act. Trusting authorities in these situations lets people plan and anticipate further actions while at the same time it means delegating control to others [25]. Strasser and Vosswinkel [26] call trust a systemic characteristic to cope with complexity and uncertainty. If a person is not able to gain the necessary information, trust enables decision-making and acting under the circumstances of uncertainty [26]. For the purpose of this study, we focused on assessing the level of trust in two organizations that potentially have the ability to cope with a food-supply crisis: food retailers and public authorities, assuming that we can shed light on the role that trust plays in facing the topic of a food-supply crisis.

As already stated above, the perception and interpretation of risks is a highly relevant condition that determines whether people prepare for disaster situations or not[5]. Accordingly, in our study we use a psychometric approach to include different aspects of risk perception, which are described in the following section.

2.3. Risk perception

In current research on the food preparedness or the perception of the risks of a severe food crisis in Germany, qualitative criteria are not applied to understand why people do or do not perceive food shortages as a risk. As stated above, there are only few available studies that address this topic in general. In statements or legal texts provided by the German state often the need for "risk analysis" is simply stated [27,28]. Risk analysis here is understood as a formal-analytical [29] or probabilistic [30,31] way to calculate risk as the product of the likelihood of occurrence[6] and the impact or potential damage[7] [32] This understanding and its popularity goes back to 1960s and 1970s when technical innovations became relevant [33], but it does not have today's complexity and systemic character [34] and is therefore outdated [35,36]. From our point view, this perspective used as a central approach does not fit the problem we address with our research questions. Therefore two other approaches are conceivable: an individualistic or a social construction approach [31]. While the second discusses larger social entities [37,38], the individualistic approach focuses the question of how people perceive risks as relevant in certain situations and why that is [39,40]. This is why we adapted the findings of Paul Slovic's psychometric paradigm (1987, 2000), which explains why people perceive critical developments as risky or not. In contrast to the previously stated socio-cultural theories that argue that the perception of risks is based on norms, beliefs and cultural identities [41,42], risk can be understood from an individual psychological perspective as a multidimensional construct that primarily relies on subjective, qualitative characteristics of the risk itself, not on the estimated probability of a potential harm or loss [43]. Slovic's psychometric paradigm (1987, 2000) in particular is a well-established approach to understanding and differentiating these qualitative characteristics in risk perception [44][8]. Based on factor analyses using variables for several types of risks, Slovic, Baruch and Lichtenstein [45] and Slovic [15,46] identified two main dimensions of risk perception[9]: dread risk and unknown risk. Dread risk includes the catastrophic potential, a lack of controllability, and a high number of affected people. Unknown risk refers to how well known the risk is or how much experience someone has had with that

[5] On a macrosocial or institutional level, this dependency is often described in "risk – or – disaster management cycles" [54].

[6] Scale used is "very likely" (5), "likely" (4), "conditionally likely" (3), "unlikely" (2) and "very unlikely" (1) (BBK [13], p. 28).

[7] Scale used is "insignificant" (1), "minor" (2), "moderate" (3), "significant" (4), "disastrous" (5). This scale is applied to different parameters categorized in man, environment, economy, supply, immaterial [32]; p. 33–35).

[8] In later publications, Slovic turns his attention to the relevance of feelings for risk assessment which are not in the focus of our work (see Refs. [55–57].

[9] In some publications, three main factors were derived from factor analysis: dread risk, unknown risk, number of people affected [48]. [50] derived five dimensions: catastrophic potential, the potential of being affected, voluntariness, controllability, responsibility.

type of risk. This refers to what [47] call availability heuristics. Risks that are known from the media or by personal experience will be judged differently from risks that are completely unknown.

According to the psychometric paradigm [15,46], risk perception is a subjective judgment. This individual judgment is based on several qualitative characteristics (e.g. severity, controllability, personal impact)[10] a risk can be described with. Nevertheless, as we are interested in specific/qualitative patterns of preparedness concerning a food-shortage scenario, we assessed subjective ratings of various risk-perception dimensions. The following selection also aimed to reduce the complexity of the research design and to focus on those dimensions (see Ref. [44] for a complete overview) that seem to be most applicable to the context of food emergencies.

- Severity: The extent to which the consequences of exposure are severe.
- Controllability: The extent to which a victim can control the severity of consequences due to exposure.
- Novelty: The extent to which the hazard is new to society.
- Easily reduced: The extent to which risk associated with the hazard can be easily reduced.
- Dread: The extent to which the effects of exposure are dreaded.
- Inequitable: The extent to which risks and benefits are not equally distributed across society.

Except for “novelty”, research has shown a direct correlation with risk perception for each of those dimensions [44].

As individual risk perception is a complex process, which is highly dependent on intuitive risk assessment, social influences [48] and cultural processes [41,49], it is also very likely to differ within a society. Accordingly, there is probably no single way “the public” in Germany perceives the risk of food shortages. To take this possible diversity into account, we suggest further differentiating the respondents of our study based on our theoretical assumptions regarding food storage behavior, responsibility for coping and risk perception and aim at identifying different types of preparedness.

3. Materials and methods

In May 2014, we conducted a survey of peoples’ risk perception of a food shortage as well as their preparedness behavior in Germany (n = 1979). We collected data using an online panel that was representative for the online population in Germany in terms of gender, age, and federal state population. In the questionnaire, we asked participants to imagine the following scenario:

A very severe pandemic has hit Germany. Due to illness and risk of infection, many employees are staying at home. It is difficult to buy groceries because many grocery stores remain closed. Restaurants, cafeteria, take-aways cannot open either. Delivery services are not operating.

The participants then were asked to answer 18 statements regarding risk, trust, and food storage. While eight items cover different dimensions of risk perception according to the psychometric paradigm [15] as well as the general perceived likelihood of such an event [50], two items focus on trust in two organizations that potentially have the ability to cope with a food-supply crisis such as described in the scenario. In addition to the scenario-specific items, we had seven items asking participants about reasons for storing food as part of their general preparedness behavior. An overview of the relevant items that were all measured using a 5-point Likert response format is provided in Table 1 below.

In addition, we assessed sociodemographic aspects (such as age, sex, type of household) as well as storage duration (number of days a household would last without concerns) and awareness of information material on disaster preparedness.

To answer our research questions, we ran descriptive and inferential statistics as well an explorative cluster analysis to reveal whether there are groups of similar respondents within the data-set [51]. We conducted a hierarchical cluster analysis using Ward's method and the squared Euclidean as a distance measure (see Ref. [52]) to identify types of preparedness in case of a food shortage. Cases with missing values were excluded. Hence, 1615 participants (82%, n = 1979) were classified into four clusters according to the elbow criterion. Afterwards, we refined our classification by applying a k-means procedure. To contrast the four types, we compared means of all variables listed in Table 1. Based on this description, we named clusters, acknowledging their specific characteristics regarding risk perception and storage/preparedness behavior. Sociodemographic aspects, storage duration, and information material awareness were additionally used to further illustrate each cluster.

4. Results

4.1. Sample characteristics

The total sample of the online survey consisted of slightly more male (53%) than female (47%) participants (n = 1979) at an average age of 43 years (SD = 15, n = 1938). Distribution of sex, age and federal state were in most aspects comparable to German census data of 2011 [53]. This also holds true for type of household: 34% lived on their own, 32% as a couple (without children), 23% as a family (with children), 7% in multi-person households and four percent as a single parent with children (n = 1979).

Based on this sample, 1615 cases were classified into four types of preparedness that are presented in section 4.4.

4.2. Reasons for storing food

Respondents mostly agreed on convenience reasons to store food (see Fig. 2): They do not want do grocery shopping every day (75%, n = 1955) and have a certain variety of food products available at home (72%, n = 1948). Being flexible in case of illness or bad weather (62%, n = 1955) as well as surprise visitors (58%, n = 1944) are also reasons to have food at home for more than a day. 25% also stated, they explicitly store food to be prepared for crisis events (n = 1947).

About 46% also have some more food at home as they buy larger quantities of special offers (n = 1951). 12% can also rely on food from their own cultivation or livestock farming (n = 1947).

4.3. Responsibility for coping with food shortages

People's trust in the organizations who (are supposed to) have the power to respond adequately to a food-supply crisis is rather low. Only 30% agree that public authorities would solve the problem quickly (n = 1.780). A few more respondents agree on trusting food retailers in such a situation (38%, n = 1774).

The individual difference of higher trust in food retail (M = 3,2, SD = 1,1) than in public authorities (M = 2,9, SD = 1,1) proves also to be statistically significant, t = 10,705, $p < .001$, n = 1738.

4.4. Risk perception of food shortage

In general, 24% of the respondents perceive an event as described in the scenario as (very) likely to happen in Germany (n = 1979). There are no differences regarding gender, but risk perception decreases slightly the older respondents are (Pearson's r = −0.064, p < . 01,

[10] Further dimensions are voluntariness, immediacy, knowledge of exposure, expert knowledge, catastrophic potential, delayed, certainly fatal, increasing, affects future generations, global catastrophe, personal impact, observability (see Ref. [44] for an overview).

Table 1
Overview of measured constructs and items.

Construct	Dimension	Item
Preparedness/Storing behavior[a]	Variety	I want to have a certain variety available.
	Convenience	I don't want to buy groceries every day.
	Flexibility	I want to be flexible in case of surprise visitors.
	Crisis preparedness	I store food to be prepared for a certain period of time in case of a crisis event.
	Illness/bad weather	I don't want to have to buy groceries in case of illness or bad weather.
	Farming/cultivation	I'm able to get food from own cultivation or livestock farming.
	Bargain	I buy larger quantities of special offers.
Trust and responsibility[a]	Food retail	Food retail would quickly solve the problem.
	Public authorities	The appropriate public authorities would quickly solve the problem.
Risk perception[a]	Severity	Consequences would be severe for me.
	Controllability	I know what to do in such a situation.
		This situation would be a challenge for me.
		I know enough people who would help me.
	Novelty	I have already experienced situations of limited food supply.
	Easily reduced	I can avoid negative consequences with adequate prevention.
	Dread	I am very scared of such a situation.
	Inequitable	I think households with low income would be more affected.
	Likelihood[b]	How likely is such an event in Germany?

[a] Response format: 1 = strongly disagree, 5 = strongly agree.
[b] Response format: 1 = very unlikely, 5 = very likely.

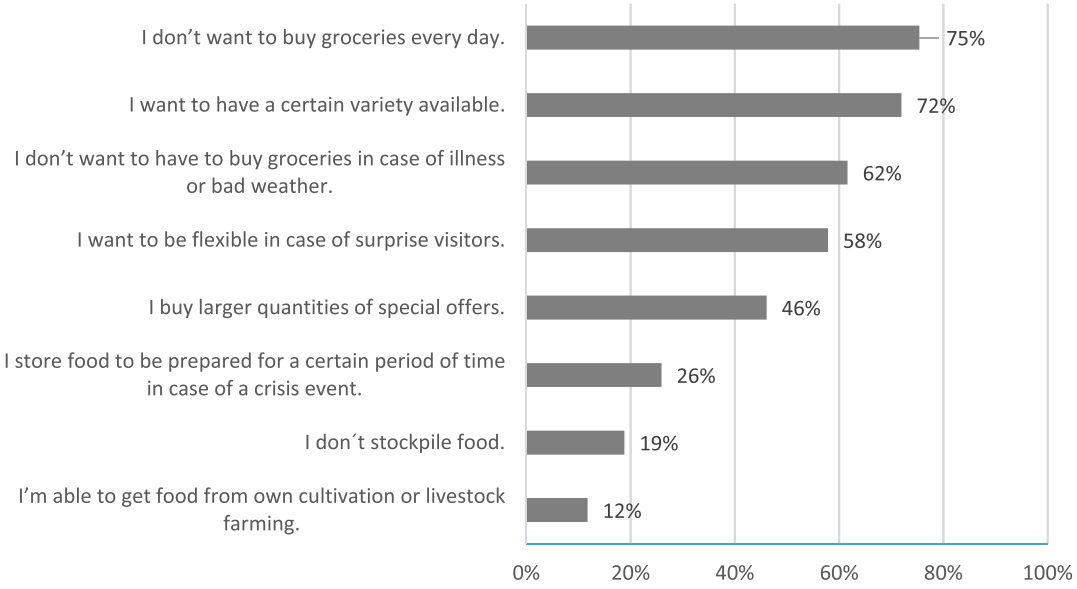

Fig. 2. Reasons for stockpiling (n = 1.944–1.955). The values 4 and 5 of the 5-point-Likert scale count as "Agreement".

n = 1938). In the following two chapters, we will describe and explore risk perception of the German population in a more detailed way. In section 4.4.1, we will present qualitative characteristics of risk perception according to Slovic [15]; followed by the four-cluster-solution as a result of the cluster analysis in section 4.4.2.

4.4.1. Qualitative characteristics of risk perception

Although not many respondents rate such a scenario as (very) likely to happen, most of them perceive it as a challenge (59%, n = 1902) and would be scared of such a situation (56%, n = 1934). Consequences of a food-supply shortage would be severe for about 39% (n = 1924). Nevertheless, 77% think households with a low income would be more affected (n = 1893).

54% think they could avoid severe consequences with adequate prevention (n = 1905) and half of the participants again would know what to do in such a situation (n = 1895). 38% know enough people, who would help them out (n = 1903).

Overall, only 15% state that they have already experienced a situation of limited food supply (n = 1928) (Fig. 3).

To explore possible patterns of individual preparedness regarding a food-shortage scenario, we ran a cluster analysis. We derived four types of preparedness, which we will describe in detail in the following section.

So far, our findings are able to give a detailed description of the German public's perception of emergency food preparedness in general. To explore a possible diversity among German's preparedness for food shortages, we merge those results into different types of preparedness.

4.4.2. Four types of preparedness

Based on our data, we named the four separate types of preparedness: the risk-oriented independents (n = 286), the unsure non-prepared (n = 431), self-confident all-rounders (n = 508) and unconcerned optimists (n = 390). Table 2 gives an overview of the cluster variable values in comparison.

4.4.2.1. Self-confident all-rounders. Self-confident all-rounders represent the biggest group (31%, n = 508) among participants. They perceive the scenario as less likely and mainly not as a challenge. They are also less afraid of personal consequences. They are confident in terms of knowing what to do in such a situation and feel that they

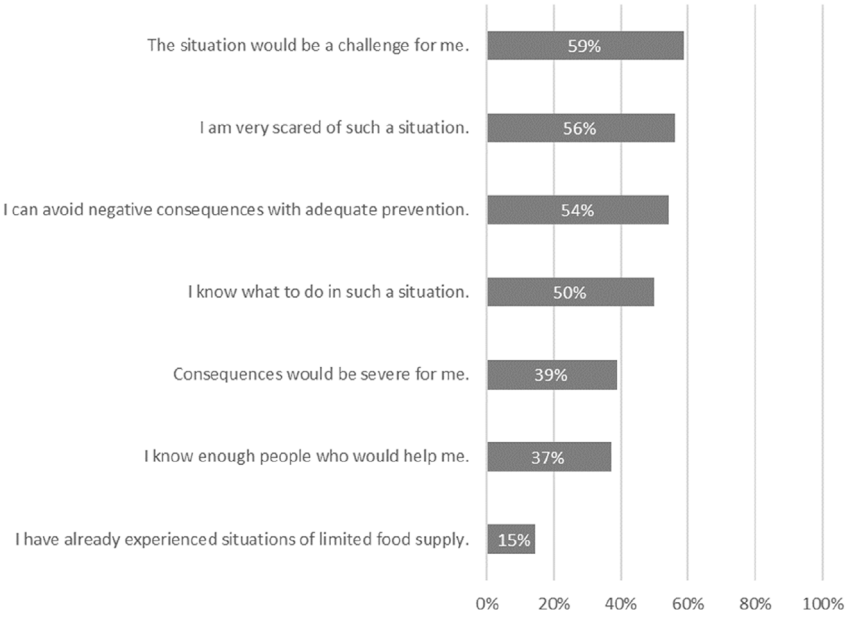

Fig. 3. Agreement on statements in the event of a food shortage (n = 1893–1934).

would have support from their personal network. Their level of trust in food retail to solve the problem is higher than that in public authorities. Additionally, they think preparing for such an event would help them to avoid negative consequences. Accordingly, being prepared for crisis events is among their many reasons to store food compared to other groups, apart from the fact that they as a whole cannot rely on food from own cultivation or farming.

Self-confident all-rounders are female (47%) as well as male (53%), n = 507. With an average age of 50 years (SD = 15, n = 504), they are the oldest group among all four types. They also hold the biggest share of people who completed vocational training (61%). 31% hold an academic degree, 6% are in school or training and 3% have no degree, n = 495. Self-confident all-rounders live usually in middle (38%) or high (37%) income households, 25% have a low income, n = 451. Self-confident all-rounders live in two-person households (37%), by themselves (32%), as a family (22%) or in other types of households (10%), n = 508. Most of these households are located in urban-rural areas (50%), followed by urban (42%) and rural (8%) areas (n = 505). They report the longest time period covered by food storage (M = 9.2 days, SD = 7.3, n = 486). About 9% of them have heard about information

Table 2
Four types of preparedness (cluster variables).

	Risk-oriented independents (n = 286)	Unsure non-prepared (n = 431)	Self-confident all-rounders (n = 508)	Un-concerned optimists (n = 390)
Risk perception				
Likelihood of a pandemic in Germany	+	+	–	–
This situation would be a challenge for me.	+	+	–	–
Consequences would be severe for me.	+	+	–	–
I know what to do in such a situation.	+	–	+	–
I am very scared of such a situation.	+	+	–	–
I can avoid negative consequences with adequate prevention.	+	–	+	–
I have already experienced situations of limited food supply.	+ +	–	–	+
I know enough people who would help me.	+	–	+	–
I think households with low income would be more affected.	+	+	+	–
Trust				
Food retail would quickly solve the problem.	+	–	+	+
The appropriate public authorities would quickly solve the problem.	+	–	–	+
Reason for storage				
Having a certain variety available	+	–	+	–
Not wanting to buy groceries every day	–	+	+	–
Being flexible in case of surprise visitors	+	–	+	–
Intentional storage to be prepared for crisis events	+ +	–	+	–
Not wanting to have to buy groceries in case of illness or bad weather	+	+	+	–
Being able to get food from own cultivation/livestock farming	+ +	–	–	–
Buying larger quantities of special offers	+	–	+	–

Note. n = 1615; means of cluster variables are z-transformed, (+) mean < 1 SD above-average; (−) mean < 1 SD below average. Method: hierarchical cluster analysis (Ward, squared Euclidian distance) following k-means-procedure.

Table 3
Sociodemographic and household details of types of preparedness.

	Risk-oriented independents 18% (*n* = 286)		Unsure non-prepared 27% (*n* = 431)		Self-confident all-rounders 31% (*n* = 508)		Unconcerned optimists 24% (*n* = 390)	
	n	% /M	n	% / M	n	% / M	n	% / M
Sex	285	m = 58% f = 43%	430	m = 49% f = 51%	507	m = 53% f = 47%	389	m = 63% f = 38%
Age in years	278	M = 42 (SD = 14)	427	M = 45 (SD = 15)	504	M = 50 (SD = 15)	383	M = 46 (SD = 15)
Information	238	15%	392	6%	457	9%	332	7%
Highest level of education	276	No degree (4%) School/Training (7%) Vocational training (53%) Higher Education (36%)	414	No degree (4%) School/Training (8%) Vocational training (57%) Higher Education (31%)	495	No degree (3%) School/Training (6%) Vocational training (61%) Higher Education (31%)	376	No degree (3%) School/Training (7%) Vocational training (56%) Higher Education (33%)
Living area	280	Rural (11%) Urban-rural (41%) Urban (48%)	430	Rural (10%) Urban-rural (41%) Urban (50%)	505	Rural (8%) Urban-rural (50%) Urban (42%)	389	Rural (10%) Urban-rural (45%) Urban (45%)
Household monthly income	254	High (45%) Middle (32%) Low (24%)	386	High (30%) Middle (38%) Low (32%)	451	High (37%) Middle (38%) Low (25%)	335	High (32%) Middle (35%) Low (33%)
Type of household	286	Families (40%) Couples (26%) Single-person (24%) Other (11%)	431	Families (23%) Couples (31%) Single-person (36%) Other (11%)	508	Families (22%) Couples (37%) Single-person (32%) Other (10%)	390	Families (17%) Couples (30%) Single-person (42%) Other (11%)
Food for … days	267	M = 6,3 (SD = 5.6)	425	M = 4,8 (SD = 4.3)	486	M = 9,2 (SD = 7.3)	368	M = 5,0 (SD = 4.3)

Note. *n* = 1615; Percentages may not add up to 100 due to rounding. (%) percent. (M) mean. (SD) standard deviation. Living area: rural (less than 100 inhabitants per square kilometers), urban-rural (101–500 inhabitants per square kilometers), urban (501 or more inhabitants per square kilometers). Income (after tax): high (2600 € or more), middle (1500–2599 €), low (up to 1499 €).

material regarding disaster preparedness (*n* = 457).

4.4.2.2. Unsure non-prepared. The second biggest group (27%, *n* = 431)—the unsure non-prepared—also perceive the pandemic scenario as rather likely. They think this situation would be a challenge for them and they are afraid of severe consequences. As the bulk of them cannot fall back on a social network, have no experience with such situations, and would not know what to do, they feel particularly insecure. They also do not think they could prevent negative consequences of such a scenario by taking action to be prepared. Additionally they have less trust in others—food retail or public authorities—that they will be able to cope with the situation. Overall, they seem not to care about storing food, except for convenience purposes.

Among the unsure non-prepared (*n* = 430) are as many women (51%) as men (49%), and this group is on average 45 years old (*SD* = 15, *n* = 427). Most of them completed vocational training (57%), followed by higher education (31%). 8% are in school or training and 4% have no degree (*n* = 414). Most households in this group have a middle income (38%). Another 32% have a low, 30% have a high income, *n* = 386. The unsure non-prepared (*n* = 425) live mostly in single-person households (36%) or as a couple (31%). 23% live as families, 11% in other household types (*n* = 431). They hold the biggest share of households in urban areas (50%) among all types, followed by urban-rural areas (41%). About 10% live in rural areas (*n* = 430). Without leading to any concerns, their food stores would last for about 4.8 days (*SD* = 4.3, *n* = 425), which is the shortest time period among all types. 6% of them have seen information material on disaster preparedness (*n* = 392).

4.4.2.3. Unconcerned optimists. Unconcerned optimists (24%, *n* = 390) are less scared of the proposed scenario and perceive such an event as less likely. Compared to other types, they feel less challenged and fear severe consequences less. This might be caused by the fact that they report previous experiences with food shortages. Nevertheless, they state that they would tend not to know what to do or whom to ask for help in such a situation. Their tendency would be to rely on food retail or public authorities to quickly come up with a solution. This group does not seem to worry about storing food either as all assessed storage reasons are rated below average.

Two thirds of this type are men (63%, women: 37%, *n* = 389) and the average age is 46 years (*SD* = 15, *n* = 383). 56% completed vocational training, 33% have a higher education. 7% are still in school or training and 3% have no degree (*n* = 376). Household income in this group is quite equally distributed: 32% have a high, 35% have a medium-level and 33% a low income (*n* = 335). They live mostly on their own (42%) or as a couple (30%). 17% live as families and 11% in other types of households, *n* = 390. They either live in urban (45%) or urban-rural (45%) areas. 10% of this type live in the countryside (*n* = 389). They have an average storage duration of 5 days (*SD* = 4, *n* = 368) and about 7% of them know about information material on disaster preparedness (*n* = 332).

4.4.2.4. Risk-oriented independents. Risk-oriented independents represent the smallest cluster (18%, *n* = 286). They perceive the likelihood of the pandemic scenario in Germany as comparatively high. They are rather scared by such a situation and would be afraid of its consequences.

Compared to other types, they store food also explicitly for crisis-preparedness reasons. Nevertheless, convenience and economic reasons also play an important role. On the one hand, they are to a certain extent independent of an external food supply as they are able to harvest food from their own cultivation and/or farming. On the other hand, they report their own experiences with food shortages and feel confident of knowing what to do in such a scenario. Their perceived preparedness is also based on their social network, as they know enough people who would help them.

More participants of this type are male (58%) than female (43%), *n* = 285. Among all four types, this is the youngest cluster with an average age of 42 years (*SD* = 14, *n* = 278). 36% hold an academic degree, 53% completed vocational training, 7% are still in school or training and 4% have no degree (*n* = 276). Compared to the other types, Risk-oriented independents include the biggest share of households with a high income per month (45%). 32% live in a middle income household, 24% have a low income (*n* = 254). Risk-oriented independents mostly live as families with children (40%), followed by

couples without children (26%), single-person households (24%) and other types of households (11%), $n = 286$. They hold the biggest share of households in rural areas (11%) compared to all other types. Nevertheless, most of them live in urban (48%) or urban-rural (41%) areas ($n = 280$). Should food supply be interrupted, they usually have food to last for an estimate of 6.3 days ($SD = 5.6$, $n = 267$) without being deeply concerned. This is the second longest time period among all clusters. Finally, they are also the ones most likely to be familiar with information material on disaster preparedness (15%, $n = 238$).

The following Table 3 summarizes additional sociodemographic and household descriptions of each type.

5. Discussion

With regard to RQ 1, our data show that people in Germany store food to a certain extent, but their storing behavior is currently driven more by convenience reasons than being prepared for an emergency. Only a quarter of the respondents store food to be prepared for the event of a crisis. With regard to RQ 2, surprisingly this is not because they trust authorities or food retailers to do so. Whereas several representatives of public authorities assumed an "all-risks-insured mentality" among the German population, only one third think that public authorities will solve the problem or rather 40% believe that food retailers will do so. As the results for RQ 3 show, most people do not think a food-supply crisis is likely to happen in Germany and the share of people with experiences with food-supply shortages is very low. This is in line with findings from 2000 [16], 2008 [9] and 2013 [11]. As there has been no severe real food-supply crisis so far, peoples' risk perception has not changed over the years and probably remains the same today. Nevertheless, more than one half of the respondents say that the scenario described in our study would be challenging and frightening for them.

When looking at peoples' risk perception and storing behavior in more detail (RQ4), people in Germany actually show different preparedness patterns: as risk-oriented independents, the unsure non-prepared, the self-confident all-rounders, and the unconcerned optimists. Despite evaluating the risk of a food shortage differently, participants of all groups think they would have enough food at home to manage the situation at least for several days. When looking at the blackout incident in Münsterland in 2005 [12], where some regions did not have power for up to five days, it also seems that none of the preparedness types would have a severe food-supply problem. Should the interruption last longer (e.g. in a large scale blackout or a severe pandemic), the unsure non-prepared and the unconcerned optimists would be the most vulnerable as they have less food stored at home than the risk-oriented independents or the self-confident all-rounders. That is why both groups, who make up 51% of the sample, should be especially addressed.

On the other hand, data shows that nearly 50% of the German population (the risk-oriented independents and the self-confident all-rounders) store some food no matter what. Furthermore, they perceive their individual abilities (e.g. self-efficacy) and their social network as additional resources for coping with such situations. Although they do not meet the official recommendations to be prepared for 10 or 14 days, nor do they store food for the reason of combating potential food-supply crises, these preparedness types lead the way to the answer of how food preparedness should be understood in Germany: Preparedness for crisis situations should not be detached from everyday lives [10].

Nevertheless, some limitations of this study have to be considered: As the typology is based on self-ratings of attitudes and behavior regarding a scenario most people have no experience with, people might under- or overestimate their reaction to such a situation. Also, unconcerned optimists and risk-oriented independents in 2014 may have changed their views in 2019. Furthermore, participants of the study were presented with only one scenario (pandemic) and therefore produced scenario-specific results. Other events or different details of the scenario description might lead to a different risk perception (types) among the public. Further research in this field should examine different food-shortage scenarios and also focus on vulnerable groups (e.g. disabled persons, elderly), particularly in terms of food supply, such as babies or people on special diets.

6. Conclusion

Our study aimed at describing to what extent the German public perceives emergency food preparedness as necessary and why. By investigating the behavioral aspects as well as individual views on emergency food preparedness for a representative sample of the German population, we gained a deeper understanding of people's risk perception and coping strategies. Our study also provides insights on how public authorities can better target the issue of preparedness and resilience in terms of food shortages when addressing the public.

As assumed, there is no macrosocial risk perception on food shortages, rather there are different perspectives among the German population. Therefore, public authorities need to improve their communication efforts regarding a reasonable food supply that meets the individual household needs and fits into their daily live routines. As Edwards [10] suggests, the concept of nudging to efficiently provide people with no or little experience in a field with good information and attaching food-emergency preparedness to everyday lives makes emergency preparedness more likely to happen. For example, adding information about preparedness aspects to special offers on products in grocery stores and explaining that they are also useful in emergency situations [10].[11] Accordingly, if storing food is a result of convenience instead of being scared of or prepared for crisis situations, preparedness messages should increasingly be connected to that.

As uncertainty drives the unsure non-prepared, recommendations for this group should emphasize, how preparedness actions can reduce these negative feelings about severe consequences and not being able to cope with such situations, especially in urban areas. This is also important, because -like the unconcerned optimists-they think adequate prevention would not help them to avoid negative consequences of a food shortage. Addressing their tendency to store food for convenience reasons by pointing out that storing food leads to advantages even in daily life (e.g. saving time by not going to the grocery story every day or being prepared for bad weather or illness), could be also an option to increase their preparedness behavior.

The unconcerned optimists overrate the capabilities of public authorities and food retailers. For them, including information about the interdependencies of the German food-supply system could be as effective as also highlighting the positive aspects of food storage for everyday life, such as having a wider variety of groceries available for cooking and being prepared for surprising events in general.

Taking into account that the share of people with low income is highest in both groups, communication strategies should include cost-effective opportunities to prepare. As both groups also hold the biggest share of single-person households, targeting messages to these individuals could also increase their perception and effectiveness.

In April 2017, the German government passed a new law that regulates the food provision for the German population in case of a crisis[12].

[11] The example is: "Consider the following hypothetical example. You are buying your nightly or weekly supplies at the local shop or supermarket and when you walk down the aisle marked household goods you see a poster advertising half-price batteries. You may be tempted to buy them. But what if underneath the sign there was a note asking you when you had last checked the batteries in your torch or smoke alarm? Would it make you think? Probably – and together with the half-price deal on batteries you might well be tempted to take the offer." [10] p. 43–44).

[12] "Ernährungssicherstellungs-und -vorsorgesetz [ESVG]", Federal Law Gazette volume 2017 part 1 number 19, released 10.4.2017.

Some progress has been made with the new law addressing especially the unconcerned optimists and the risk-oriented independents in our research. This is because public authorities strengthened their capabilities to ensure food provision and force food retailers to cooperate and e.g. provide detailed information about their stored resources when asked for it. Paragraph 14 of the law states that public authorities should continue taking measures to improve self-protection within the population to fortify its preparedness for a food-shortage crisis. However, the law does not specify what these measures could look like. Based on our empirical findings, we might contribute to elaborating these measures and support efforts to strengthen the food preparedness and resilience of the German society.

Conflicts of interest

None declared.

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