



Research Note

Food safety risk perceptions and mitigation techniques in the dumpster diving community in Sweden



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ARTICLE INFO

Keywords:

Alternative lifestyle
Best before
Food waste
Foodborne bacteria
Foodborne disease
Shelf-life

ABSTRACT

An online questionnaire was used to investigate behaviors and habits relating to food retrieval by Swedish dumpster divers. Respondents were also asked to share information on their background, reasons for engaging in dumpster diving, and perceptions of potential bacterial hazards associated with the consumption of discarded foods. The questionnaire was mainly distributed to Swedish social media groups focusing on dumpster diving, and a total of 92 responses were received. The most common reason given for engaging in dumpster diving was to reduce food waste and associated negative environmental impacts (60%, $n = 55$). Many of the respondents (65%) had completed university education, and around three-quarters (73%) had some form of employment or were enrolled in studies. Half the respondents (52%, $n = 48$) perceived a risk of falling ill after consuming food obtained through dumpster diving, but very few (2%) reported they had been made ill by food they had picked up from dumpsters. Around one-fifth (22%) of the respondents did not know of any bacteria that could cause foodborne infections or food poisoning. Salmonella was mentioned by 35% of the respondents, while Listeria was mentioned by 18%. The respondents reported employing various techniques to reduce the risk of encountering harmful microbiological agents, for example, rinsing their food retrievals or discarding food that appeared spoiled. These are novel findings on dumpster divers' perceptions of perceived health risks and the strategies they use to mitigate such risks with food obtained through dumpster diving.

Food waste is increasingly being recognized as a global problem, due to its negative consequences for environmental, economic, and social sustainability (Scherhauser et al., 2018). Within the European Union (EU), approximately 129 million ton of food waste are generated yearly along the food supply chain, of which about 5% arises at the distribution and retail level (Caldeira et al., 2019). The most commonly reported reason for food waste at retail level is customer-related, specifically limited predictability of customer demand and undesirable customer behavior when selecting and handling products in-store (e.g., damaging products, choosing “newest” products). Other common reasons relate to retail personnel and their behaviors (e.g., poor handling, lack of experience) and products being delivered too close to the expiry date by the supply company (Stenmarck et al., 2011; Teller et al., 2018). For environmental, economic, or political reasons (the latter in the context of the anticonsumerism movement) (Eikenberry and Smith, 2005; Rombach and Bitsch, 2015; Vinegar et al., 2016), some food that is discarded at retail is collected by members of the public from the retail garbage containers and consumed. This is called ‘dumpster diving’, a term generally used for obtaining

items (in this case food for consumption) from dumpsters (Eikenberry and Smith, 2005). The legal status of dumpster diving is described as a legal ‘gray area’, since the act is not recognized by the Swedish legislation but littering or breaking locks to garbage containers is prohibited by law (Karlsson, S., 2021; Sundberg, 2020).

Dumpster diving may increase the risk of foodborne disease, as food that has been deemed unfit for consumption (e.g., damaged food or products that have passed their best-before date) is being consumed. Awareness of the food safety risks have been partly addressed in studies in the US and Germany (Eikenberry and Smith, 2005; Vinegar et al., 2016), but to our knowledge, no study has specifically investigated awareness of potential bacterial hazards among dumpster divers, and the strategies they use to mitigate risks related to the presence and potential growth of bacterial pathogens in food. There are a wide range of bacterial pathogenic contaminants in food that can thrive at higher temperatures (such as in a dumpster) and reach levels that may pose the risk of foodborne disease even if they were present in very low numbers at retail level, for example, *Salmonella*, Shiga toxin-producing *Escherichia coli* (STEC), *Campylobacter* spp., and *Liste-*

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ria monocytogenes (Söderqvist et al., 2017; U.S. Department of Agriculture Food Safety and Inspection Service, 2022). Another concern is bacteria which can grow and produce heat-resistant toxin in food at abuse temperatures, for example, *Staphylococcus aureus* (Kadariya et al., 2014).

This study investigated reasons for dumpster diving, behaviors and habits relating to retrieval of foods, awareness of bacterial food safety risks among dumpster divers, and the measures they employ to mitigate perceived risks.

Materials and methods

This descriptive study was conducted January-March, 2021. An online questionnaire, directed at people who retrieve food from retail garbage containers in Sweden, was developed in Swedish and English using Google Forms (Google Ireland Limited, Ireland). Twenty-four questions were included, of which 14 were multiple choice questions, eight were multiple choice questions with an opportunity to add own alternatives or comments, and two were open-ended (the questionnaire is presented as Supplemental Material). The questions covered respondents' characteristics (age, education level, and occupation), reasons for dumpster diving, the most popular food items to collect, and the proportion of food consumed obtained from dumpster diving. Some questions also covered awareness of bacterial food safety risks associated with consuming food obtained from dumpster diving and potential food safety risk mitigation practices. The questionnaire was pretested by a small subset of the general public and adjusted accordingly before the study began. A link to the questionnaire was distributed within four Swedish social media groups, one Swedish website, and one blog targeting those interested in dumpster diving. To encourage participant recruitment, a reminder about the study was posted in February 2021 via the social media channels. Participation in the study was voluntary and anonymous, and no compensation was offered for contribution. Filling in and submitting the questionnaire was taken as consent to participate. Ethical clearance was not needed for this study. Data were processed using Microsoft Excel for Mac v16.48 (Microsoft). A chi-square test was performed to test for associations between level of education and awareness of bacterial food safety risks using Epi Info 7.0 (Centers for Disease Control and Prevention, Atlanta, the US). A p value ≤ 0.05 was considered statistically significant.

Results and discussion

A total of 92 responses were received. Among the respondents, 70% (n = 64) were female and 53% (n = 49) were aged 18 to 29 years (Table 1). A similar age distribution for dumpster divers has been reported in previous studies in Canada (Carolsfeld and Erikson, 2013; Vinegar et al., 2016), and in a report in Sweden (Karlsson, S., 2021). Respondents in the present study were students (35%) or employed (38%), and 65% reported having completed university studies (Table 1). This is a higher level of education than in the general Swedish population (Statistics Sweden, 2022), which is in agreement with Canadian findings of a generally high level of education among dumpster divers (Carolsfeld and Erikson, 2013). The questionnaire was distributed using social media groups targeting those interested in dumpster diving. The results are thus only valid for this group of people.

The most common reason given (60%, n = 55) for engaging in dumpster diving was to reduce food waste and/or make a contribution to the environment, although 31% (n = 29) of respondents in this study reported engaging in dumpster diving for economic reasons, to save money (27%, n = 25) or due to poor economy (4%, n = 4). Similarly, a study in Canada and two reports in Sweden found that dumpster divers as a group have varying reasons for retrieving food from

Table 1

Characteristics of respondents to the online questionnaire on dumpster diving for food

Parameter	Respondents (%)
Gender	
Female	64 (70)
Male	23 (25)
Nonbinary	4 (4)
Age	
18–29 years	49 (53)
30–49 years	25 (27)
50–69 years	18 (20)
Occupation	
Student/Postgraduate student	32 (35)
Employee	35 (38)
Not in work ¹	25 (27)
Highest completed level of education	
Primary school	2 (2)
High school	23 (25)
University	60 (65)
Other training	7 (8)

¹ For example, sick leave, unemployed, retired.

dumpsters, e.g., economic, environmental, experiential, and ideological reasons (Karlsson, 2021; Larsson, 2017; Vinegar et al., 2016). The most popular foodstuffs for respondents to retrieve from dumpsters are shown in Table 2. More than half of all respondents were positively inclined to retrieve most of the foods listed in Table 2, except for unpackaged bread. A preference to retrieve packaged food was also detected in a study in Minneapolis, US, where most participants reported eating only packaged food to avoid cross-contamination or physical hazards (Eikenberry and Smith, 2005). A slight majority of respondents in the present study (54%, n = 50) reported that food obtained through dumpster diving made up an estimated 25% of the food they consumed during the year. A further one-fifth (21%) estimated that 25–50% of their yearly food consumption came from dumpster diving, while 25% reported that more than half the food they consumed came from dumpsters. Among the latter, 13% claimed that most or all of the food they consumed came from dumpster diving.

Since discarded food is no longer subject to food safety regulations, dumpster divers have to rely on their own judgment to evaluate whether the food they retrieve is edible and safe to consume. Around half of the respondents (52%, n = 48) recognized a risk of falling ill after consuming food obtained through dumpster diving, and 5% of these (n = 5) perceived a risk of contracting a severe infection. However, only 2% (n = 2) of the participants reported falling ill after consuming food they had retrieved from dumpsters, and the symptoms

Table 2

Food categories most commonly retrieved from retail garbage containers by dumpster divers

Category of food	Food products retrieved by:
Packaged food	
bread, vegetables, root vegetables, fruit and berries, canned food and dry products, such as pasta, cereals, rice, and spices	≥90%
Unpackaged food	
fruit, berries, root vegetables, and vegan alternatives to dairy products	80–89%
unpackaged vegetables	65%
unpackaged bread	45%
Foods with limited shelf-life	
raw meat products, ready-to-eat food, pastries and confectionary, and dairy products	70–79%
cooked fish and meat products, and eggs	60–69%
raw fish products	58%

were reported to be mild and of short duration (a few hours to a day). In contrast, over half of the participants in a study in Canada by Vinegar et al. (Vinegar et al., 2016) described falling ill, or knowing someone who had become ill, after eating food retrieved from dumpsters (Vinegar et al., 2016). There was no information about the actual illness rate in that study which makes comparisons difficult. However, most participants in a study of dumpster divers in Minneapolis, US, by Eikenberry and Smith (2003) reported becoming ill at some point after eating dumpster food (Eikenberry and Smith, 2005). This might be because the participants in the latter study were primarily homeless and without easy access to a kitchen. The majority of respondents in the present study were young and probably in good health, which may have contributed to the low self-reported occurrence of foodborne illness in this group. However, the symptoms of foodborne illness were not specified in the questionnaire and since the symptoms may be diffuse, they sometimes tend not to be associated with foodborne disease. In addition, due to the long incubation time for some foodborne infections (e.g., listeriosis), it can be difficult to make assumptions about the food actually causing illness. Even if half of the respondents (52%, $n = 48$) were aware that they might get a foodborne infection or food poisoning from food obtained from dumpster diving, only a few ($n = 5$) recognized a risk of becoming seriously ill. It appears that the motivation to engage in dumpster diving is stronger than the perceived risk of foodborne illness. There were some respondents that added comments in free text to this particular question, for example, one person who claimed that the risk of becoming ill was the same, regardless if the food were bought from a grocery store or retrieved from a dumpster.

Of the respondents in this study, 35% ($n = 32$) mentioned being aware of *Salmonella* as a foodborne pathogenic bacteria. This was followed by *Listeria* (mentioned by 18%), *Clostridium* and *E. coli* (12% each), and *Campylobacter* (7%). Only a few mentioned *Bacillus* (2%), *Shigella*, and *Yersinia* (1% each). More than one bacterial agent was mentioned by 26% ($n = 25$) of the respondents, and 7% ($n = 7$) reported nonbacterial health hazards such as chemicals, mold, nematodes, and toxins. However, 22% could not name any bacteria that could spread through food and cause illness. While *Salmonella* was by far the best-known bacterial pathogen among the respondents, campylobacteriosis, strongly associated with the consumption of chicken meat, is the most commonly reported foodborne disease in the EU (European Food Safety Authority and European Centre for Disease Prevention and Control, 2021), with more than twice as many reported cases as salmonellosis. Almost one-fourth could not mention any foodborne bacterial pathogen which may reflect a general gap in knowledge. The questionnaire did not investigate the field of participants' education. There was however no association between education level and knowledge of foodborne bacterial pathogens. Low consumer knowledge of foodborne pathogens has also been found in other studies, with *Salmonella* again being the best-known foodborne pathogen (Al-Mohaithef, 2021; Henke et al., 2020).

The majority (83%, $n = 76$) of the respondents in the present study used some kind of personal protection equipment while collecting food from retail garbage containers. Using gloves was most commonly mentioned (79%, $n = 73$), followed by protective clothing (34%, $n = 31$), use of facemasks (4%, $n = 4$), and using a reacher-grabber (3%, $n = 3$). Almost half (49%, $n = 45$) of the 92 respondents reported checking the news, social media groups for dumpster divers, and other sources for information on recalls of food for different reasons, e.g., through the website of the Swedish Food Agency, before dumpster diving for food. Around one-third (36%, $n = 33$) of the respondents reported adjusting their pick-up times based on information and experiences of when garbage containers were filled. One-third ($n = 30$) reported not retrieving food that had passed its expiry date, but almost one-third ($n = 28$) reported retrieving food that was up to a month after its best-before date and 21% ($n = 19$) reported retrieving food that was up to seven days after its best-before date. However, this

question did not distinguish perishable refrigerated food from food that can be stored for a long time at room temperature, e.g. canned food and cereals, making it difficult to draw any conclusions about potential food safety consequences of these habits. It should be noted that many of the foods carrying a higher risk of foodborne diseases, such as refrigerated ready-to-eat foods (Söderqvist et al., 2016), usually decay quickly and noticeably, and seldom risk being picked up by dumpster divers once a certain level of deterioration has occurred.

The most common measures employed by respondents in the present study to avoid potential health risks included discarding foods that smelled bad or did not look fresh, applying what is regarded as "look, smell, and taste", which has been the catchphrase of several campaigns aimed at minimizing household food waste (for example, see Livsmedelsverket, 2022). This decision tool was used by 93% ($n = 86$) of the participants, alongside rinsing fruits and vegetables (93%, $n = 86$). Many respondents avoided eating moldy foods (80%, $n = 74$), and a similar proportion applied thorough hand hygiene when handling the retrieved food (82%, $n = 75$). More than half reported cutting away mold if they found it on cheese (60%, $n = 55$). The majority of those who reported that they were willing to retrieve raw meat (total $n = 65$) said that they handled it separately from other foods (72%, $n = 47/65$). The participating respondents seemed to have a general notion of 'risk foods', but types of 'risk food' were seldom explained by the respondents, and the only types of foods mentioned directly in the context of 'risk food' were meat and dairy. However, the assumption that avoidance of meat or dairy can dramatically reduce the risk of foodborne disease is not correct. Most of the bacterial burden on meat can easily be reduced through heat treatment, which is seldom applicable to ready-to-eat foods, salads, fruits, and vegetables.

Refrigerated food that is discarded leaves the cold chain, which will increase the rate of microbial growth. While the advice to 'look, smell, and taste' food to check whether it is edible will likely guide dumpster divers to discard spoiled food, it has been shown that food can occasionally contain large numbers of pathogens without being categorized as spoiled (Söderqvist et al., 2017). Baseline surveys of ready-to-eat food have revealed that *L. monocytogenes* can be present in ready-to-eat food in the EU and that, even if the pathogen is likely to be present only in low numbers during its shelf-life (European Food Safety Authority, 2013), it can proliferate if food is left in a dumpster at abuse temperatures for some time. Moreover, the growth of for example *Bacillus cereus* and *S. aureus* can occur in refrigerated food stored at abuse temperature, resulting in toxin being produced which will not be destroyed by heat treatment.

To our knowledge, no previous study has investigated perceived health risks among dumpster divers themselves in relation to food retrieved from dumpsters and strategies employed by them to mitigate such perceived risks. While the present study was limited in size, we believe that the results reflect average knowledge, habits, and attitudes of those practicing dumpster diving for food in Sweden. Only around half of our respondents perceived a risk of contracting disease after consuming food obtained through dumpster diving, leading us to conclude that general knowledge of foodborne bacterial pathogens among dumpster divers is poor.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors wish to thank all dumpster divers who participated in the study.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jfp.2022.10.006>.

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