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To cite this article: Elina Leinonen, Jenni Kaskela, Riikka Keto-Timonen & Janne Lundén (2022): Results of routine inspections in restaurants and institutional catering establishments associated with foodborne outbreaks in Finland, International Journal of Environmental Health Research, DOI: [10.1080/09603123.2022.2041563](https://doi.org/10.1080/09603123.2022.2041563)

To link to this article: <https://doi.org/10.1080/09603123.2022.2041563>



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Published online: 09 Mar 2022.



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Results of routine inspections in restaurants and institutional catering establishments associated with foodborne outbreaks in Finland

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ABSTRACT

Official food control is intended to ensure food safety in the food business. In Finland, inspections of food service are performed using a 4-point risk-based grading system. This study compared routine inspection results of outbreak and nonoutbreak establishments in restaurants and institutional catering to investigate whether certain inspection results were associated with the occurrence of foodborne outbreaks. Also a more specific sample of outbreak establishments was defined using strength of evidence registered for each outbreak. Grade distributions of specific inspected items were compared separately. No significant differences were seen in restaurants but in institutional catering significantly poorer inspection results ($p < 0.05$) were detected in items concerning the order and cleanliness of facilities, surfaces and equipment in outbreak establishments. Effective correction of noncompliances in cleanliness of the food handling environment and equipment and constant maintenance of a favourable situation is essential in ensuring a high level of consumer safety in food service.

ARTICLE HISTORY

Received 3 November 2021
Accepted 9 February 2022

KEYWORDS

official food control; food safety grading system; foodborne outbreaks; food inspection; food hygiene

Introduction

Protection of human health is a fundamental objective of food safety legislation (European Communities 2002). Official controls are carried out to verify compliance with the requirements set out in food law (European Union 2017). Associations between routine inspection results and occurrence of foodborne outbreaks have been studied in a few studies with mixed results. Poor inspection scores, poorer food hygiene rating of the premises and detection of specific violations have been associated with increased risk of foodborne outbreaks in restaurants (Irwin et al. 1989; Petran et al. 2012; Fleetwood et al. 2019), whereas in other studies overall rating or mean scores did not predict outbreaks (Cruz et al. 2001; Jones et al. 2004). The predictive value of routine inspection results within restaurant chains affected by single outbreaks has also varied (Patel et al. 2010; Lee and Hedberg 2016; Firestone et al. 2020).

In Finland, municipal food control authorities take care of food control in restaurants and other food service based on their annual control plans (Food act 2021). The Finnish food safety grading system Oiva was implemented in food service in May 2013. In the Oiva system, food inspectors use inspection forms that include items to be inspected based on food legislation. The evaluation of each item is based on legal requirements and is performed using evaluation

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guidelines. All items are inspected at least once during a period of 3 years. Each inspected item is graded using a 4-point scale of ‘Excellent’, ‘Good’, ‘To be corrected’ and ‘Poor’. The highest grading ‘Excellent’ indicates that the inspected item is in compliance with food safety regulations. The grade ‘Good’ indicates small noncompliances that do not impair food safety or mislead the consumer. The grade ‘To be corrected’ means that the inspector has detected a noncompliance that impairs food safety or misleads the consumer. Consumers can be misled, for example, due to incorrect information provided on foods. The lowest grade ‘Poor’ means that the inspector has detected an issue that jeopardises food safety or considerably misleads the consumer. Grades can be lowered if noncompliances detected earlier have not been corrected. The final result of an inspection is determined according to the worst item-specific grade among inspected items. Inspection reports are submitted to a national database maintained by the Finnish Food Authority and the system creates a public summary report that must be disclosed by the food business operator in the vicinity of the entrance and on the website (Evara 2016). Public disclosure of restaurant inspection results in Finland have been shown to affect consumers’ risk perceptions and behavioural intentions (Vainio et al. 2020).

The Oiva system covers routine inspections based on the control plans of municipal food control authorities and re-inspections. A re-inspection follows inspections with ‘To be corrected’ or ‘Poor’ results (Evara 2016). The results of inspections differ between restaurants and institutional catering in Finland and the rate of compliance with statutory requirements is at a higher level in institutional catering (Finnish Food Authority 2020). It is not known whether associations between routine inspection results and the occurrence of foodborne outbreaks are different in restaurants compared with institutional catering. The category ‘institutional catering’ includes central kitchens, industrial kitchens, catering and kitchens that prepare precooked food products for sale.

Municipal outbreak investigation groups are responsible for the investigation of suspected foodborne outbreaks in their area. The local outbreak investigation groups notify the National Institute for Health and Welfare (THL) where an outbreak is suspected and submit an investigation report to the Finnish Food Authority once the investigation is finished (Government decree 2011). Notifications of suspected outbreaks and investigation reports are submitted using an electronic reporting system and the data is stored in the National Foodborne Outbreaks Register. The Finnish Food Authority together with the THL evaluates each final investigation report, and confirmed foodborne outbreaks are further classified based on strength of evidence. Strength of evidence is registered as ‘strong evidence’ (A), ‘probable evidence’ (B), ‘possible evidence’ (C) or ‘not clear evidence’ (D) based on descriptive and analytical epidemiological evidence, results of laboratory analyses (detection of causative agent) and possible contributory factors (Pihlajasaari et al. 2019). Assessment of strength of evidence of confirmed foodborne outbreaks has not been investigated in studies that compared inspection results of outbreak and nonoutbreak restaurants (Irwin et al. 1989; Cruz et al. 2001; Jones et al. 2004; Petran et al. 2012; Fleetwood et al. 2019).

Based on the National Foodborne Outbreaks Register, a total of 467 foodborne outbreaks were registered in Finland in 2010–2019. The most commonly recognised place of exposure in confirmed foodborne outbreaks was food service. In 2010–2019, the place of exposure was registered as ‘Restaurant, café, pub, bar, hotel or catering service’ or ‘Canteen or workplace catering’ in 62% ($n = 290$) of confirmed outbreaks.

The aim of this study was to investigate whether some routine inspection results are associated with the occurrence of foodborne outbreaks in restaurants and institutional catering. The hypothesis was that poorer inspection results in specific items would be associated with elevated risk of foodborne outbreaks. The strength of evidence registered for each outbreak was used to evaluate confidence in the outcome that a particular food service establishment was associated with an outbreak.

Materials and methods

Outbreak investigation data and food service establishment inspection reports

Data from the National Foodborne Outbreaks Register was used to investigate foodborne outbreaks reported in Finland in 2015–2018. Data was provided by the Finnish Food Authority. A total of 143 outbreaks were associated with restaurants and institutional catering establishments that were under regular official control by municipal food control authorities (Table 1). In seven outbreaks, two restaurants or institutional catering establishments were linked to the same outbreak and possibly contributed to the onset of the outbreak. Therefore, a total of 150 restaurants and institutional catering establishments (henceforth outbreak establishments) linked to the outbreaks were selected as cases for the study. Since some of the establishments were associated with more than one outbreak, the 150 outbreak establishments represented in total 136 separate establishment locations.

To increase the specificity of outbreak data, another sample of outbreaks was defined by selecting only outbreaks with strength of evidence registered as A, B or C ($n = 89$). This sample included 94 outbreak establishments that were associated with 89 outbreaks and represented 87 separate establishment locations.

Inspection reports of restaurants and institutional catering establishments inspected according to the Oiva system in Finland in May 2013–December 2018 were requested from the Finnish Food Authority. We identified outbreak establishments in the data and selected the most recent routine inspection prior to the outbreak conducted on each of them. Inspections that were conducted more than 24 months before the outbreak ($n = 9$) were not included and 20 outbreak establishments did not have a routine inspection preceding the outbreak during May 2013 – December 2018. A preceding routine inspection could be lacking because the facility and/or the operator was new, or the latest inspection had been conducted before May 2013. Consequently, routine inspections were available for 121 outbreak establishments (Table 2). Median time between inspections and following outbreaks was 7.7 months. The most often recognized causative agent in outbreaks associated with the 121 outbreak establishments was norovirus (Table 3).

Food service establishments other than outbreak establishments were selected as controls of the study. One routine inspection per each control establishment inspected at least once during May 2013 – December 2018 was selected randomly for analyses (Table 2).

Analysis

Results of the latest routine inspection before the outbreak in outbreak establishments were compared with results of one randomly selected routine inspection in each control establishment. Distributions of Oiva grades were studied separately for each Oiva item. Statistical analyses were conducted using IBM SPSS Statistics for Windows, version 25.0. Significances of differences in the

Table 1. Place of exposure of foodborne outbreaks associated with restaurants and institutional catering in Finland in 2015–2018.

Place of exposure ^a	Number of outbreaks
The registered place of exposure referred to an identified restaurant or institutional catering establishment that was under regular official control by the municipal food control authority.	118
The place of exposure was not a restaurant or institutional catering establishment (but for example a school or nursing home). Food vehicle originated from a restaurant or institutional catering establishment under regular official control by the municipal food control authority and outbreak investigation data suggested that the outbreak was associated with a restaurant or institutional catering establishment or some stage preceding it rather than to any factor after the food had left the restaurant or institutional catering establishment.	25
Total	143

^aRefers to the place where the food had been eaten.

Table 2. Number of outbreak and control establishments involved in analyses and ratio of outbreak establishments to control establishments according to type of establishment.

Type of establishment	Outbreak establishments ^a		Control establishments ^b	Ratio of all outbreak establishments ^a to control establishments ^b
	All	Outbreaks with strength of evidence from A to C ^c		
Restaurants ^d	87	51	12 885	6.8/1 000
Institutional catering ^e	34	23	15 787	2.2/1 000
Total	121	74	28 672	4.2/1 000

^aOutbreak establishments with at least one routine inspection within 24 months before outbreak between May 2013-December 2018.

^bControl establishments with at least one routine inspection between May 2013-December 2018.

^cOutbreak establishments associated to outbreaks with strength of evidence registered as A, B or C.

^dDoes not include cafes, pubs or grill and fast food establishments.

^eIncludes central kitchens, industrial kitchens, kitchens that prepare precooked food products for service and catering.

Table 3. Causative agents in outbreaks associated with outbreak establishments^a.

Causative agent	Number of outbreaks
Unknown	61
Norovirus	38
<i>Bacillus cereus</i>	6
<i>Campylobacter</i>	4
<i>Clostridium perfringens</i>	4
<i>Salmonella</i>	3
<i>Yersinia enterocolitica</i>	2
<i>Cryptosporidium</i>	1
<i>Listeria monocytogenes</i>	1
Sodium nitrate	1
Total	121

^aOutbreak establishments with at least one routine inspection within 24 months before outbreak between May 2013-December 2018.

distribution of different grades between outbreak establishments and control establishments were analysed using Pearson's Chi-squared exact test and Fisher's exact test. The chi-squared test was used provided that the expected frequency was less than five in a maximum of 20% of the cells in the crosstab and not below one in any of the cells. Since the proportion of the grade 'Poor' was very small in both case and control groups, the grades 'To be corrected' and 'Poor' were combined when using the chi-squared test. If the requirements set for the use of the chi-squared test were not met, we used Fisher's exact test with all grades separately. P-values < 0.05 were considered statistically significant.

Results

Inspection results of institutional catering showed differences in grade distributions between outbreak establishments associated with outbreaks with A, B or C as strength of evidence and control establishments (Table 4). Differences were significant in the item 'General order and cleanliness of facilities' in which the proportion of the grade 'Excellent' was smaller and the proportions of both the grades 'Good' and 'To be corrected' were correspondingly larger in outbreak establishments ($p=0.03$). A larger proportion of the grades 'Good' and 'To be corrected' was also seen in outbreak establishments in the case of the item 'Management of shelf-life and sale period of products in serving of foods' ($p=0.05$). In the cases of the items 'Working utensils, fixtures and equipment', 'Cleanliness of working utensils and equipment',

Table 4. Grades of latest routine inspection before the outbreak in outbreak establishments associated with outbreaks with A, B or C as strength of evidence in Finland in 2015–2018, and one randomly selected routine inspection per each control establishment in institutional catering.

Oiva item ^a	Number and grade (%) of outbreak establishments ^b				Number and grade (%) of control establishments ^c						
	n	Excellent	Good	To be corrected	Poor	n	Excellent	Good	To be corrected	Poor	p ^d
Own-check plan											
Own-check plan and its controllability	16	93.8	6.3	0.0	0.0	10,949	93.2	5.1	1.7	0.0	0.68
Adequacy of the own-check plan	16	81.3	18.8	0.0	0.0	8886	85.4	14.1	0.6	0.0	0.53
Suitability, adequacy and maintenance of facilities and equipment											
Suitability of facilities for use as food premises	17	88.2	11.8	0.0	0.0	11,315	90.9	7.6	1.5	0.0	0.52
Condition of premises	17	70.6	29.4	0.0	0.0	11,542	87.7	11.3	1.0	0.0	0.08
Working utensils, fixtures and equipment	16	75.0	25.0	0.0	0.0	11,456	91.5	7.7	0.8	0.0	0.05
Cleanliness of facilities, surfaces and equipment											
General order and cleanliness of facilities	23	82.6	13.0	4.3	0.0	15,650	93.7	5.7	0.6	0.0	0.03
Cleanliness of working utensils and equipment	23	87.0	13.0	0.0	0.0	15,031	96.6	3.1	0.3	0.0	0.05
Cleanliness of the space for cleaning equipment and cleaning equipment	23	82.6	17.4	0.0	0.0	15,082	91.4	8.2	0.5	0.0	0.20
Vermin and other animals	6	100.0	0.0	0.0	0.0	5956	98.1	1.7	0.2	0.0	1.00
Waste management	8	100.0	0.0	0.0	0.0	7321	98.9	0.9	0.2	0.0	1.00
Actions and training of personnel											
Hygiene of work practices used by personnel	21	100.0	0.0	0.0	0.0	13,921	98.2	1.6	0.2	0.0	1.00
Hand hygiene	21	95.2	4.8	0.0	0.0	15,308	96.0	3.7	0.3	0.0	0.57
Work clothes	22	95.5	4.5	0.0	0.0	14,690	91.7	7.7	0.6	0.0	1.00
Monitoring of employees' health status	5	80.0	20.0	0.0	0.0	5544	90.5	8.7	0.8	0.0	0.39
Instruction, guidance and training of personnel	5	100.0	0.0	0.0	0.0	4118	93.5	5.8	0.8	0.0	1.00
Verification of hygiene proficiency	8	75.0	25.0	0.0	0.0	8725	95.7	4.1	0.2	0.0	0.06
Hygiene of food production or handling											
Risk management in production	2	100.0	0.0	0.0	0.0	1109	97.5	2.0	0.5	0.0	1.00
Packaging	1	100.0	0.0	0.0	0.0	1550	97.5	2.4	0.1	0.0	– ^e
Food temperature management											
Storage of foodstuffs	20	95.0	5.0	0.0	0.0	13,018	95.0	4.6	0.3	0.0	0.64
Cold-stored foodstuffs	23	91.3	8.7	0.0	0.0	15,429	83.9	14.0	2.1	0.0	0.86
Hot-stored foods	6	100.0	0.0	0.0	0.0	5617	94.7	4.5	0.7	0.0	1.00
Chilling	16	75.0	25.0	0.0	0.0	5270	75.8	20.2	4.0	0.0	0.87
Temperature management in production	2	100.0	0.0	0.0	0.0	397	97.7	2.0	0.3	0.0	1.00
Sale and serving											
Separation of product groups and hygiene during selling and serving	13	100.0	0.0	0.0	0.0	8223	98.9	0.9	0.2	0.0	1.00
Management of shelf-life and sale period of products in sale of foods	4	100.0	0.0	0.0	0.0	2545	86.7	11.2	2.1	0.0	1.00
Management of shelf-life and sale period of products in serving of foods	18	72.2	16.7	11.1	0.0	11,716	86.6	11.0	2.5	0.0	0.05
Substances causing allergies or intolerances											
Separation and cross-contamination	14	100.0	0.0	0.0	0.0	12,460	97.1	2.8	0.1	0.0	1.00
Information provided on foods											
General labelling	9	88.9	11.1	0.0	0.0	2719	94.4	5.4	0.2	0.0	0.41

(Continued)

Table 4. (Continued).

Oiva item ^a	Number and grade (%) of outbreak establishments ^b				Number and grade (%) of control establishments ^c						
	n	Excellent	Good	To be corrected	Poor	n	Excellent	Good	To be corrected	Poor	p ^d
Packaging materials and food contact materials											
Packaging materials and other food contact materials	2	100.0	0.0	0.0	0.0	3826	95.9	4.1	0.0	0.0	1.00
Transport of foods											
Reception of foodstuffs	15	100.0	0.0	0.0	0.0	9644	88.0	10.3	1.7	0.0	0.53
Temperature management in transport	5	80.0	0.0	20.0	0.0	1294	86.9	10.2	2.8	0.1	0.21
Traceability and recalls											
Traceability of foodstuffs	4	100.0	0.0	0.0	0.0	3956	98.6	1.3	0.1	0.0	1.00
Recalls	2	100.0	0.0	0.0	0.0	1753	99.2	0.8	0.0	0.0	1.00
Food testing											
Sampling referred to in the own-check plan	4	100.0	0.0	0.0	0.0	4433	90.1	9.2	0.7	0.0	1.00
Actions taken based on test results	1	100.0	0.0	0.0	0.0	2432	97.2	2.7	0.1	0.0	0.5
Display of the Oiva report											
Display of the Oiva report	11	90.9	9.1	0.0	0.0	6251	92.7	7.2	0.1	0.0	0.56

^aOiva items inspected during at least one routine inspection prior to the outbreak in outbreak establishments in institutional catering.

^bResults of the most recent routine inspections prior to the outbreak.

^cResults of one randomly selected routine inspection per each control establishment.

^dP-values according to Fisher's exact test.

^eCould not be computed.

‘Verification of hygiene proficiency’ and ‘Condition of premises’ the smaller proportion of the grade ‘Excellent’ in outbreak establishments was accompanied by an increase in the proportion of the grade ‘Good’ ($p = 0.05$, $p = 0.05$, $p = 0.06$ and $p = 0.08$, respectively).

When inspection results of outbreak establishments associated with outbreaks with D as strength of evidence were included in the analyses, the grades of the item ‘Cleanliness of working utensils and equipment’ were significantly poorer in outbreak establishments than in control establishments in institutional catering ($p = 0.04$). Differences between grade distributions were also seen in the item ‘General order and cleanliness of facilities’ but the differences were not significant ($p = 0.05$).

In restaurants, no remarkable differences in any Oiva item were observed in grade distribution between outbreak establishments associated with outbreaks with strength of evidence A, B or C and control establishments ($p \geq 0.10$) (Table 5). When outbreaks with strength of evidence registered as D were also considered, grading of the item ‘Sampling referred to in the own-check plan’ was poorer in outbreak restaurants ($p = 0.08$). At the same time, restaurant inspection results concerning the items ‘Work clothes’ and ‘Hand hygiene’ were more favourable in outbreak establishments compared to those of control establishments ($p = 0.05$ and $p = 0.06$). The ratio of outbreak establishments to control establishments was higher in restaurants than in institutional catering (Table 2).

Discussion

In institutional catering significant differences were seen in items that considered order and cleanliness of facilities, surfaces and equipment. Differences were also observed in items concerning adequacy and maintenance of facilities and equipment. These findings suggest that a well maintained and clean food handling environment is essential for the prevention of foodborne illness. Differences in items related to facilities and equipment were mainly due to minor noncompliances not considered to be a risk for food safety, indicating that even slight noncompliances in these items might predispose to the occurrence of foodborne illness.

Inspection results of institutional catering have not been studied separately previously. However, specific violations related to the food handling environment and equipment in restaurants have been connected to the occurrence of foodborne outbreaks in general (Irwin et al. 1989; Petran et al. 2012) or to cases of *Salmonella* outbreaks within restaurant chains (Patel et al. 2010; Firestone et al. 2020). Other specific violations reported in previous studies include issues related to temperature management in preparation and storage of food and hygienic work practices in restaurants (Irwin et al. 1989; Petran et al. 2012). In our study inspection results of items concerning work practices of personnel or food temperature management in the kitchen did not differ between outbreak and control establishments in institutional catering. However, in the case of the item ‘Management of shelf-life and sale period of products in serving of foods’ the proportion of both the grades ‘Good’ and ‘To be corrected’ was higher in outbreak establishments associated with outbreaks with at least moderate strength of evidence than in control establishments in institutional catering. This item covers, for example, time for displaying food for serving, temperatures during sale or displaying for serving, and temperature records and possible corrective actions by the food business operator. Time and/or temperature abuse in the storage of food has been identified as a common contributory factor in registered foodborne outbreaks, especially in the case of causative agents like *Clostridium perfringens* and *Bacillus cereus*, which pose a risk to human health especially as a consequence of the growth of bacteria in food (EFSA and ECDC 2021).

Inspection results of institutional catering were also poorer in outbreak establishments in the item ‘Verification of hygiene proficiency’. The violations noticed in two outbreak establishments related to verification of the existence of hygiene proficiency certificates of the personnel. Noncompliances related to recordkeeping on one issue might indicate increased risk of failure in the management of operations in the establishment more generally, with further risk of foodborne illness.



Table 5. Grades of latest routine inspection before the outbreak in outbreak establishments associated to outbreaks with A, B or C as strength of evidence in Finland in 2015–2018, and one randomly selected routine inspection per each control establishment in restaurants.

Oiva item ^a	Number and grade (%) of outbreak establishments ^b				Number and grade (%) of control establishments ^c				p	
	n	Excellent	Good	To be corrected	Poor	Excellent	Good	To be corrected		Poor
Own-check plan	30	81.1	5.4	13.5	0.0	78.1	11.5	10.2	0.2	0.50 ^e
Own-check plan and its controllability	24	70.8	25.0	4.2	0.0	72.6	23.9	3.5	0.0	0.78 ^e
Adequacy of the own-check plan										
Suitability, adequacy and maintenance of facilities and equipment	37	83.8	16.2	0.0	0.0	77.2	16.9	5.8	0.1	0.29 ^d
Suitability of facilities for use as food premises	42	83.3	16.7	0.0	0.0	73.0	23.3	3.7	0.0	0.22 ^d
Condition of premises	42	78.6	19.0	2.4	0.0	77.9	18.3	3.7	0.0	0.92 ^d
Working utensils, fixtures and equipment										
Cleanliness of facilities, surfaces and equipment	50	76.0	22.0	2.0	0.0	70.1	23.6	6.1	0.1	0.42 ^d
General order and cleanliness of facilities	49	79.6	16.3	4.1	0.0	82.8	13.7	3.4	0.0	0.86 ^d
Cleanliness of working utensils and equipment	46	73.9	21.7	4.3	0.0	68.9	26.3	4.9	0.0	0.79 ^d
Cleanliness of the space for cleaning equipment and cleaning equipment	26	92.3	3.8	3.8	0.0	91.9	6.6	1.3	0.1	0.39 ^e
Vermin and other animals	22	100.0	0.0	0.0	0.0	94.7	4.3	1.0	0.0	0.70 ^e
Waste management										
Actions and training of personnel										
Hygiene of work practices used by personnel	41	97.6	2.4	0.0	0.0	93.9	4.9	1.2	0.1	0.83 ^e
Hand hygiene	46	93.5	6.5	0.0	0.0	84.3	13.2	2.4	0.0	0.22 ^d
Work clothes	45	88.9	11.1	0.0	0.0	76.3	20.5	3.2	0.0	0.11 ^d
Monitoring of employees' health status	17	64.7	29.4	5.9	0.0	66.7	25.5	7.7	0.1	0.92 ^e
Instruction, guidance and training of personnel	5	100.0	0.0	0.0	0.0	89.5	7.6	2.9	0.0	1.00 ^e
Verification of hygiene proficiency	31	83.9	12.9	3.2	0.0	86.5	11.0	2.5	0.0	0.63 ^e
Hygiene of food production or handling										
Risk management in production	6	100.0	0.0	0.0	0.0	87.0	9.1	3.7	0.2	1.00 ^e
Packaging	6	100.0	0.0	0.0	0.0	91.0	6.9	2.1	0.0	1.00 ^e
Food temperature management										
Storage of foodstuffs	37	78.4	21.6	0.0	0.0	81.9	15.0	3.0	0.1	0.31 ^d
Cold-stored foodstuffs	49	63.3	22.4	14.3	0.0	66.4	23.2	10.3	0.1	0.70 ^d
Hot-stored foods	17	70.6	29.4	0.0	0.0	79.9	14.3	5.8	0.1	0.22 ^e
Chilling	31	71.0	12.9	16.1	0.0	54.3	30.1	15.5	0.1	0.10 ^d
Temperature management in production	2	100.0	0.0	0.0	0.0	98.1	1.9	0.0	0.0	1.00 ^e
Quick-freezing	1	100.0	0.0	0.0	0.0	81.6	13.3	5.1	0.0	1.00 ^e
Sale and serving										
Separation of product groups and hygiene during selling and serving	25	100.0	0.0	0.0	0.0	96.6	2.9	0.5	0	1.00 ^e
Management of shelf-life and sale period of products in sale of foods	5	100.0	0.0	0.0	0.0	76.9	17	5.9	0.2	0.70 ^e
Management of shelf-life and sale period of products in serving of foods	38	68.4	15.8	15.8	0	74.1	17.6	8.2	0.2	0.25 ^e
Substances causing allergies or intolerances										
Separation and cross-contamination	31	93.5	3.2	3.2	0.0	93.8	5.4	0.8	0.0	0.29 ^e
Special requirements for specific food products										

(Continued)

Table 5. (Continued).

Oiva item ^a	Number and grade (%) of outbreak establishments ^b				Number and grade (%) of control establishments ^c				p		
	n	Excellent	Good	To be corrected	Poor	n	Excellent	Good		To be corrected	Poor
Foodstuffs with protected status	1	100.0	0.0	0.0	0.0	125	68.8	28.0	3.2	0.0	1.00 ^e
Information provided on foods											
General labelling	9	55.6	33.3	11.1	0.0	2574	75.4	22.3	2.3	0.0	0.12 ^e
Nutrition labelling	1	100.0	0.0	0.0	0.0	36	88.9	5.6	5.6	0.0	1.00 ^e
Labelling of meat required by specific legislation	2	100.0	0.0	0.0	0.0	27	96.3	0.0	3.7	0.0	1.00 ^e
Packaging materials and food contact materials											
Packaging materials and other food contact materials	10	90.0	10.0	0.0	0.0	3029	87.8	10.6	1.7	0.0	1.00 ^e
Transport of foods											
Reception of foodstuffs	26	80.8	11.5	7.7	0.0	4932	80.5	15.8	3.7	0.0	0.35 ^e
Temperature management in transport	2	100.0	0.0	0.0	0.0	558	87.1	9.1	3.8	0.0	1.00 ^e
Traceability and recalls											
Traceability of foodstuffs	9	88.9	11.1	0.0	0.0	2423	89.1	9.0	1.7	0.1	0.65 ^e
Labelling and traceability of beef	1	100.0	0.0	0.0	0.0	58	93.1	3.4	3.4	0.0	- ^f
Recalls	2	100.0	0.0	0.0	0.0	801	97.6	2.1	0.2	0.0	1.00 ^e
Food testing											
Sampling referred to in the own-check plan	6	66.7	16.7	16.7	0.0	1798	70.9	23.7	5.3	0.1	0.41 ^e
Actions taken based on test results	1	100.0	0.0	0.0	0.0	706	90.1	8.4	1.6	0.0	1.00 ^e
Display of the Oiva report											
Display of the Oiva report	29	82.8	17.2	0.0	0.0	5000	83.2	15.6	1.1	0.0	0.86 ^e

^aOiva items inspected during at least one routine inspection prior to the outbreak in outbreak establishments in the category of restaurants.

^bResults of the most recent routine inspections prior to the outbreak.

^cResults of one randomly selected routine inspection per each control establishment.

^dPearson Chi-squared exact test.

^eFisher's exact test.

^fCould not be computed.

Classification of outbreaks according to strength of evidence was used in this study to enhance the accuracy of outbreak investigation data. When outbreak establishments associated with outbreaks with the weakest evidence were rejected from the sample studied, more differences in inspection results between outbreak and control establishments were seen in institutional catering.

Differences between the inspection results of outbreak and control establishments were seen in institutional catering but in restaurants the differences were fewer. Only inspection results concerning sampling according to the own-check plan were poorer in restaurants with outbreaks than those of control restaurants when strength of evidence was not considered. In two items inspection results were more favourable in outbreak restaurants in the sample where outbreaks with any strength of evidence were concerned. In institutional catering, persons eating the food often form known cohorts for example, school classes or customers at an elderly home, which might enhance both the detection and investigation of outbreaks and further increase the correspondence between registered outbreaks and all outbreaks that have actually occurred. In institutional catering, operation culture might also be more stable than in restaurants, and therefore conditions of the most recent pre-outbreak inspection may better reflect the conditions under which the outbreak occurred. These characteristics might have enhanced the detection of associations between inspection results and risk of foodborne outbreaks in institutional catering in our study.

The correction of noncompliances after an inspection may mean that violations detected during the latest routine inspection before an outbreak are no longer present at the time of the outbreak. A recent study comparing restaurant inspection results between consecutive inspections showed that the item-specific grade 'To be corrected' was corrected to either 'Excellent' or 'Good' by the next inspection in the majority of cases. The grade 'Good' was not corrected to 'Excellent' equally often (Kaskela et al. 2021). Correction of noncompliances as well as the possible emergence of new noncompliances might have weakened the associations between item-specific grades on routine inspections and foodborne outbreaks that follow in our study.

Factors predisposing to the occurrence of foodborne outbreaks may play different roles in restaurants or institutional catering establishments with different types of operations. Factors that increase the risk of foodborne outbreak may also vary between different causative agents, food vehicles and transmission routes. When the food vehicle is a ready-to-eat product contaminated at an earlier stage in the production chain, an outbreak may occur despite full compliance with food safety regulations at the food service establishment. As a result, routine inspection results may have a limited ability to predict foodborne outbreaks in general. Analysing outbreaks with specific characteristics and association with certain type of restaurants or institutional catering establishments separately, and using data of inspections conducted recently before the outbreak could enhance the detection of associations between inspection results and risk of foodborne illness.

The risk of foodborne outbreaks with a specific food vehicle and causative agent has been studied in restaurant chains affected by single *Salmonella* outbreaks. Relationships were observed between violations on routine inspections and cases associated with the outbreak when the primary source of the infection was contaminated raw material that had been served cooked (Patel et al. 2010) or contaminated fresh produce (Firestone et al. 2020). In another outbreak linked to contaminated fresh produce previous inspection results did not predict which chain restaurant locations would be involved in the outbreak (Lee and Hedberg 2016). In our study, the rarity of registered outbreaks with an identified causative agent and food vehicle prevented the separate investigation of specific causative agent-food vehicle pairs.

The majority of outbreaks with an identified causative agent in our study were caused by norovirus. In norovirus outbreaks, an infected food handler is a frequently reported contributory factor (Pihlajasaari et al. 2019). Hygiene of work practices is documented in routine inspections, but the ability of routine inspections to document factors associated with the presence of infected food

handlers can be limited. This may impair the detection of association between inspection results and the occurrence of foodborne outbreaks when a large proportion of outbreaks has been caused by norovirus, as in our study.

Registered foodborne outbreaks can be considered a sample of all foodborne outbreaks that have occurred and this sample cannot be regarded as fully representative. Outbreaks with different characteristics and associations with different types of restaurants or institutional catering establishments may have different probability to be detected and inspected. The ability of an outbreak investigation group to collect data and achieve sufficient epidemiological evidence is also affected by the circumstances under which the outbreak and subsequent investigation occurs. For example, information on the affected cohort or the availability of human and food samples can vary from outbreak to outbreak. The possible over-representation of certain types of outbreaks in outbreak investigation data may limit the opportunity to measure the impact of specific noncompliances on foodborne illness in general. Moreover, outbreak investigation data does not cover sporadic cases of foodborne illness.

The higher ratio of outbreak establishments among restaurants than institutional catering might point to a higher incidence of outbreaks in restaurants. The ratio is higher in restaurants despite the possible more effective detection of outbreaks in institutional catering discussed above. At the same time, results of inspections are poorer in restaurants than in institutional catering (Finnish Food Authority 2020). These observations are consistent to the hypothesis of associations between poorer inspection results and the occurrence of foodborne outbreaks.

In conclusion, our study showed differences in routine inspection results between outbreak and control establishments mainly in institutional catering. Significant associations between poorer inspection results and the occurrence of foodborne outbreaks were seen in institutional catering in items concerning general order and cleanliness of facilities, surfaces and equipment. Food business operators need to pay attention to the cleanliness of the food handling environment and equipment, and official control effectively enforce compliance regarding these issues to ensure a high level of consumer safety in food service.

Acknowledgments

We thank the Finnish Food Authority for submitting the data used in this study.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

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