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RESEARCH ARTICLE

Post-disaster food safety and food security: An example of the Türkiye earthquake

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Abstract

The present study aimed to determine the risk levels affecting food safety and security in foods distributed to earthquake victims by organizations. This descriptive and cross-sectional study was conducted in food distribution organizations in Kahramanmaraş and Hatay between 20–24 February 2023 ($N=40$). The data were collected face-to-face by using the Descriptive Data Form and Food Safety and Security Observation Form (FSSOF) developed by the researchers. According to FSSOF, organizations had a 41.6% risk concerning food safety and security. According to the multiple linear regression analysis, organizations that did not control the foods were found to be associated with an increased total score of FSSOF (β: -0.527, $p=0.010$). No relationships could be found between the type of organization, the population served, having a food technologist and/or dietitian, the distance between the organization and waste, and the total scores of FSSOF ($p>0.05$). The organizations that did not control the food were found to be associated with Organization-specific conditions (β: -0.623, $p=0.002$), Food distribution conditions (β: -0.531, $p=0.015$), Personnel hygiene (β: -0.608, $p=0.005$), Food security (β: -0.480, $p=0.036$) and Environmental conditions (β: -0.537, $p=0.018$) were found to be associated with an increased level of risks. Also, not having an engineer and/or dietitian was associated with an increased risk of Food storage practices (β: -0.469, $p=0.005$), and increased the number of staff was associated with an increased risk of Organization-specific conditions (β: 0.348, $p=0.007$). The level of risk of the organizations concerning food safety and security was found to be relatively high. Control of the food provided was the most important determinant of food safety and security.

Keywords Earthquake · Food control · Food distribution · Food safety · Food security · Natural disaster · Risk

1 Introduction

The concept of food safety is defined as the set of measures taken to eliminate food-borne risks (physical, chemical, and/or biological), and it encompasses issues related to hygiene and sanitation (Güder, 2006). These food-borne risks can arise during the processing, transportation, storage, purchasing, preservation, preparation, and cooking stages (Oğur & Çam, 2022).The concept of food security, in addition to being related to food safety, also encompasses the availability, accessibility, distribution, and sustainability of reliable and healthy food (Almohamad et al., 2024; FAO, 2006; Mcneely et al., 2024). In other words, food security is defined as access for everyone at all times to sufficient, healthy, and nutritious food for a healthy lifestyle (Ainehvand et al., 2019). From this perspective, the situation of food security should be stabilized by ensuring the supply and distribution of a general food ration to the affected community (IFRC, 2008).

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In natural disasters, the risks to the food supply chain include ensuring food safety and monitoring food safety(Manzini & Accorsi, 2013; Perdana et al., 2022). Disruptions in the food supply chain can cause problems in the distribution, storage, preparation, and access to food in regions affected by natural disasters (Toland et al., 2023). Research has shown that post-disaster food insecurity leads to challenges in accessibility, acceptability, utilization, and availability, significantly affecting vulnerable populations. For instance, a study on Hurricane Irene (2011), the Moore Tornado (2013), Hurricane Florence (2018), and COVID-19 found that disaster survivors faced severe food insecurity due to access barriers and supply chain disruptions (Clay et al., 2023). Inefficient distribution systems further threaten food security in emergencies. Chodur et al. (2018) emphasized that disruptions in food storage and distribution after disasters are a critical challenge, as seen in the Great East Japan Earthquake (Chodur et al., 2018; Nakazawa & Beppu, 2012). Similarly, research in Japan found that fresh produce shortages led to vitamin C and fiber deficiencies, contributing to gastrointestinal issues (Inoue et al., 2014). Additionally, prolonged displacement and dietary changes have been linked to rising obesity rates among evacuees (Tsuboyama-Kasaoka et al., 2021a, 2021b). Beyond logistical challenges, studies highlight the importance of coordinated humanitarian responses. Nekouie Moghadam et al. (2017) stressed the need for better logistics coordination in food aid, while Scarpin and Silva (2014) identified bureaucratic inefficiencies as a major barrier to food distribution in Brazil (Nekouie Moghadam et al., 2017; Scarpin & Silva, 2014). These findings indicate that post-disaster food insecurity may lead to malnutrition and the worsening of existing systemic or chronic diseases in disaster victims (Aydın et al., 2024; Tsuboyama-Kasaoka & Purba, 2014). Post-earthquake investigations show that nutritional problems are caused by disruptions in the food supply chain (Alataş & Arslan, 2024; Özsel Özcan Araç & Ateş Duru, 2021).

On February 6, 2023, two major earthquakes that had magnitudes 7.7 and 7.6 occurred in Turkey, with epicenters in Pazarcık and Elbistan (Kahramanmaraş), affecting 11 surrounding cities (Durmaz Yurt & Yeniçırak, 2024; Yeniçırak & Durmaz Yurt, 2024). These earthquakes ranked 7 th among earthquakes with the highest death toll worldwide since 1950 (Ergönül et al., 2023). More than 2.5 million people were affected by these earthquakes and more than 50 thousand people lost their lives (Aydın et al., 2024).

In Turkey, the Disaster and Emergency Management Authority (AFAD) and the Turkish Red Crescent (KIZILAY) are state organizations that provide food aid (AFAD, 2019; Doğru & Ede, 2020). On the relevant dates, a total of 334 mobile kitchens, 86 catering vehicles, 33 mobile bakeries, and 252 service vehicles were sent to the area by the AFAD, KIZILAY, Ministry of National Defense, Gendarmerie, and Non-Governmental Organizations (NGOs). Approximately 9 million hot foods, 2 million soups, 7.6 million packaged drinking water, 9 million bread rolls, 6.6 million treats, and 750 thousand beverages were distributed in the disaster area (AFAD, 2023). Considering the number of people affected, a serious need for nutrition and shelter emerged because of the priority of rescue operations after the earthquakes and the lack of perception of the extent of the disaster. Food has become one of the most urgent needs of disaster victims in this emergency (Aydın et al., 2024).

In the world, studies on nutrition or food safety and security remain inadequate after natural disasters because priorities are associated with vital processes (Kalyoncu Atasoy et al., 2023). This lack of scientific evidence may cause limitations in foreseeing several approaches (e.g., ensuring food safety and security in unusual situations, identifying risks, controlling and organizing food provided). Although there are studies in the literature evaluating food safety and security after natural disasters, there are a limited number of studies focusing on issues such as food storage, distribution, access, organization, and environmental conditions affecting food safety and security immediately following natural disasters. For these reasons, the aim of this study is to examine the food safety and security of emergency food distributed to survivors by a total of forty organizations located in Kahramanmaraş and Hatay, the provinces heavily affected by the earthquake in Turkey.

2 Method

2.1 Study design

This descriptive and cross-sectional survey was conducted between 20–24 February 2023 in Kahramanmaraş Central district ($n = 24$) and Hatay Antakya district ($n = 16$) (Fig. 1). In the earthquakes that affected 11 provinces, Kahramanmaraş was chosen because it was the epicenter of the earthquakes, and Hatay was chosen because it was one of the places where the most destruction occurred. The total number of food distribution organizations in the cities where the study was conducted was not known. For this reason, organizations that employed at least 3 personnel, regularly distributed at least 1 meal, and served at least 100 people were preferred. A total of 40 food distribution organizations, including public institutions, municipalities, foundations, associations, and NGOs that met these inclusion criteria, were randomly selected. These institutions and organizations that distributed food are called “organizations” throughout the study.

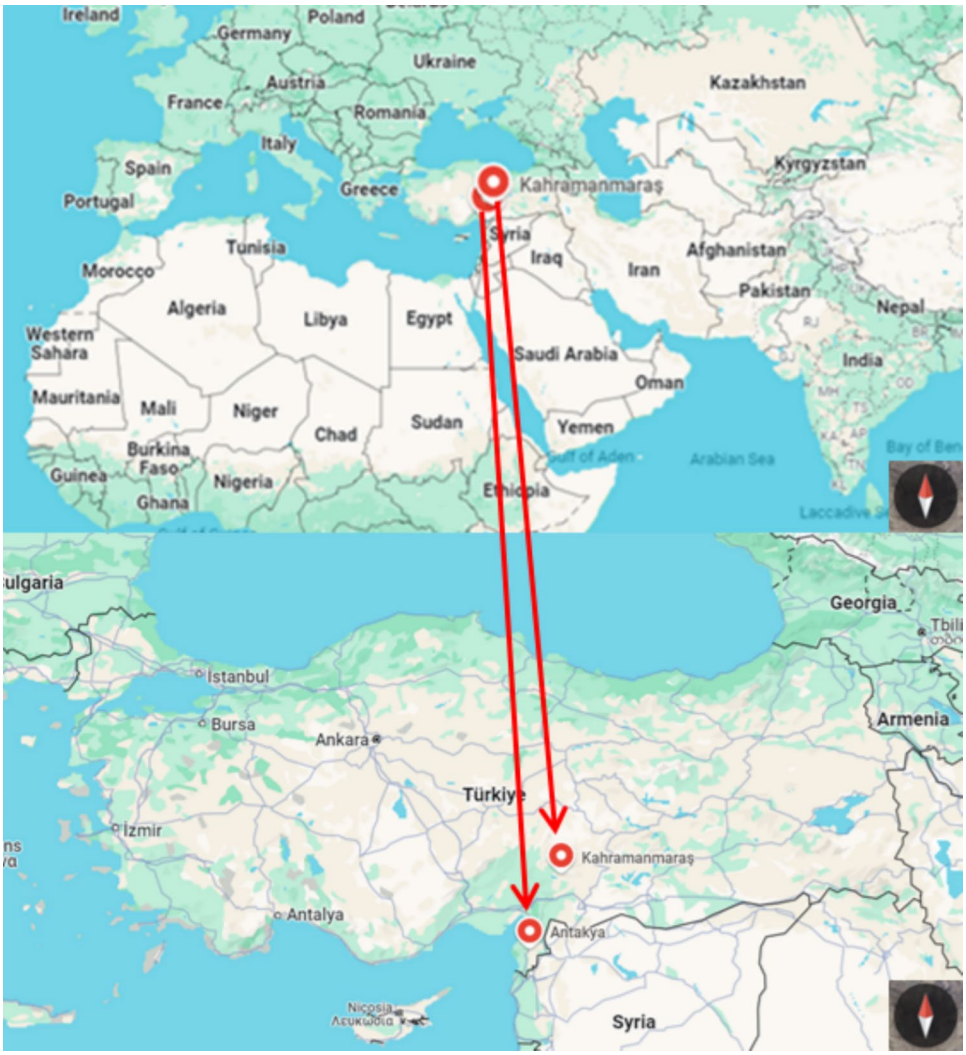

Fig. 1 Location of Kahramanmaraş (Central District) and Hatay (Antakya) in Türkiye

2.2 Data collection

The data were collected with face-to-face interviews using the Descriptive Form and Food Safety and Security Observation Form.

2.2.1 Descriptive form

In this form that was prepared by the researchers based on the literature data, organization characteristics, organization types, number of staff, number of meals, size of the population served, presence of a food engineer and/or dietitian, distance between organization and tent city, distance between organization and wastes, and whether the food provided was controlled or not were questioned (Güden & Borlu, 2023; KIZILAY, 2002; Tavakoli et al., 2008; Yanagihara et al., 2012). It was also questioned whether the expiration date of packaged foods, visible deterioration in foods requiring cold chain, and packaging integrity in packaged foods were checked during the control of the provided foods (KIZILAY, 2002; UNHCR, UNICEF, WFP, WHO, 2004).

2.2.2 Food safety and security observation form

The Food Safety and Security Observation Form (FSSOF) was developed by researchers in line with Commissions Codex Alimentarius, official control forms of relevant government departments, and literature data as a checklist to evaluate food safety and food security according to the size and severity of risks in foods distributed by various organizations to earthquake victims (Abdullah Sani & Siow, 2014; Aksoy Kendilci & Oğur, 2022; Codex Alimentarius, 2003; Rotich, 2017; World Health Organization, 2012; Zanin et al., 2017). This form, which consisted of 56 items and had a 5-point Likert style, was rated as "(0) no risk, (1) low risk, (2) moderate risk, (3) risky, (4) very risky". A minimum of 0 and a maximum of 224 points can be obtained from FSSOF, and increased scores indicate increased risks. FSSOF had six dimensions, all of which were created from positive

statements (Organization-specific conditions (11 items), Food storage practices (10 items), Food distribution conditions (15 items), Personnel hygiene (4 items), Environmental conditions (5 items), and Food security (11 items)). Of these dimensions, the Food security dimension was created by taking into account availability (41.– 42. statements), accessibility (43.– 44. statements), utilization (45.– 47. statements), and stability (48.– 51. statements) which constitute the concept of food safety(Ben Hassen & El Bilali, 2024; Clay et al., 2023; Seligman et al., 2010). Cronbach's Alpha coefficient obtained in the total dimension of FSSOF was found to be 0.983. Cronbach's Alpha coefficients obtained in the sub-dimensions of Organization-specific conditions, Food storage practices, Food distribution conditions, Personnel hygiene, Environmental conditions, and Food security were calculated as 0.977, 0.918, 0.956, 0.957, 0.961and 0.834, respectively. In this context, FSSOF was found to be quite reliable. In addition, the level of risk ratio that was determined in the present study was calculated as the percentage equivalent of the average obtained over 224 points (e.g.: *(Average obtained*×*100)/224*).

2.2.3 Observation and evaluation

Before the study, researchers held online meetings to standardize the observations and evaluations, and the risk scale of each item in the FSSOF between 0–4 was determined and evaluated. The organizations were visited by the researchers at random times. Each organization was visited once, and each interview and/or examination lasted approximately 90–120 min. Researchers questioned and/or observed the items in the FSSOF in detail during their time in the organizations (Fig. 2). The following steps were taken into account in the evaluation of the items in the FSSOF.

A Hazard Analysis and Critical Control Points (HACCP)-certified Digital Food Thermometer with a 14 cm long stainless probe that could measure between − 50 °C and

Fig. 2 Images of some of the visited organizations

+300 °C was used to determine the temperature of the meals.

A tape measure sensitive to 1 mm was used for the solid waste landfill distance with the organization.

In terms of food safety and security, practices aimed at preventing microbiological, chemical, and physical contamination during the preparation, storage, transportation, and distribution of meals under disaster conditions were taken into consideration. In this context, critical factors such as the status of transportation of meals under closed and hygienic conditions, the protection of the cold chain, the exposure of food to dirt, dust, insects, or chemical contamination during transportation, the cleanliness of the vehicle in which the food is transported, the appropriateness of food storage conditions, the implementation of cleaning procedures, employee hygiene, the presence of hand washing stations and the adequacy of disinfection practices were evaluated by the researchers for each item during the research and the results were recorded in FSSOF.

During the observation period, when practices such as safe transportation of foods, preparation of raw and cooked foods separately, safe thawing of frozen foods, use of bain-marie in serving foods, serving foods at appropriate temperatures, and washing hands for at least 20 s were not encountered, questions were asked to the institution officials during the study. The evaluation was made according to these answers and recorded in FSSOF.

To evaluate whether the menus provided adequate and balanced nutrition, provided the daily optimum amount of food, and whether the daily calories and nutrients were sufficient, photos of the menus were taken during the research. These photos were evaluated by a dietician after the research and the results were entered into FSSOF.

2.3 Study analysis

Numbers (n), percentages (%), mean, standard deviation (± SD), median, minimum (Min.), and maximum (Max.) values were used to analyze the study data. Reliability analysis was made for the reliability of FSSOF and the results were evaluated with Cronbach's Alpha coefficient. The normality of distribution was tested with the Kolmogorov–Smirnov Test. Student's t-test, which is one of the parametric tests, and Mann Whitney-U test, which is one of the nonparametric tests, were used to compare the means of two independent groups. In nonparametric distributions of the numeric variables, z transformation was used to ensure that the data conformed to normal distribution. Nominal variables that had more than two categories were categorized as the reference group (0) and the risk group (1) to create a dummy variable. The relationship between FSSOF and its sub-dimensions and independent variables was examined with Multiple linear regression analysis by providing the necessary conditions for regression analysis. The Enter Method was employed in regression models and dummy variables and variables with $p < 0.20$ in univariate analyses were included in the created models. The explanatory nature of the data was shown with Adjusted R-square (Adj. R^2). Based on the results, the change in variances for the total and sub-dimensions of FSSOF was explained between 26.2% and 52.8%. The data were analyzed in the SPSS 26.0 statistical software. When the *p*-value was less than 0.05, it was considered statistically significant.

3 Results

Table 1 shows the distribution of the descriptive characteristics of food distribution organizations. A total of 25.0% of the organizations were municipality-owned, and 22.5% were mobile. It was determined that 37.5% of the organizations employed 5–9 personnel, 75.0% served 3–5 meals daily, 37.5% served 2000–3999 people daily, and 12.5% employed a food engineer and/or dietitian. The distance of 60.0% of the organizations to the tent city was less than 100 m, 27.5% of them were less than 6 m from the solid waste landfill and 47.5% of the organizations checked the food provided.

Table 2 gives the distribution of organizations'total, subdimension, and item mean scores from FSSOF. The FSSOF total score mean was 93.10 ± 41.13, corresponding to a risk of 41.6%. The mean scores in the dimensions of Organization-specific conditions, Food storage practices, Food distribution conditions, Personnel hygiene, Food security, and Environmental conditions were found to be 17.50 ± 11.32 (level of risk 39.8%), 21.65 ± 9.94 (54.1%), 22.23 ± 11.75 (37.1%), 6.08 ± 3.72 (38.0%), 18.55 ± 4.63 (42.2%) and 7.10 ± 3.74 (35.5%), respectively. The first three statements above the average in FSSOF were "*Appropriate diet must be provided for situations requiring a special diet* (3.95 ± 0.32)", "*Allergen information must be provided to the consumer in prepared foods* (3.78 ± 0.83)", "*Samples must be taken from the foods* (3.58 ± 1.22)".

Table 3 shows the comparison of the descriptive characteristics of food distribution organizations according to the total and sub-dimension score averages of FSSOF. Organizations that did not have a food engineer and/or dietician and did not ensure control of the food given were found to have high FSSOF Total ($p < 0.01$), Organization-specific conditions ($p < 0.05$), Food storage practices ($p < 0.001$), Food distribution conditions ($p < 0.05$), Personnel hygiene ($p < 0.05$), Food security ($p < 0.05$) and Environmental conditions ($p < 0.05$) dimension mean scores. Those with a fixed organization type had high Organization-specific conditions ($p = 0.013$) and Food storage practices ($p = 0.039$) dimension mean scores. Organizations serving a population of less

Table 1 Descriptive characteristics of the food distribution organizations

Variables	n	%
Organization characteristics		
Public institution	6	15.0
Municipality	10	25.0
NGO	12	30.0
Foundation/Association	12	30.0
Organization types		
Mobile	9	22.5
Fixed	31	77.5
Staff number		
3–5	8	20.0
5–9	15	37.5
10–14	11	27.5
≥ 15	6	15.0
Number of meals		
1–3	10	25.0
3–5	30	75.0
Population served		
500–2000	8	20.0
2000–3999	15	37.5
4000–5999	6	15.0
6000–7999	7	17.5
8000–15000	4	10.0
Having a dietician and/or food engineer		
Yes	5	12.5
No	35	87.5
Organization-tent city distance (metres)		
< 100	24	60.0
≥ 100	16	40.0
Organization-solid waste landfill distance (metres)		
< 6	11	27.5
≥ 6	29	72.5
Control of provided food		
Yes	19	47.5
No	21	52.5

than 4000 had high FSSOF mean scores in Environmental conditions ($p = 0.044$) dimension and organizations with a solid waste landfill distance of less than 6 m had high FSSOF score averages in Food security dimension ($p = 0.022$). No statistically significant differences were detected between the total and sub-dimension score averages of FSSOF and the organization characteristics, number of staff, number of meals, and organization-tent city distance ($p > 0.05$).

Table 4 gives the descriptive characteristics of the food distribution organizations and the Multiple linear regression analysis of FSSOF. The change in variances for the total and sub-dimensions of FSSOF was explained between 26.2% and 52.8%. A negative and statistically significant association was detected between the control of the food provided and the Total score FSSOF (β: − 0.527, $p = 0{,}010$). Type of organization, population served, presence of a food engineer and/or dietician, and distance between organization and solid waste landfill were not found to be associated with the total scores of FSSOF ($p > 0.05$).

A negative and statistically significant association was detected between the control of the food provided and the Organization-specific conditions (β: − 0.623, $p = 0.002$), Food distribution conditions (β: − 0.531, $p = 0.015$), Personnel hygiene (β: − 0.608, $p = 0.005$), Food security (β: − 0.480, $p = 0.036$) and Environmental conditions (β: − 0.537, $p = 0.018$) subdimensions scores. A positive and statistically significant association was found between the number of staff and scores of the Organization-specific conditions (β: 0.348, $p = 0.007$) and a negative, statistically significant association was detected between having a food engineer and/or dietitian and scores of Food storage practices (β: − 0.469, $p = 0.005$). The organization type was not found to be associated with FSSOF total score and all sub-dimensions scores ($p > 0.05$). No significant association was detected between organization characteristics and Organization-specific conditions and Personnel hygiene ($p > 0.05$). While having a food engineer and/or dietician was not associated with all dimensions except Food storage practices, control of food provided was related to Food storage practices ($p > 0.05$). There was no association between Organization-specific conditions, Food storage practices, Environmental conditions scores, and population served, organization-solid waste landfill distance variables ($p > 0.05$). Additionally, no significant association was found between Food distribution conditions and population served; between Food Security and organization-solid waste landfill distance; and between Personnel hygiene and number of meals ($p > 0.05$) (Table 4).

4 Discussion

The foods distributed to earthquake victims by 40 public institutions, municipalities, foundations, associations, and NGOs between the 14 th and 18 th days after Kahramanmaraş-centered earthquakes in Turkey were examined regarding food safety in the present study.

In this study, the risk levels of the organizations regarding food safety and reliability were found to be relatively high. In previous studies conducted to date, these situations, which indicate the prevention of cross-contamination, keeping foods that require cold chain in appropriate conditions, keeping them at inappropriate temperatures, keeping a sample taken from each type of food batch produced under appropriate conditions for seventy-two hours, vector control, food storage practices, were shown to pose a risk (Aldemir, 2023;

Table 2 The distribution of organizations' total, sub-dimension, and item score averages from the FSSOF

Dimensions and items ($N=40$)	Mean ± SD	Min.-Max. of the organizations	Min.-Max. of the FSSOF
Total	93.10 ± 41.13	12–171	0–224
Organization-specific conditions	17.50 ± 11.32	0–43	0–44
1. The organization must be clean and in good condition	1.63 ± 1.25	0–4	0–4
2. Safe and clean water must be used	1.10 ± 0.96	0–4	0–4
3. Adequate facilities for cleaning and disinfection of equipment must be available	1.78 ± 1.27	0–4	0–4
4. Appropriate storage space must be available	1.63 ± 1.17	0–4	0–4
5. It must be positioned to prevent contamination of food and harboring of pests	1.83 ± 1.13	0–4	0–4
6. Kitchen utensils must not be used for other aims	1.55 ± 0.99	0–4	0–4
7. Lighting must be sufficient	1.50 ± 1.06	0–4	0–4
8. Ventilation must be sufficient	1.42 ± 1.06	0–4	0–4
9. Cleaning and maintenance must be provided regularly	1.67 ± 1.21	0–4	0–4
10. The work area must allow for hygiene practices	1.70 ± 1.20	0–4	0–4
11. The organization must be audited at appropriate intervals	1.70 ± 1.20	0–4	0–4
Food storage practices	21.65 ± 9.94	2–40	0–40
12. Perishable foods must be kept in the refrigerator until use	2.68 ± 1.62	0–4	0–4
13. Raw and cooked foods must be stored separately	2.32 ± 1.56	0–4	0–4
14. Food storage areas must have sufficient capacity	1.38 ± 0.95	0–4	0–4
15. Storage conditions must be specific to the food	1.90 ± 1.26	0–4	0–4
16. Samples must be taken from foods	3.58 ± 1.22	0–4	0–4
17. Leftover foods must be stored under appropriate conditions	2.13 ± 1.42	0–4	0–4
18. Food storage areas must be free from pests	1.90 ± 1.22	0–4	0–4
19. Food storage areas must be created in a way that pests cannot enter	1.90 ± 1.19	0–4	0–4
20. Chemicals used for hygiene aims must be stored separately from foods	1.62 ± 1.03	0–4	0–4
21. Cold chain must be maintained according to food types	2.25 ± 1.46	0–4	0–4
Food distribution conditions	22.23 ± 11.75	0–48	0–60
22. Food must be transported safely to the area to be distributed	1.33 ± 0.92	0–4	0–4
23. Cooked foods must be stored appropriately during food distribution	1.40 ± 0.96	0–4	0–4
24. Raw and cooked foods must be prepared separately	1.60 ± 1.17	0–4	0–4
25. Frozen foods must be thawed safely	2.80 ± 1.52	0–4	0–4
26. Packaged and labelled foods must be used	1.20 ± 0.61	0–2	0–4
27. Adequate hygiene facilities must be provided in the distribution of food	1.67 ± 1.14	0–4	0–4
28. Adequate water supply must be provided to the food distribution area	1.25 ± 0.84	0–4	0–4
29. Tools and equipment must be kept clean	1.40 ± 0.87	0–4	0–4
30. Items such as spoons and forks used must be disposable	1.40 ± 1.01	0–4	0–4
31. A bain-marie must be used to serve food	1.48 ± 1.09	0–4	0–4
32. Foods must be served at appropriate temperatures	1.43 ± 1.01	0–4	0–4
33. Swollen or damaged canned foods must not be used	1.30 ± 0.85	0–4	0–4
34. Foods with damaged qualities and appearance must not be used	1.25 ± 0.74	0–4	0–4
35. Foods with damaged packaging must not be used	1.28 ± 0.75	0–4	0–4
36. There must be no residue that could cause physical contamination	1.45 ± 1.09	0–4	0–4
Personnel hygiene	6.08 ± 3.72	0–14	0–16
37. Gloves must be used when contacting food	1.73 ± 1.09	0–4	0–4
38. Staff must wash their hands for at least 20 s	1.47 ± 0.99	0–4	0–4
39. Staff must use staff protective equipment	1.63 ± 1.06	0–4	0–4
40. Staff must be healthy	1.25 ± 0.81	0–3	0–4
Food security	18.55 ± 4.63	8–26	0–44
41. Menus must provide adequate nutrition	1.12 ± 0.69	0–2	0–4
42. Menus must be designed to meet the optimal daily	0.97 ± 0.42	0–2	0–4

Table 2 (continued)

Dimensions and items ($N=40$)	Mean ± SD	Min.-Max. of the organizations	Min.-Max. of the FSSOF
43. Food must be accessible when required	0.95 ± 0.45	0–2	0–4
44. An adequate amount of packaged water must be provided per person	1.00 ± 0.68	0–4	0–4
45. All provided foods must be consumable and can be integrated into meals	1.12 ± 0.69	0–2	0–4
46. Allergen information must be provided to the consumer in prepared foods	3.78 ± 0.83	0–4	0–4
47. Appropriate diet must be provided for situations requiring a special diet	3.95 ± 0.32	2–4	0–4
48. Meals must be culturally acceptable	1.12 ± 0.69	0–2	0–4
49. Menus must be allow for balanced nutrition	1.12 ± 0.69	0–2	0–4
50. Provided foods must not caused health problems	0.05 ± 0.32	0–2	0–4
51. Menus must be prepared considering daily calories and nutritional needs	3.35 ± 1.25	0–4	0–4
Environmental conditions	7.10 ± 3.74	0–15	0–20
52. Food leftovers must be removed from the organization without delay	1.35 ± 0.74	0–3	0–4
53. Liquid wastes must be removed from the organization appropriately	1.43 ± 0.78	0–3	0–4
54. Solid wastes must be removed from the organization in an appropriate manner	1.43 ± 0.78	0–3	0–4
55. Toilets must be at least 8 m away from cafeterias	1.38 ± 0.81	0–3	0–4
56. The risk of contamination from pests in public feeding areas must be prevented	1.53 ± 0.91	0–4	0–4

Dereli & Yıldırım, 2023; KIZILAY, 2002; Küçük, 2023; Onbaşı & Çınar, 2021). After several disasters in Vermont, North Carolina, and Oklahoma, and in the Bam Earthquake and the Great East Japan Earthquakes, it was reported that food storage equipment and food supplies were inadequate, and disruptions in distribution systems led to food insecurity (Clay et al., 2023; Moosazadeh et al., 2014). It was found that our results were compatible with the literature data and our findings supported these studies.

Providing appropriate diets for situations that require a special diet and providing allergen information to the consumer were the statements with the highest risk in the FSOF. It was reported that approximately half of the allergic children in the Great East Japan Earthquake were unable to obtain allergen-free food for more than a week (Tsuboyama-Kasaoka et al., 2021a, 2021b). One study also found that patients with food allergies who were evacuated to emergency shelters had difficulty eating the food provided (Tsuboyama-Kasaoka et al., 2014a, 2014b). It was reported by the Chamber of Food Engineers for the same earthquake that there were not enough good practices in the coordination centers or storage areas for individuals with celiac disease, diabetes, intolerance or sensitive nutrition needs, vegan or vegetarian diets in the first 6 days of the earthquake (TMMOB, 2023). In a qualitative study that examined 37 cooking and preparation points in the Malatya, Adıyaman, and Kahramanmaraş-Pazarcık regions, two-thirds of the participants said that individuals considered vulnerable thought that sufficient precautions were not taken to ensure food safety, and four-fifths stated that there was no food variety (Alataş & Arslan, 2024). It was reported that it is difficult to obtain allergen-free foods during disasters, that people with food allergies or special dietary needs constitute disadvantaged groups, and this may cause other healthcare issues (Tsuboyama-Kasaoka et al., 2021a, 2021b). This finding supports our results in this regard.

Another expression with the highest risk in FSOF was determined to be taking samples from the foods. Institutions or organizations that provide food services for mass consumption, such as food enterprises and food factories, are obliged to take samples from each meal produced and preserve them under appropriate conditions under normal circumstances. This has been made mandatory to determine the source of a foodborne epidemic that may occur and to take the necessary precautions (Onbaşı & Çınar, 2021). Mass feeding services are also provided in earthquake areas and the organizations providing this service must also fulfill this obligation (KIZILAY, 2021). To provide qualified service, monitoring, and audits are carried out by people authorized by public authorities, increasing the frequency of audits and applying sanctions when necessary is important in minimizing possible risks (KIZILAY, 2017). This finding, which is also valid for ordinary conditions, could not be discussed as there were no studies in the literature regarding this finding.

In the present study, organizations that did not control the food provided were found to be associated with an increase in FSOF's total score, Organization-specific conditions, Food distribution conditions, Personnel hygiene, Food security, and Environmental conditions dimension scores. Expired tinned foods, improper storage, inadequate refrigerators, lack of hygiene of service staff, and problems with dishwashing were reported during the 1999 Izmit and 2002 Afyon earthquakes in Türkiye (KIZILAY, 2002). The Chamber of Food Engineers reported that the risks stemming from

Table 3 The comparison of the descriptive characteristics of the food distribution organizations according to FSSOF total and sub-dimension score averages

Variables	Total[a]	Organization-specific conditions[b]	Food storage practices[a]	Food distribution conditions[b]	Personnel hygiene[a]	Food security[b]	Environmental conditions[b]
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Organization characteristics							
Public/municipal	84.75 ± 28.31	14.31 ± 7.52	20.56 ± 8.95	19.81 ± 8.19	5.06 ± 2.57	18.19 ± 3.29	6.81 ± 2.83
NGO/foundation/association	98.67 ± 47.60	19.63 ± 12.99	22.38 ± 10.67	23.83 ± 13.54	6.75 ± 4.25	18.79 ± 5.40	7.29 ± 4.29
Organization type							
Fixed	99.58 ± 42.39	**19.65 ± 11.80***	**23.39 ± 9.82***	23.52 ± 12.07	6.55 ± 3.83	18.94 ± 4.81	7.55 ± 4.01
Mobile	70.78 ± 28.06	**10.11 ± 4.81**	**15.67 ± 8.26**	17.78 ± 9.90	4.44 ± 2.96	17.22 ± 3.90	5.56 ± 2.13
Staff number							
< 10	88.26 ± 40.05	15.30 ± 10.34	20.13 ± 8.86	21.09 ± 11.09	5.57 ± 3.51	18.78 ± 5.32	7.39 ± 4.04
≥ 10	99.65 ± 42.88	20.47 ± 12.21	23.71 ± 11.18	23.76 ± 12.76	6.76 ± 3.99	18.24 ± 3.63	6.71 ± 3.37
Number of meals							
< 3	105.70 ± 40.59	22.70 ± 13.14	23.30 ± 9.87	24.70 ± 11.46	7.60 ± 3.75	19.70 ± 3.50	7.70 ± 3.97
≥ 3	88.90 ± 41.12	15.77 ± 10.31	21.10 ± 10.07	21.40 ± 11.92	5.57 ± 3.64	18.17 ± 4.94	6.90 ± 3.71
Population served							
< 4000	102.04 ± 41.30	20.17 ± 12.18	24.13 ± 9.63	24.22 ± 11.95	6.48 ± 3.57	19.22 ± 4.61	**7.83 ± 3.73***
≥ 4000	81.00 ± 38.83	13.88 ± 9.17	18.29 ± 9.62	19.53 ± 11.25	5.53 ± 3.97	17.65 ± 4.64	**6.12 ± 3.64**
Having a food engineer and/or dietitian							
No	**100.60 ± 36.84****	**19.26 ± 10.74***	**23.63 ± 8.81*****	**24.23 ± 10.69***	**6.60 ± 3.51***	**19.20 ± 4.28***	**7.69 ± 3.51***
Yes	**40.60 ± 31.95**	**5.20 ± 7.26**	**7.80 ± 5.50**	**8.20 ± 9.60**	**2.40 ± 3.36**	**14.00 ± 4.85**	**3.00 ± 2.74**
Organization-tent city distance							
< 100 m	97.83 ± 45.38	18.96 ± 12.92	23.17 ± 10.24	23.00 ± 13.38	6.17 ± 3.71	19.00 ± 4.82	7.54 ± 4.26
≥ 100 m	86.00 ± 33.94	15.31 ± 8.29	19.38 ± 9.32	21.06 ± 9.04	5.94 ± 3.86	17.88 ± 4.40	6.44 ± 2.78
Organization-solid waste landfill distance							
< 6 m	110.36 ± 36.35	21.91 ± 10.46	25.82 ± 8.33	25.91 ± 11.02	6.73 ± 2.65	**21.18 ± 3.12***	8.82 ± 4.09
≥ 6 m	86.55 ± 41.51	15.83 ± 11.35	20.07 ± 10.17	20.83 ± 11.89	5.83 ± 4.07	**17.55 ± 4.76**	6.45 ± 3.45
Control of provided foods							
Not available	**119.43 ± 31.85*****	**24.81 ± 10.11*****	**27.48 ± 7.43*****	**28.86 ± 9.86*****	**8.24 ± 3.05*****	**20.81 ± 3.67****	**9.24 ± 3.58*****
Available	**64.00 ± 28.92**	**9.42 ± 5.74**	**15.21 ± 8.32**	**14.89 ± 9.11**	**3.68 ± 2.87**	**16.05 ± 4.35**	**4.74 ± 2.21**

$^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$.[a] *Student's t-test*, [b]*Mann Whitney U test*

improper checks in local collection areas were directly reflected in the earthquake area in Kahramanmaraş-centered earthquakes. In the help areas, encountering products whose Expiry Date (ED) and Recommended Consumption Date (RCD) had passed were given as examples (TMMOB, 2023). In the interviews conducted with 45 authorized persons in Malatya, Adıyaman, and Kahramanmaraş-Pazarcık regions, it was found that more than half of them did not have cold storage facilities (Alataş & Arslan, 2024). It was reported that during the Thoko earthquake in Japan in 2011, logistics problems and unplanned deliveries caused fresh fruits and vegetables to rot (Zhu et al., 2020). It was found that our results are in line with the literature and support the studies carried out and the reports prepared.

In the present study, it was also found that while the risk level of organization-specific conditions increased in organizations employing ten or more personnel, the risk level of food storage conditions decreased in organizations employing food engineers and/or dietitians. Unpredictable demand for help during disasters, simultaneous initiatives of many organizations, the involvement of a large number of volunteers, and the lack of sufficient infrastructure bring with them various problems (Ainehvand et al., 2019; Kovács & Spens, 2007). Improper distribution was reported as one of the most important problems because of the lack of nutrition and health experts in food distribution in the Bam Earthquake (Maayeshi & Salehi-Abargouei, 2018; Tavakoli et al., 2008). During the tsunami that resulted from the Great East

Table 4 The multiple linear regression analysis of FSSOF with descriptive characteristics of the food distribution organizations

Predictors	β	SE	p
Total			
Organization type (fixed*)*	0.048	16.978	0.786
Population served (≥*4000 people)*	− 0.056	10.316	0.661
A food engineer and/or dietitian (*yes*)	− 0.282	19.356	0.083
Organization-solid waste landfill distance (≥*6 m)*	0.002	11.780	0.990
Control of food provided (*yes*)	− 0.527	15.783	**0.010** *
Adj. R^2*: 0.455, F: 7.502* ***			
Organization-specific conditions			
Organization characteristics (NGOs*/foundation/association)*	0.135	0.237	0.260
Organization type (*fixed*)	− 0.082	0.408	0.640
Number of staff (≥*10 people*)	0.348	0.242	**0.007** **
Population served (≥*4000 people*)	− 0.153	0.239	0.209
A food engineer and/or dietitian (*yes*)	− 0.111	0.451	0.467
Organization-solid waste landfill distance (≥*6 m*)	− 0.058	0.274	0.642
Control of food provided (*yes*)	− 0.623	0.364	**0.002** **
Adj. R^2*: 0.528, F: 7.240* ***			
Food storage practices			
Organization type (*fixed*)	0.264	4.076	0.137
Population served (≥*4000 people*)	− 0.121	2.477	0.338
A food engineer and/or dietitian (*yes*)	− 0.469	4.647	**0.005** **
Organization-solid waste landfill distance (≥*6 m*)	− 0.015	2.828	0.906
Control of food provided (*yes*)	− 0.246	3.789	0.210
Adj. R^2*: 0.462, F: 7.687* ***			
Food distribution conditions			
Organization type (*fixed*)	− 0.049	0.449	0.798
Population served (≥*4000 people*)	− 0.018	0.270	0.893
A food engineer and/or dietitian (*yes*)	− 0.234	0.509	0.179
Control of food provided (*yes*)	− 0.531	0.409	**0.015** *
Adj. R^2*: 0.353, F: 6.319* **			
Personnel hygiene			
Organization characteristics (*NGOs/foundation/association*)	0.070	1.056	0.623
Organization type (*fixed*)	− 0.094	1.709	0.633
Number of meals (≥*3 meals*)	− 0.142	1.169	0.310
A food engineer and/or dietitian (*yes*)	− 0.086	1.909	0.619
Control of food provided (*yes*)	− 0.608	1.497	**0.005** *
Adj. R^2*: 0.353, F: 5.252* **			
Food security			
Organization type (*fixed*)	− 0.126	0.480	0.537
A food engineer and/or dietitian (*yes*)	− 0.118	0.547	0.523
Organization-solid waste landfill distance (≥*6 m*)	− 0.179	0.329	0.238
Control of food provided (*yes*)	− 0.480	0.434	**0.036** *
Adj. R^2*: 0.262, F: 4.454* **			
Environmental conditions			
Organization type (*fixed*)	− 0.066	0.458	0.734
Population served (≥*4000 people*)	− 0.059	0.278	0.674
A food engineer and/or dietitian (*yes*)	− 0.169	0.522	0.340
Organization-solid waste landfill distance (≥*6 m*)	− 0.068	0.317	0.637
Control of food provided (*yes*)	− 0.537	0.425	**0.018** *
Adj. R^2*: 0.330, F: 4.839* **			

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$. Reference groups (0): organization characteristics (*public/municipal)*, organization type (*mobile*), Number of staff (*< 10 people*), Number of meals (*< 3 meals*), Population served (*< 4000 people*), food engineer and/or presence of a dietitian (*no*), organization-solid waste landfill distance (*< 6 m*), Control of provided foods (*no*)

Japan Earthquake, it was found that dietitians took part in coordination, food supply, purchasing, storage, ensuring supply–demand balance, cooking, and providing diet support was useful (Yanagihara et al., 2012). It was seen that our result supports the literature data.

4.1 Study limitation

The fact that the study had a cross-sectional design within a certain period was an important limitation. This did not allow the food engineer to observe some items in the FSSOF form during the observation period, and some evaluations were based on the statements of the institution officials. For example, if practices such as the safe transportation of foods, the safe thawing of frozen foods, and the staff washing their hands for at least 20 s were not carried out within the specified time while the researcher was present, this was recorded in the FSSOF based on the statement. However, the accuracy of the answers given by the institution officials due to their concerns about being audited may have negatively affected this situation. In addition, the chaotic conditions and the actions taken by the institutions for acute situations in the research conducted on the 14 th and 18 th days of the earthquake may have affected the reliability of the data. Although more institutions that met the inclusion criteria were visited, the fact that some institution officials did not allow the research to be conducted might have weakened the obtaining of more qualified results. This, together with the fact that the total number of food distribution organizations in the research region is not known exactly and that more organizations could not be visited because of transportation difficulties in the earthquake region, might have affected the generalizability of the study. It is not known whether the personnel working in the food distribution organizations have received training before. This might have affected the standardization of the organizations regarding food distribution in a safe manner. The fact that only one researcher evaluated within the limited observation period, that the organizations could not be evaluated at different times, and that the results were obtained by taking pictures during the evaluation of the menus constituted other limitations. Generalizations can be made for similar situations because the effects of the earthquake were affected by the development level of the city and the risk assessment was conducted on the 14 th and 18 th days.

4.2 Study strength

The most powerful aspect of the present study was that it provided a resource in disaster preparedness plans for possible situations to evaluate food safety and security in the acute phase of a natural disaster and formed the basis for strengthening and improving food safety and security for other possible unusual situations. Another strength was that it was one of the first studies conducted on this subject in the literature.

5 Conclusion

The risk levels of the organizations regarding food safety and security were relatively high (41.6%). When each dimension was evaluated separately, the risk increased by half (35.5%– 54.1%). The fact that the organizations did not provide appropriate diets for situations that required a special diet, did not provide allergen information to the earthquake victims, and did not take samples from the meals constituted the highest risks in the FSSOF. Organizations that did not control the foods were the most important determinants of increased risk in the FSSOF of Total, Organization-specific conditions, Food distribution conditions, Personnel hygiene, Food security, and Environmental conditions. Organizations employing ten or more personnel increased the risk level of Organization-specific conditions, while organizations that have food engineers and/or dietitians decreased the risk level of Food storage conditions, but the presence of food engineers and/or dietitians was not found to be a determinant of most risk levels in food distribution organizations. The type of organization, whether mobile or fixed, and the characteristics of the organization, such as public, municipal, or NGO, were not determinants of the risk levels in food distribution organizations. The size of the population served, the number of meals served and organization-solid waste landfill distances were not determinants of the risk levels in food distribution organizations.

In line with the results, our recommendations are as follows. To ensure food safety and security in unusual situations such as earthquakes, disaster preparedness plans must be made more seriously, trained and equipped staff must be trained in this regard, and necessary precautions must be determined with proactive approaches. Standards must be determined for the supervision and control of organizations associated with the humanitarian Food Supply Chain (FSC), and organizations that have risky production or distribution processes must be kept under control or must not be included in service processes in the regions. Although some precautions were taken in public institutions, it is seen that systematic and structured approaches are lacking in NGOs and other organizations. Also, inadequate information and lack of control even in public institutions increase food safety risks. To maintain food safety standards, specific application guides regarding these processes should be effectively applied and public authorities should increase inspections by introducing stricter regulations. In disaster situations, the quality of staff/volunteers becomes more important than their number. Food safety and security

training must be planned among the training subjects given to AFAD volunteers at the national level, and this staff must be provided with a key role in unusual situations. Interdisciplinary collaboration must be encouraged in humanitarian aid processes, and a more effective communication network should be established between nutritionists, healthcare staff, and logistics teams. The development of operational strategies, conducting empirical research, and implementing training programs will strengthen disaster preparedness. To increase food safety and security and the quality of the service provided during disaster periods, it is important to ensure controls, monitoring, and audits by people authorized by public authorities, to increase the frequency of audits, and to impose sanctions when necessary, to minimize possible risks. A digital tracking system must be activated for food logistics, and the status of food aid, logistics processes, and distribution points can be monitored instantly to ensure that aid is distributed effectively in terms of food safety. For this reason, standardized online training should be created for volunteers and professionals who will work in disaster areas, and training should be made more effective, especially on issues such as food control, hygiene protocols, and contamination prevention. It may be necessary to increase the presence of food engineers or dietitians on duty to check food safety in food distribution centres. In this context, drones can be used to monitor food distribution centers at certain intervals and to check the appropriateness of storage, preparation, and service processes. Mobile inspection vehicles can perform on-site checks and ensure rapid response to violations. During audits, it must be checked whether organizations provide appropriate diet in foods for conditions or diseases that require a special diet. If this type of service is not provided in small organizations, earthquake victims must be directed to organizations that provide this service and access to the service must be provided. Foods that meet the needs of disaster victims who have special dietary requirements (e.g., celiac patients, diabetics, those with food intolerance/allergy, and vegans/vegetarians) must be systematically included in disaster relief packages. Also, the authorities must examine whether organizations provide allergen information and the necessary sanctions must be applied in this regard. Even if organizations provide services, it is also important to deliver this information to the society. Organizations must make the necessary efforts to deliver this information to the public. In this context, a central database should be actively used to facilitate the tracking of disaster victims with special dietary needs and to ensure their access to appropriate food. This system must be integrated with healthcare records to ensure that appropriate food is delivered to those in need more effectively. Also, the establishment of scientific criteria for assessing food safety and security in disaster situations will contribute to more efficient post-disaster management processes. In light of these findings, another suggestion is to improve the FSSOF created by the researchers. The implementation of these recommendations will significantly improve food safety and security in disaster-affected areas.

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Data Availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethical approval Ethical approval was received from Kırklareli University Rectorate Scientific Research and Publication Ethics Committee to conduct the study. Written permission was received from AFAD Headquarters to investigate the food distribution organizations in the earthquake zone. Also, verbal permission was obtained from the organization officials of the volunteer NGOs, foundations or associations visited.

Competing interest The authors have no competing interests to declare that are relevant to content of this article.

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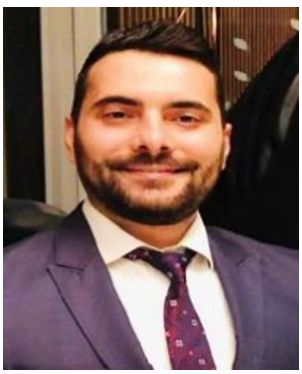

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