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Association between the financial situation of food production establishments and food control inspection grades in Finland

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ABSTRACT

The repeated violation of food safety legislation by food business operators (FBOs) constitutes a health risk for consumers. However, the possibilities for recognizing these FBOs at an early stage are limited. This study aimed to investigate the association between the financial situation of Finnish FBOs and the food control inspection grades that their food production establishments received. Our hypothesis was that a weak financial situation would increase the risk of recurring non-compliance. We used food control inspection reports on meat, fish, and dairy establishments in Finland from 2016 to 2020 (612 establishments) and the publicly available financial statements of these companies. Due to missing financial data and stringent requirements for case-control pairs, 45 case-control pairs and 88 cases were analysed. The cases included food production establishments with non-compliances in recurring years. Randomized matched controls were paired for each case. The analyses showed that the likelihood of belonging to the case group was lower when the food production establishment's operating margin, describing profitability, was in the best-performing tertile (OR = 0.21, p = 0.01) or the middle tertile (OR = 0.22, p = 0.03) compared to the worst-performing tertile. Furthermore, a trend was observed within the cases, showing that the likelihood of non-compliances during a year was lower when the current ratio (ln), describing liquidity, increased (generalized estimating equations, OR = 0.73, p = 0.08). Therefore, the low profitability of a food production establishment implies an elevated risk of recurring non-compliances. Additionally, the low liquidity of a food production establishment indicates a higher risk of non-compliances during the same year. These financial indicators could be used for mapping FBOs that are at a higher risk of repeatedly violating food safety, and inspections could be targeted at them. This could increase the effectiveness of food control.

1. Introduction

The aim of food control is to protect human health and consumers' interests, and food control should be performed regularly and on a risk basis (Codex Alimentarius, 2013; EC, 2002). While many food business operators (FBOs) comply with the legislation or correct non-compliances when requested, some repeatedly violate food safety legislation (Aalto-Araneda et al., 2018; Kaskela et al., 2021; Patel et al., 2021). These FBOs compromise food safety and represent a health risk to consumers. Additionally, they may mislead consumers and distort competition in the food business. Therefore, it is important to increase the compliance of FBOs that repeatedly violate food safety legislation.

Compliance of food production establishments is important since they produce and distribute food to large numbers of consumers. However, non-compliances requiring control measures have occurred in 18% of food control inspections in fish establishments and 14% of meat and 9% of dairy establishments in Finland (FFA, 2023a). Moreover, the correction of non-compliances has been partly insufficient (correction rates ranging from 51 to 92% depending on the type of non-compliance). Several types of non-compliances are problematic for food production establishments to correct. Most commonly, these concern sampling and own-check tests, maintenance of facilities, and the cleanliness and order of facilities, which can all affect food safety (Kosola et al., 2022).

In the Finnish food control system, the central authority, the Finnish

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Food Authority (FFA), steers food control actions with the contribution of the regional authorities (Regional State Administrative Agencies). Food control inspections of food production establishments are performed at the local level by municipal food control inspectors (Food Act, 2021). These inspections are targeted through assessing the risk of a food production establishment based on production type and volume. Inspection frequencies range from one inspection per year for low-risk production types with a yearly production volume of under 10,000 kg to 12 inspections per year for high-risk production types with a yearly production volume of over 10,000,000 kg. Food control inspectors can also reduce the inspection frequency after six consecutive inspections with full compliance (FFA, 2023b). However, there are no tools to further distinguish between establishments at a higher or lower risk of non-compliance within the same production type and volume.

To protect human health, it is important to identify FBOs at a higher risk of recurring non-compliance, which would allow for earlier and more precise targeting of food control inspections. A risk-based approach is necessary as resources are limited and only 73.2–82.7% of meat, fish and dairy production establishments are inspected yearly in Finland, although the target is 100% (FFA, 2023a). Elsewhere, for instance in Sweden, only 61% of facilities that produce, distribute, prepare, or sell food to consumers are inspected yearly, and even the inspections of high-risk facilities cover only 94% of such FBOs (Swedish Food Agency, 2022). Furthermore, in some provinces of Austria, under 50% of meat production establishments are inspected yearly, although most provinces can cover all meat establishments (Austrian Federal Ministry of Social Affairs, 2023). As many countries even experience difficulties in controlling FBOs with risky activities, additional means of risk classification are required.

One option for pinpointing FBOs that are expected to engage in non-compliances could be the identification of financial challenges. The financial success of a company is essential for its ability to function, and we hypothesize that a weak financial situation (e.g., delays or difficulties in making payments, the business making a loss) could affect the capability of an FBO to comply with the legislation. Thus, financial indicators could serve as a tool to recognize FBOs with financial challenges, enabling inspections to be targeted at those businesses. Previous studies from other sectors suggest a connection between a company's financial situation and compliance with regulations. For example, in China, those publicly-listed companies from varying sectors that implemented proper governance practices and complied with regulations performed better financially than non-compliant companies (Tam et al., 2010). In addition, a recent study showed that the weak financial situation of slaughterhouses was associated with an increased risk of non-compliance with animal welfare regulations in the slaughter process (Sundermann et al., 2023). While previous research on the economy of food safety has mainly focused on identifying the benefits of food safety control and the costs of food safety incidents (Focker & van der Fels-Klerx, 2020), to our knowledge the opposite case (i.e. that food production establishments' financial situation may contribute to food control inspection results or that financial indicators could be used for mapping companies at increased risk of non-compliance) has not been studied. Therefore, this study aimed to investigate the association between the financial situation of FBOs in Finland and the food control inspection grades that their food production establishments received. Our hypothesis was that a weak financial situation increases the risk of non-compliance. Hence, this study represents a novel contribution to the literature. The results can be used in developing risk-based food control.

2. Materials and methods

2.1. Establishments and inspection reports

This study included food control inspection reports on meat, fish, and dairy production establishments in Finland from 2016 to 2020. Of the 805 establishments inspected during these years, we excluded 16 establishments that lacked a business identity code, which was necessary for acquiring financial indicators, and removed 56 establishments due to missing production volume information. Additionally, we excluded 121 establishments that had been inspected only for one year to be able to define the outcome of inspection results over at least a two-year period. Altogether, the data included 612 establishments. These consisted of 218 (36%) establishments from the meat sector, 284 (46%) from the fish sector, 94 (15%) from the dairy sector, and 16 (3 %) mixed establishments with activities in more than one sector.

The food control inspections of food production establishments in Finland are harmonized i.e., performed and reported according to the guidelines of the Finnish Food Authority (FFA, 2022). In these guidelines, the requirements of the food legislation are divided into 18 subsections with a total of 99 individual inspection items. According to the instructions, only a small number of inspection items are examined during each inspection, but all are inspected at least once in three years. The food control inspections can result in four different evaluation outcomes for each individual inspected item and for the overall grade of the inspection, which is based on the weakest inspected item: A = Excellent, operations are in line with the legislation; B = Good, small issues which do not impair food safety or mislead consumers; C = To be corrected, issues impairing food safety or misleading consumers; and D = Poor, issues endangering food safety or considerably misleading consumers or the FBO does not comply with issued orders.

2.2. Case group and control group

The case group (n = 150) included all establishments that had received overall inspection grades of C or D during two or more years in the five-year period. The controls were selected from establishments that received overall inspection grades of C or D during none or only one year of the five-year period (n = 462). Case-control pairs were created by randomly pairing a case with an establishment from the same sector (e.g., meat establishment), type (e.g., cutting plant) and similar production volume (in kilograms, minimum half and maximum twice the production volume of the case), except for 19 cases where the production volume could not be matched. For these cases, controls were selected with a production volume closest to the cases. Seven cases were excluded because controls matching the production type were not found, as was one case-control pair because both establishments were owned by the same FBO. Altogether, 142 case-control pairs were created. However, financial statements were available only for 210 of the establishments. Additionally, it was necessary to remove 52 establishments due to FBOs including multiple establishments within the same financial statement. Finally, financial data was available for both the case and the control for 45 pairs and for 88 of the cases (Table 1).

2.3. Financial indicators

Indicators of FBOs' financial health were acquired using the official financial statements of the case-control pairs for the years 2015–2020 (Suomen Asiakastieto Oy). The nature of some of the FBOs was such that they did not report specific financial indicators in the format used in the study, and thus some indicators could not be acquired for all establishments.

The components of the financial capacity of a company are divided into profitability and finance. Finance, in turn, is usually separated into two aspects: liquidity and solvency (Leppiniemi et al., 2021). Eight indicators expressing the financial situation of the FBO were thus formed. These indicators described the FBOs' relative profitability – gross profit (%), operating profit (%), operating margin (%), and net profit (%) – liquidity (quick ratio and current ratio) and solvency (assets/debt and debt/revenue).

Profitability is a measure of the financial profit gained by a business. The benefit of using relative profitability is that the effect of firm size on profitability parameters is reduced. While absolute profitability refers to

Table 1
Establishments included in the study.

Establishment type	Analysis with case-control pairs								Analysis with cases				
	Number of case-control pairs	Number of establishments	Number of years with overall inspection grade C and/or D						Number of cases	Number of years with overall inspection grade C and/or D			
			Controls		Cases								
			0	1	2	3	4	5		2	3	4	5
Meat	29	58	19	10	14	6	6	3	45	21	10	9	5
Fish	13	26	9	4	3	3	5	2	35	14	9	8	4
Dairy	3	6	2	1	2	0	1	0	8	6	1	1	0
Total	45	90	30	15	19	9	12	5	88	41	20	18	9

the difference between a company's revenue and expenses, relative profitability indicates profitability as a percentage of a firm's turnover. Liquidity, in turn, represents a company's capability to handle all payments on time and in the most affordable way possible (Committee for corporate analysis, 2017). Finally, solvency stands for the long-term ability of a company to meet its obligations. A key feature of good solvency is the possibility of raising new external capital if required (Leppiniemi et al., 2021). Because the indicators in each of the three classes (profitability, liquidity, and solvency indicators) describe similar issues and correlate with each other, only one indicator per class was selected.

Our goal was to choose those indicators that described the financial situation of the FBO and that could affect compliance with food safety regulations. The indicators selected for the analyses were 1) current ratio to describe liquidity, 2) operating margin percent, also known as EBITDA (earnings before interest, tax, depreciation, and amortization), to describe profitability, and 3) assets/debt to describe solvency. These indicators were selected because they resulted in the best explanatory power, measured as the overall classification (case, control) accuracy of models estimated by using different indicators as explanatory variables.

The current ratio measures a company's ability to manage its short-term debts using its financial and current assets (Committee for corporate analysis, 2017). A company's operating margin is the net income derived from its core business operations. It is obtained by subtracting operating costs, such as raw materials, services, salaries, and some other expenses, from the revenues generated by the company. The operating margin does not include financial income and expenses, appropriations, or taxes (Accounting Ordinance, 1997). The operating margin percentage is obtained by dividing a company's operating margin by its turnover. The ratio of assets-to-debt is the inverse of the debt-to-assets ratio used in the finance literature (Brealey et al., 2011). It is the total assets of a company divided by the total debt, which includes both short-term and long-term debt. It is a measure of the long-term solvency of a company and describes its ability to meet all its debt commitments.

2.4. Statistical analyses

A logistic regression model was used to study whether the financial indicators explained the belonging to the case group (i.e., establishments that had received inspection grades C or D during two or more years during the study period). The balance sheet total was used as a covariate to categorize the size of the establishment in the analyses. Cases and controls did not differ by the distribution of the number of years they were inspected; thus, the number of years the establishment was inspected was omitted from the covariates. In the analysis of case-control pairs, the financial indicators were aggregated by calculating yearly averages.

The association between the financial indicators in a specific year and whether an establishment had received an inspection grade C or D during that year was studied within the cases. To account for non-independence of observations due to repeated measures, generalized estimating equations (GEE) with a logit link function were used to analyse the association. The balance sheet total was used as a covariate to categorize the size of the establishment in the analyses. These analyses were also conducted for all inspection subsections. In addition, Spearman's rank correlation coefficient (rho) was used to test the association between the proportion of establishments' C and D overall inspection grades in a single year and the yearly financial indicators within the cases.

We used the current ratio and the balance sheet total as natural logarithmic values, and the assets/debt and operating margin were classified into three different groups by binning to overcome the problem of outlier values. We could not use natural logarithmic values with the assets/debt and operating margin due to some negative values.

Statistical analyses were performed using IBM SPSS software 28 and SAS 9.4 (SAS Institute, Cary NC). Fig. 1 was created using Microsoft Excel (Microsoft 365 MSO version 2307). The threshold level for statistical significance in all tests was $p < 0.05$.

3. Results

3.1. Establishments repeatedly violating food safety regulations

Of the 612 establishments included in the study, 150 (24.5%) had received overall inspection grades of C or D for at least two of the five years under investigation. Of all establishments inspected every year during the five-year period (n = 262), 16 (6.1%) received an overall inspection grade of C or D every year, whereas 22 (8.4%) received such a grade four of the five years and 19 (7.3%) three years.

Of the 150 establishments with repeated non-compliances, 78 (52.0%) were from the meat sector, 62 (41.3%) from the fish sector and only 10 (6.7%) from the dairy sector. There were also marked differences in the distribution of years with overall inspection grades C or D. For those fish establishments and meat establishments belonging to the case group, 56.5% and 53.8%, respectively, received an overall inspection grade of C or D during three, four or five years, while the proportion of such establishments in the dairy sector was only 30.0%.

3.2. Relationship between financial indicators and compliance in case-control pairs

The regression analyses revealed that the likelihood of belonging to the case group was lower when the food production establishment's operating margin (describing profitability) was in the best-performing tertile (group 3, consisting of 33.3% of FBOs who had the highest operating margin, OR = 0.21, p = 0.01) or the middle tertile (group 2, 33.3% of FBOs with operating margin around the median margin, OR = 0.22, p = 0.03) compared to the worst-performing tertile (group 1, 33.3% of FBOs with the lowest operating margin) (Table 2). The parameters related to assets/debt or current ratio were not statistically significant.

3.3. Relationship between financial indicators and compliance within cases

We performed correlation analysis to identify possible correlations between the yearly (2016–2020) proportion of overall inspection grades

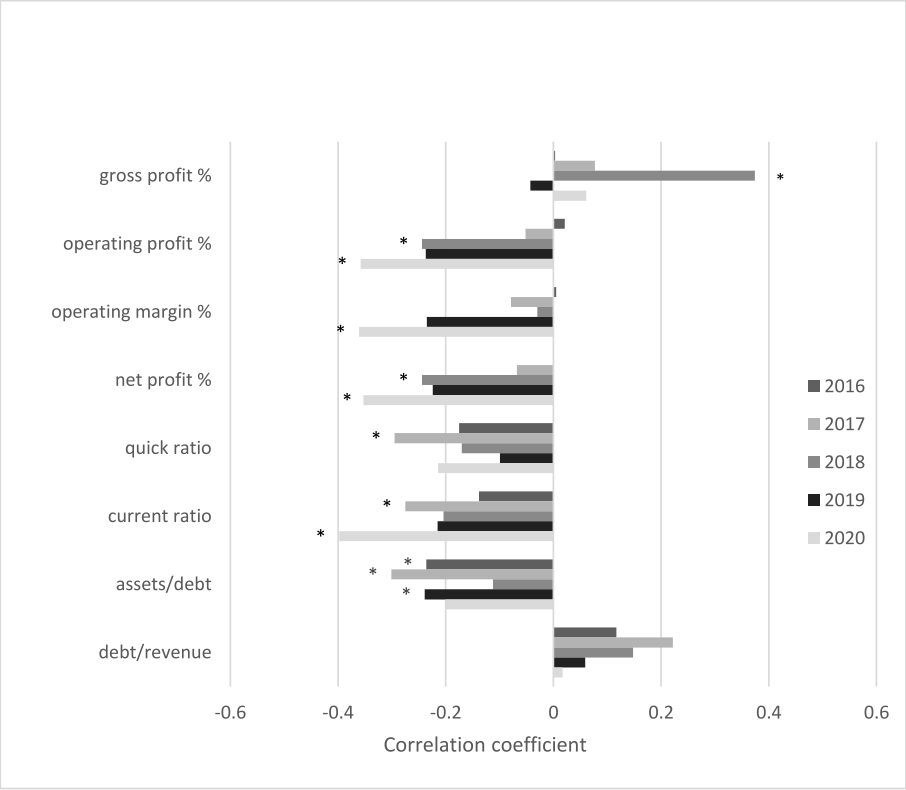

Fig. 1. Correlation between the yearly (2016–2020) proportion of overall inspection grades C and D and the financial indicators within the case group (Spearman correlation, *p < 0.05). The year 2016 is not visible for gross profit % and net profit % as the correlation is zero or close to zero.

Table 2
Financial indicators explaining belonging to case group (logistic regression) (N = 90).

Financial indicator	Adjusted OR[a] (95% CI[b])	p-value
Current ratio (ln)	0.77 (0.41–1.47)	0.43
Operating margin[c]		
group 1	1	
group 2	0.22 (0.06–0.85)	0.03
group 3	0.21 (0.06–0.73)	0.01
Assets/debt[d]		
group 1	1	
group 2	2.53 (0.68–9.36)	0.17
group 3	0.96 (0.19–4.85)	0.96

[a] OR = Odds ratio adjusted for other financial indicators and balance sheet total.
[b] CI = Confidence interval.
[c] Group 1: 33.3% with lowest operating margin, group 3: 33.3% with highest operating margin.
[d] Group 1: 33.3% with lowest assets/debt, group 3: 33.3% with highest assets/debt.

C and D and the financial indicators within the cases (N = 88). Of the eight financial indicators examined, seven correlated significantly with the proportion of overall inspection grades C and D at least for one year. Of those, six (75%) indicators correlated significantly at least for 1 year as hypothesized (Spearman's rho), indicating that a high proportion of overall inspection grades C and D is associated with a weak financial situation. Only gross profit showed a significant correlation for one year that was not as hypothesized (Fig. 1).

The generalized estimating equations analysis showed that the likelihood of receiving an overall inspection grade of C or D during a year tended to be lower within the cases when the current ratio (ln) increased (OR = 0.73). However, because of low statistical significance (p = 0.08), the result was only indicative. Furthermore, the likelihood of receiving an inspection grade C or D during a year within the cases was lower for assets/debt in the best-performing tertile (group 3, 33.3 % with the highest assets/debt ratio) and the middle tertile (group 2, 33.3 % of FBOs having their assets/debt ratio around the median) when compared to the worst-performing tertile (group 1, 33.3 % with the lowest assets/debt ratio) of assets/debt, although the result was statistically significant only for the middle tertile (OR = 0.50, p = 0.04). The parameters estimated for operating margin were not statistically significant (Table 3).

An analysis of the subsection grades was performed within the cases to determine the association between the financial indicators and the grades in an inspection subsection. Out of the existing 18 subsections, 14 contained sufficient data for statistical analysis. After removing from the analysis subsections with less than 10 inspection grades C or D, two subsections displayed significant results. In the subsection "Compliance with requirements for approval", the likelihood of a C or D grade during a year was lower when the current ratio (ln) increased (OR = 0.48, p = 0.003). In the subsection "Information provided on foods" the likelihood of receiving a C or D grade during a year was lower in the middle operating margin tertile (group 2, 33.3 % with operating margin around the median) when compared to the worst-performing tertile (group 1, 33.3 % with the lowest operating margin) (OR = 0.37, p = 0.0496). Furthermore, in the subsection "Maintenance of facilities and equipment", the likelihood of receiving a C or D grade during a year tended to be lower in the best-performing operating margin tertile (group 3, 33.3 % with the highest operating margin) when compared to the worst-performing tertile (group 1, 33.3 % with the lowest operating margin) (OR = 0.50, p = 0.07) (Table 3).

4. Discussion

This study found significant relationships between food production establishments' violations of food safety legislation in recurring years

Table 3
Financial indicators explaining the incidence of years with C or D grades in the case group (generalized estimating equations with logit link function, analyses with less than ten C or D inspection grades were removed) (N = 88).

Overall or subsection inspection grade	Financial indicator						
	Current ratio (ln)		group	Operating margin[a]		Assets/debt[b]	
	Adjusted OR[c] (95% CI[d])	P-value		Adjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Overall	0.73 (0.51–1.04)	0.08	group 1	1		1	
			group 2	0.89 (0.49–1.61)	0.70	0.50 (0.26–0.97)	0.04
			group 3	0.76 (0.42–1.39)	0.38	0.80 (0.38–1.68)	0.55
Compliance with requirements for approval	0.48 (0.29–0.77)	0.003	group 1	1		1	
			group 2	1.16 (0.46–2.90)	0.75	1.00 (0.39–2.54)	0.99
			group 3	1.1 (0.47–2.56)	0.83	1.22 (0.38–3.90)	0.74
Maintenance of facilities and equipment	1.19 (0.72–1.96)	0.51	group 1	1		1	
			group 2	0.97 (0.46–2.01)	0.92	1.36 (0.6–3.11)	0.46
			group 3	0.50 (0.24–1.06)	0.07	0.60 (0.23–1.58)	0.30
Information provided on foods	0.80 (0.49–1.33)	0.39	group 1	1		1	
			group 2	0.37 (0.14–1.00)	0.0496	0.90 (0.40–2.03)	0.80
			group 3	0.47 (0.18–1.21)	0.12	0.53 (0.18–1.54)	0.24

[a] Group 1: 33.3 % with lowest operating margin, group 3: 33.3 % with highest operating margin.
[b] Group 1: 33.3 % with lowest assets/debt, group 3: 33.3 % with highest assets/debt.
[c] OR = Odds ratio adjusted for other financial indicators and balance sheet total.
[d] CI = Confidence interval.

and the weak financial situation of FBOs. In addition, a high yearly proportion of overall inspection grades C and D was associated with a weak financial situation. These are important findings as financial indicators could be used in food control for mapping FBOs that are at a higher risk of repeatedly violating food safety. This could be utilized in targeting food control inspections. Similarly, to increase the effectiveness of animal welfare control, a recent study suggested a risk-based inspection approach in slaughterhouses considering, among other things, the financial situation of the FBO (Sundermann et al., 2023). Currently, the Finnish food industry is facing many challenges regarding profitability as production costs have risen over 30 percent from 2021 to 2023 and no relief is expected (ETL, 2023). Therefore, the results of our study are especially timely as this difficult economic situation could cause ever more FBOs to experience financial challenges, thereby increasing the likelihood of non-compliances.

Our data indicated that almost one-fourth of meat, fish and dairy establishments repeatedly violate food safety regulations in Finland. This is a substantial problem that must be addressed because non-compliances can mislead consumers or risk their health. Repeated non-compliances were more often observed in the meat and fish sector than in the dairy sector. Our results are consistent with an earlier study where fewer and less severe non-compliances were detected for dairy establishments when using enforcement measures than for meat and fish establishments (Lundén, 2013). Kosola et al. (2022) hypothesized that the poorer performance of meat and fish establishments could be caused by differences in risk perception compared to dairy establishments or by the greater number of specific inspection items for meat establishments. To improve compliance, they suggested that food control should focus more on meat and fish establishments by increasing their inspection frequency, the FBO's knowledge of food safety, and the advice provided by food control inspectors. However, more research is required on the reasons behind the differences between sectors in inspection results.

The significant association between the weak financial situation of the food production establishment and problems with complying with food safety regulations was shown for operating margin (describing profitability) in the case-control analysis. Profitability is a prerequisite for a company to continue its business (Committee for corporate analysis, 2017). Moreover, the more profitable a company's operations are, the greater the debt burden it can bear (Leppiniemi et al., 2021). While temporarily low profitability might not substantially affect liquidity or solvency, persistently low profitability will also impair the solvency and liquidity of a firm and reduce its ability to invest in food safety.

The chance of failure is inherent in all business activities. Loss-making actions can result from the entrepreneur's own choices or from extrinsic factors (e.g. economic fluctuations or changes in the competitive situation). Solutions to financial problems include increasing revenue, cutting expenses, or both (Karjalainen, 2013). In a weak financial situation, neglecting legislative requirements to save money may possibly be tempting (Yapp & Fairman, 2006). This might be probable especially in the short term if the FBO does not consider food safety to be important and is struggling to maintain adequate liquidity. Indeed, it has been found that Finnish FBOs' risk perceptions differ, and that risk perception is associated with compliance with regulations (Kaskela et al., 2019). Therefore, it is possible that FBOs with a lower risk perception and financial difficulties may fall more easily into non-compliance.

Liquidity describes a company's ability to meet its payment obligations (Leppiniemi et al., 2021). Liquidity is related to a firm's payment capacity at a certain moment, and the chance to avoid paying bills may exert a more immediate effect on liquidity than on profitability or solvency. Thus, liquidity problems can immediately affect compliance and may act as an early warning signal. The analysis of cases in the present study indicated that a weak current ratio was associated with low inspection grades during the same year, highlighting the temporal proximity between this financial indicator and non-compliances. Thus, low liquidity could indicate an elevated risk of non-compliances during the same year. The explanation for this connection is that the implementation of some legislative demands requires money (Taylor & Taylor, 2007). These results indicate that the current ratio could be a promising indicator of an elevated risk of non-compliance at a particular moment.

We detected significant associations between financial indicators and non-compliances within the cases in the inspection subsections that are important for food safety. This was particularly prominent in the inspection subsection "Compliance with requirements for approval", which contains requirements highly relevant to food safety. These include the suitability of the facilities and the firm's own-check system, including the Hazard Analysis and Critical Control Point (HACCP) system. Poorly designed production facilities impair food safety and are a potential risk for product contamination (Maller, 2011). Moreover, unsuitable premises can result in significant costs if large renovations are required after a business has already begun operating. In addition to renovation costs, the costs of possible production interruption due to unsuitable premises can also negatively affect the financial situation of the FBO. A FBO's own-check and HACCP system are key food safety elements in EU and Finnish food legislation (EC, 2004; Food Act, 2021). As HACCP is a powerful approach to reduce the risk of food safety failure

and improve product safety (Wallace & Mortimore, 2016), shortcomings in this subsection could lead to health risks for consumers.

In addition, poor grades in the subsection "Information provided on foods" were significantly associated with a weakened financial situation. This subsection includes the labelling of foods. Thus, deficiencies in this subsection may place consumers at significant risk of unintentionally exposing themselves to allergens or food additives (Gallo et al., 2020) if, for example, allergens or additives are not labelled correctly. Interestingly, deficiencies in labelling allergens are the most common cause of withdrawals in Finland, and the number of such cases actually increased in 2022 (FFA, 2023a). The root cause of these deficiencies in allergen labelling is unclear, but companies' financial situation may offer one answer. The effect of a weak financial situation on this subsection could possibly be explained, for example, by FBOs' failure to order new packaging material (to cut costs) when product recipes change, resulting in inaccurate product information.

Interestingly, the association between the financial situation of the FBO and inspection grades in the subsection "Maintenance of facilities and equipment" was not statistically significant, although we expected a significant result, as maintenance of equipment is an important part of a company's total operating costs. Additionally, attempts to save money by neglecting maintenance can even worsen the financial situation of the FBO, as the hidden costs of poor maintenance (e.g., lost production, lower quality, or safety risks) are even greater than the direct costs of properly maintaining equipment (Wienker et al., 2016).

Some non-compliances in the subsections connected to financial indicators could probably be corrected easily and without investing a considerable amount of money. These include the FBO updating its own-check plans and monitoring critical control points. The reluctance of FBOs to correct these kinds of non-compliances could be explained by the tendency to focus on the core functions of the company during periods of financial weakness to improve financial performance and to disregard food safety requirements. Additionally, a poor financial situation might weaken the motivation of the FBO to follow the legislation, as a previous study concluded that lack of money was one of the main barriers to compliance (Yapp & Fairman, 2006).

While operating profit and the current ratio showed a clear association with non-compliances, the connection to assets/debt was more ambiguous. The only significant difference in the assets/debt ratio (describing solvency) was seen between the worst-performing tertile and the middle tertile in the analysis of overall inspection grades within cases. This could be explained by the fact that the best-performing companies may be more inclined than other companies to invest, leading to an increase in their debt. Therefore, it seems that assets/debt is not a suitable financial indicator for detecting FBOs with an elevated risk of repeated non-compliance.

Although this research found a connection between a weak financial situation and non-compliances, many other elements can contribute to the failure to comply, and these vary between FBOs. Previous research has shown three complex attitudinal factors explaining non-compliance in small and medium-sized food enterprises: lack of trust in food safety legislation and inspectors, lack of motivation in dealing with food safety legislation, and lack of knowledge and understanding (Yapp & Fairman, 2006). In addition, Campbell et al. (2015) demonstrated that non-compliant FBOs were less likely to understand instructions on correcting non-compliances issued by the inspector than were compliant FBOs. Furthermore, Fietz et al. (2018) confirmed the findings of Yapp and Fairman (2006) that compliance is promoted by the FBO accepting regulations; moreover, they added a new finding: compliance is also facilitated by FBOs' fear of embarrassment if non-compliance is revealed to relevant others.

According to previous research, there are distinct differences between compliant and non-compliant FBOs in their intention to fully implement HACCP (Ramalho et al., 2015). Since the reasons behind non-compliances are complicated and food control resources are limited, new strategies should be developed both to improve the compliance of FBOs that repeatedly endanger food safety and to use food control resources as effectively as possible. As a longer inspection interval is associated with worse inspection grades (Kosola et al., 2022), it is especially important to keep the inspection interval sufficiently short for FBOs at risk of repeatedly violating food safety legislation. Combining the use of financial indicators for targeting food control inspections with approaches already applied in food control, such as assessing the risk of a food production establishment based on production type and volume, would improve targeting and earlier intervention. This is extremely important as one-fourth of establishments repeatedly violate food safety regulations and over six percent do this yearly. In fact, one might ask whether food control authorities allow FBOs to violate the legislation for too long at the expense of food safety before intervening. Whatever the case may be, it is clear that the effectiveness of food control should be improved. However, more research is required to elucidate whether improved targeting and earlier intervention would increase compliance among FBOs repeatedly violating food safety.

To be able to utilize financial indicators in food control, information on the financial situation of FBOs should be easily accessible to inspectors. Indicators should be both quick to collect and in a format that is easy to interpret. A centralized and automated way of gathering and updating the data would enable the effective use of financial indicators for the planning of yearly food control inspections. The data could be added to the Finnish national information management system for food control and other environmental health control (FFA, 2023c), which is already used by the authorities. According to a previous study, digitalizing food control is important to ensure standardization and uniformity of the control process (Grau-Noguer et al., 2023).

The results of this study suggest that financial indicators can be used to identify food production establishments at risk of repeatedly violating the legislation. Additionally, this approach might be utilized in the prevention of food fraud as financial problems may predispose businesses to engage in fraudulent actions (Moyer et al., 2017). This is especially interesting for the meat, fish, and dairy sector studied here, as the animal product supply chain is at particular risk of food fraud when compared to businesses in other supply chains (van Ruth & Nillesen, 2021). A recent study found that food fraud case detection was demanding for food control inspectors (Joenperä et al., 2022). Our research shows that financial indicators can be a helpful tool for inspectors to detect FBOs at a higher risk of non-compliance with the legislation and therefore also possibly at a higher risk of committing food fraud. However, it is important to note that an FBO with financial problems must not be considered fraudulent a priori even though, at a population level, the risk of fraudulent actions might be elevated among such FBOs.

In addition to food control, consideration of financial indicators is also advantageous for FBOs. For instance, financial indicators might be used by FBOs for risk assessment when evaluating the food safety credibility of the other FBOs with whom they trade. This may interest larger-sized businesses in particular, which face more threats from food fraud than smaller companies (van Ruth & Nillesen, 2021). However, more research is necessary to determine the most efficient approach for the application of financial indicators among FBOs.

The current research contains some limitations that should be addressed. First, it was necessary to exclude many FBOs from our analysis due to missing financial indicators, production volumes or business identity codes or because the companies included multiple establishments within the same financial statement. This reduced the number of cases and controls. Nevertheless, associations were observed between inspection results and the financial situation of the food production establishment. Second, this study does not prove causality between a weak financial situation and the occurrence of non-compliances. However, a weak financial situation presumably influences the possibility of correcting non-compliances. We also argue that the financial situation of the FBO influences the inspection results rather than vice versa, as the cases had failed to correct their non-compliances. Third,

this study considered food production establishments, but recurring non-compliances also occur in retail establishments, which should be studied in the future. Additionally, we did not consider the influence of the COVID-19 pandemic on the inspection results or the financial situation of the FBOs. However, the pandemic affected only one year of our research material. Moreover, it can be argued that the pandemic influenced the whole food sector and therefore was not a confounding factor in the analyses.

5. Conclusions

This study showed a significant association between the weak financial situation of food production establishments and repeated non-compliances. Knowledge of the operating margin, describing profitability, and the current ratio, describing liquidity, could be used for mapping FBOs that are at a higher risk of repeatedly violating food safety. These indicators could be utilized in targeting food control inspections, which could increase the effectiveness of food control and intensify the use of food control resources.

CRediT authorship contribution statement

Katri Kiviniemi: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Mikko Kosola:** Writing – review & editing, Methodology, Formal analysis, Data curation, Conceptualization. **Annukka Vainio:** Writing – review & editing, Conceptualization. **Jarkko K. Niemi:** Writing – review & editing, Methodology, Formal analysis, Data curation, Conceptualization. **Janne Lundén:** Writing – review & editing, Supervision, Methodology, Conceptualization.

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.

Data availability

The authors do not have permission to share data.

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