

A Comparison of Pre and Post COVID-19 Pandemic Pest Related Violations in Restaurants within the Fraser Health Authority

Elena Lazovski¹, Amardeep Kambo²

¹ Lead Author, B. Environmental Public Health, School of Health Sciences, British Columbia Institute of Technology, 3700 Willingdon Ave, Burnaby, BC V5G

² Supervisor, School of Health Sciences, British Columbia Institute of Technology, 3700 Willingdon Ave, Burnaby, BC V5G 3H2

Abstract

Background: The COVID-19 pandemic has impacted the food service sector, particularly in-person dining at restaurants and bars, leading to a decrease in regular inspections by Environmental Health Officers (EHOs) in British Columbia. As restrictions on indoor dining ease, it is essential to ensure that food is being prepared and handled in a safe and sanitary manner. However, neglecting pest management and sanitation practices in restaurants can lead to food-borne illnesses. The research project investigated whether there had been an increase in the number and severity of pest-related violations in the Fraser Health Authority (FHA) following the COVID-19 pandemic

Methods: Electronic inspection data from FHA HealthSpace Cloud was analyzed using Microsoft Excel and NCSS 2023 Statistical Software. The data analysed only included routine restaurant inspections conducted in 2019 and 2022 throughout FHA’s jurisdiction. 2019 represented the year pre-COVID-19 while 2022 represented the year post COVID-19.

Results: The data analysis showed an increase in violations for code 304 (“Premises not free of pests”) and code 305 (“Conditions favoring pests”) and a decrease in code 306 (“Premises not maintained in a sanitary condition”) from 2019 to 2022. Statistically significant associations with the year of inspection were found for violation codes 304 and 306, while the observed increase in code 305 was not statistically significant. Mean violation scores for codes 304 and 306 were significantly higher in 2022 compared to 2019, indicating an increase in the severity of these violations post-pandemic. Regional differences were also identified, with Fraser North exhibiting the largest increase in the proportion of violations related to codes 304, 305, and 306.

Conclusion: The findings of this study show that the COVID-19 pandemic has led to a significant increase in pest-related violations in the FHA, with violation codes 304 and 306 displaying statistically significant associations with the year of inspection. These findings could also inform future research on pest management practices and the development of more effective pest control strategies during public health emergencies. Additionally, exploration of potential factors behind the discrepancy between the high proportions of pest-related violations in Fraser North and other regions in FH could be beneficial.

Keywords: *environmental health officers (EHO), restaurant inspections, COVID-19, pests, sanitation*

Introduction

The COVID-19 pandemic has significantly impacted the food service industry and disrupted the routine operations of EHOs, causing a decrease in the number of inspections of food premises. This has raised concerns about the food service

establishments’ adherence to food safety regulations and the potential for increased food-borne illnesses. Personal communication with several EHOs suggests an increase in pest-related violations in restaurants post-COVID-19. his study aims

to investigate the impact of the COVID-19 pandemic on the prevalence of pest-related violations in the Fraser Health Authority (FHA) in British Columbia, Canada. Specifically, it is essential to investigate whether there has been an increase in the number and severity of pest-related violations in the Fraser Health Authority post-COVID-19 pandemic to ensure public health and safety.

Literature review

Legislative Requirements in British Columbia

In British Columbia, EHOs are essential in the prevention of foodborne outbreaks and are designated under section 78 of BC's *Public Health Act*, SBC 2008, c 28 (*PHA*), and have the authority to inspect food premises under section 23 of the *PHA*. Along with inspecting food premises, EHOs approve food safety and sanitation plans, educate operators of food premises, and enforce legislation such as the *Food Premises Regulation* BC Reg. 210/99. Section 26 of the *Food Premises Regulation* states that all food premises must be free of pests or conditions which harbour them (Food Premises Regulation, 1999). The Canadian Food Retail and Food Services Code (also

known as the Food Code) provides operators, the food industry, and EHOs with evidence-based guidelines on food premises maintenance, sanitation and maintaining a pest free premises (Food Retail and Food Services Code, 2016).

Fraser Health Inspection Reporting

Section 25 of the *PHA* authorizes EHOs to conduct either scheduled or impromptu inspections of food premises (Public Health Act, 2008). By paying close attention to potential health hazards EHOs ensure compliance with the *PHA*, and requirements under the *Food Premises Regulation* are being met. Inspections can be conducted on either a routine basis or in response to a complaint, and an inspection report will be generated and provided to the operator following the inspection (Fraser Health Authority, 2022a).

In Fraser Health, the routine inspections of Food premises assess facility's compliance on the following five basic sections, I. Construction and Approvals II. Control of Food Hazards III. Maintenance and Sanitation IV. Hygiene and Communicable Disease and V. Education and Training (Fraser Health Authority, 2022b). These sections are then further categorized into critical and non-critical violations. Critical

violations may pose a direct threat to public health in that they can lead to foodborne illness. Critical violations include improper hot holding, improper cooling, or inadequate handwashing. While a non-critical violation is not considered a direct or immediate threat to public health; however, it can lead to a potentially hazardous situation.

The FHA has a Food Premises Hazard Rating Checklist which is used to calculate a hazard rating for each food premises (Fraser Health Authority, 2022b). Finally, based on the observed contraventions during the inspection, an overall hazard rating is given to each establishment. These inspection reports are published on an online database specific to each health authority which is accessible to the public (Fraser Health Authority, 2022b).

Hazards Associated with Pests

The Food Code defines pests as any animal, including rodents or insects which are destructive to the operation of the food premises, and may contaminate food or food-contact surfaces (Food Retail and Food Services Code, 2016). Yearly, it is estimated that rodents cause upwards of 19 billion dollars' worth of damage to global food products (Turcott, 2021). Rodents such as the brown rat, roof rat, and house mouse are

of predominant concern to the North American restaurant sector (Kiyokawa et al., 2022; *Province of British Columbia*, n.d.). By allowing these rodents to be on the premises poses a risk to food safety, to the customers, and to employees as diseases such as tularemia can be transmitted directly (Orkin, 2022.). Additionally, transmission can occur through contamination of food or food-contact surfaces with their feces, urine, or body hair (Hamidi, 2018; Parsons et al., 2021). Insects such as the German cockroaches and house flies carry pathogens such as *Campylobacter spp.*, *Salmonella spp.*, and *Escherichia coli 0157:H7* (Donkor, 2020; Hamidi, 2018; Lim et al., 2021) causing diarrhea, gastroenteritis, and dysentery (Orkin, 2022.).

Pests and COVID-19

In the early spring of 2020, all major cities and communities were shut down throughout the world due to the COVID-19 pandemic, and it has been reported that pest sighting frequency has increased throughout urban neighborhoods (Parsons et al., 2021). The reduced supply of available food from restaurants has led pests to search for new sources in and around homes in urban settings where food sources such as garbage

were more widely available (Murray et al., 2021).

Parsons et al., 2021 indicated that overall, calls about rat sightings increased near food service establishments slightly during the start of the pandemic, however, there was an overall decrease on average. The decrease in pest-related calls from restaurants were attributed to the stay-at-home orders, closures of businesses, and lesser time spent outdoors in communal environments. The stark contrast between the loss of food sources from food service establishments (FSEs) and an increase in food sources from nearby residences could have resulted in increased rat sightings in public spaces. If social distancing has indeed changed populations of rodents, then stressed rat populations may initially subside due to loss of food and subsequently increased competition. However, rats breed rapidly, and should theoretically quickly rebound to pre-COVID-19 numbers (Parsons et al., 2021).

Within the recent years, Greater Vancouver has seen a significant increase in rodents. Westside Pest Control reported a 21% increase in rat callings, and 72% increase in mouse sightings (Radio Canada, 2019).

Some common reasons for the resurgence of rodents in Vancouver B.C. include the relatively warm and wet weather making it the ideal environment for pests (Integral, 2021). Another factor could be a rise in construction activity which has disturbed traditional nesting sites (Integral, 2021). Rodents living around construction areas and in neighbouring sewers are forced to relocate when there is increased activity occurring in those areas. Another reason is the decrease in seabirds, the main predator of rodents which was used to limit population growth (Integral, 2021).

Sanitation and Pests

Pest infestations often begin from the outside of the restaurant before moving inside, and the presence of unsanitary conditions inside and around the restaurant such as large amounts of garbage and debris encourage the harborage of pests (Bole, 2021). The presence of pests is considered an unhealthy indicator, which highlights the need for restaurant operators to find ways to maintain their premises, as noted by Lim et al. (2021). One common method of pest control includes the use of insecticides and rodenticides. However, these methods of

control are either not recommended due to their toxic nature (Hamidi, 2018; Lim et al., 2021; Turcott, 2021) or are banned altogether within B.C. Due to the concerns about pesticide toxicity, B.C. has banned Second Generation Anticoagulant rodenticides. Native wildlife was being adversely affected and secondary poisoning of predators such as owls and other raptors who prey on rodents was occurring (Turcott, 2021).

Integrated Pest Management (IPM) practices can be implemented to effectively control pest populations and the use of toxic chemicals. IPM includes a combination of both non-chemical control measures such as sanitation, trapping, monitoring, eliminating food, water, and harborage for pest, building maintenance s and proper garbage disposal (Lim et al., 2021, UC IPM, n.d.) with the chemical controls mentioned above.

Furthermore, it was noted that the level of cleanliness influences customer satisfaction levels, meaning that the cleaner the surfaces such as floors and walls are the more likely a customer is to return (Lim et al., 2021).

Impact of COVID-19

Due to the COVID-19 pandemic, an estimated 121,500 restaurant sector employees were laid off in B.C. alone and 1 in 10 B.C. restaurants had closed

permanently (Restaurants Canada, 2020).

The Greater Vancouver Board of Trade reported that half of all B.C. businesses have experienced a 75% decrease in revenue due to the COVID-19 pandemic (Board of Trade, 2020). The decrease in revenue partnered with the staff shortages, disruptions in the food supply chain, and decreased inspections contributed to changes in operators' attitudes towards maintaining their premises (Menu Canada's foodservice magazine, 2021; Nakat, Z., & Bou-Mitri, C, 2021; Smith et al., 2022).

While, it is assumed that operators' increased knowledge about transmission of COVID-19 would have resulted in higher levels of sanitation in the food premises. However, the economic factors such as supply chain disruptions, continuously changing requirements on social distancing and seating, decrease in the number of dine-in customers, and high staff turnover may have negatively affected the behaviour and mentality of operators and food handlers, potentially leading to decreased compliance with food safety regulations (Goddard, 2020, Smith et al., 2022).

Purpose of the Study

This research seeks to determine whether there has been a significant change in the

number and severity of pest related violations post-pandemic in restaurants under Fraser Health's jurisdiction.

Methods and Materials

Materials

This study employed the use of secondary data, which was provided by the Manager of the Health Protection division of the Fraser Health Authority (FHA) in British Columbia. The inspection data was received in two separate Microsoft Excel spreadsheets and stored on a Windows PC operating system. Microsoft Excel was used to generate descriptive statistics such as graphs, charts, and statistical tables. Inferential statistical analysis of the inspection data was conducted using NCSS 2023, a statistical analysis software (NCSS, 2023).

Methods

The methods used for this research project involved requesting electronic copies of inspection report data from the FHA's HealthSpace Cloud. Specifically, information pertaining to routine restaurant (FE1) inspections conducted between January 1st, 2019 – December 31st, 2019, and January 1st, 2022 - December 31st, 2022, was requested. This data included the

facility name, physical address, city, inspection date, the violation code, violation hazard score, and overall hazard score. The sample population for the study was determined using the inclusion and exclusion criteria discussed below.

Inclusion and Exclusion

For this study, only routine inspections were considered, with initial, follow-up, and complaint inspection reports being excluded. Initial inspections are conducted prior to a facility opening and are likely to identify fewer violations, while follow-up inspections are typically conducted to assess whether the identified violations from a previous inspection have been addressed and are not meant to assess the overall condition of a restaurant.

Lastly, only inspection reports pertaining to restaurants or food service establishments were included in the study. Inspection data from food stores, ice-cream parlours, convenience stores, gas stations, grocery stores, school cafeterias, hospitals, long-term-care facilities, bakeries, concessions in fitness centers, soup kitchens and mobile food premises was excluded.

Results

Descriptive Statistics

The secondary data obtained for this research included nominal and numerical data. Nominal data included information such as the city and FH region where the facility is located, the address of the facility, and the specific violation codes of interest. On the other hand, the numerical data included the overall hazard rating score of the establishment, and the specific violation hazard scores assigned to violation codes 304, 305 and 306.

Results

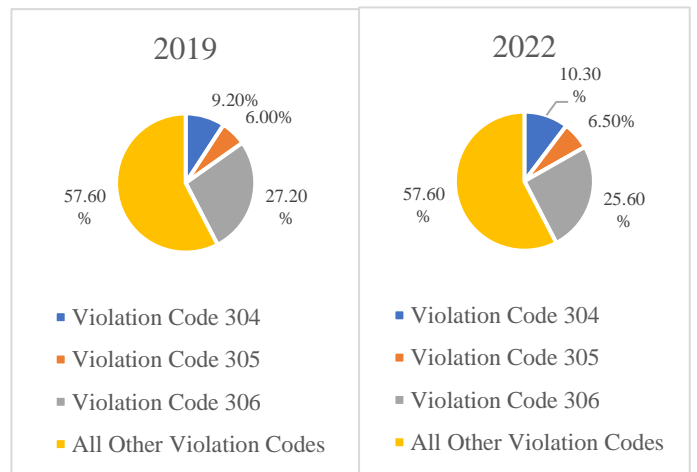
Overall, there was a slight decrease in the total number of violations identified within FH restaurants from 2019 (N=9203) to 2022 (N=9158), however, the number of identified violations varied across the geographical regions (Table 1). Fraser East experienced a substantial decrease in the total number of violations from 2019 (N=1231) to 2022 (N=862) in addition to a decline in pest and sanitation related violations. On the other hand, both the total number of violations and pest and sanitation specific violations increased in Fraser South and Fraser North regions (Table 1).

Table 1: Violation Code Counts for Pest and General Sanitation Related Infractions in Routine Restaurant Inspections in Fraser Health Regions

		Violation Code Count			
		304	305	306	Total number of violations per region
2019	Fraser South	397	225	1027	4015
	Fraser North	416	253	1070	3957
	Fraser East	32	76	408	1231
	FHA Total	845	554	2505	9203
2022	Fraser South	426	266	1054	4323
	Fraser North	484	292	1097	3973
	Fraser East	29	41	196	862
	FHA Total	939	599	2347	9158

304 “Premises not free of pests”, 305 “Conditions favouring pests”, 306 “Premises not maintained in a sanitary condition”

The relative proportion of violation codes 304, 305



and 306 in restaurant routine inspections across Fraser Health Authority was also evaluated (Figure 1). Violation code 304 which corresponds with *Premises not Free of Pests* saw the greatest increase from 2019 (9.20%) to 2022 (10.30%) (Figure 1). Violation code 306 which corresponds with *Premises not Maintained in a Sanitary*

Condition experienced a decrease from 2019 (27.20%) to 2022 (25.60%).

Figure 1: Proportions of Violations in Restaurant Routine Inspections in Fraser Health s in 2019 and 2022

Inferential Statistics

The findings obtained from the inferential statistical analysis are presented in Table 3.

Notably, in FH there was a statistically significant association between the year of inspection and the proportion of inspections with violation codes 304

and 306. Additionally, the mean violation scores for violations 304 and 306 in FH restaurants were statistically significantly different between the years 2019 and 2022 (Table 3).

Table 3: Summary of Inferential Statistics

H0 and HA	Test used	Result	Conclusion
<p>Ho = There is no association between the year of inspection and the proportion of restaurant violations with violation code 304. (“Premises not free of pests”)</p> <p>HA = There is an association between the year of inspection and the proportion of restaurant violations with violation code 304. (“Premises not free of pests”)</p>	Pearson Chi-square test	P = 0.0154	<p>P = 0.0154, therefore, reject the Ho and conclude that there is a statistically significant association between the year of inspection and the proportion of restaurant violations with violation code 304.</p> <p>Significantly higher number of restaurant routine inspections resulted in violation code 304 (“Premises not free of Pests”) in 2022 compared to 2019</p>
<p>Ho = There is no association between the year of inspection and the proportion of restaurant violations with violation code 305. (“Conditions favouring pests”)</p> <p>HA = There is an association between the year of inspection and the proportion of restaurant violations with violation code 305. (“Conditions favouring pests”)</p>	Pearson Chi-square test	P = 0.121	<p>P = 0.1212, therefore, do not reject Ho and conclude that there is no statistically significant association between the year of inspection and the proportion of restaurant violations with violation code 305.</p>
<p>Ho = There is no association between the year of inspection and the proportion of restaurant violations with violation code 306. (“Premises not maintained in a sanitary condition”)</p>	Pearson Chi-square test	P = 0.000	<p>P = 0.0000, therefore, reject the Ho and conclude that there is a statistically significant association between the year of inspection and the proportion of restaurant violations with violation code 306.</p>

<p>H_A = There is an association between the year of inspection and the proportion of restaurant violations with violation code 306. (“Premises not maintained in a sanitary condition”)</p>			<p>Significantly lower number of restaurant routine inspections resulted in violation code 306 in 2022 compared to 2019.</p>
<p>Ho: There is no difference in the mean violation score for code 304 in the year 2019 and 2022 ($\mu_1=\mu_2$)</p> <p>H_A: There is a difference in the mean violation score for code 304 in the year 2019 and 2022 ($\mu_1\neq\mu_2$)</p>	<p>Two tailed Independent 2-sample T test</p>	<p>P = 0.0124</p> <p>Power=0.7584</p>	<p>P = 0.0124, therefore, reject Ho and conclude that there is a statistically significant difference between the mean violation scores for code 304 in 2019 and 2022. In 2022, the mean violation score for code 304 was significantly higher than in 2019.</p> <p>Power for this test is 0.7584 suggesting that the test has 75.84% probability of detecting a statistically significant difference between the means if such a difference exists.</p>
<p>Ho: There is no difference in the mean violation score for code 305 in the year 2019 and 2022 ($\mu_1=\mu_2$)</p> <p>H_A: There is a difference in the mean violation score for code 305 in the year 2019 and 2022 ($\mu_1\neq\mu_2$)</p>	<p>Two tailed Independent 2-sample T test</p>	<p>P = 0.6491</p> <p>Power=0.05</p>	<p>P= 0.6491, therefore do not reject the Ho and conclude that there is no statistically significant difference between the mean violation scores in 2019 for code 305 and the mean violation scores for code 305 in 2022.</p> <p>The power for this test is 0.05, suggesting that there is a 5% (very low) probability of correctly of detecting a true difference between the means if it exists in the population</p>
<p>Ho: There is no difference in the mean violation score for code 306 in the year 2019 and 2022 ($\mu_1=\mu_2$)</p> <p>H_A: There is a difference in the mean violation score for code 306 in the year 2019 and 2022 ($\mu_1\neq\mu_2$)</p>	<p>Two tailed Independent 2-sample T test</p>	<p>P = 0.0008</p> <p>Power=0.9869</p>	<p>p = 0.0008, therefore reject the H0 and conclude that there is a statistically significant difference between the mean violation scores for code 306 in 2019 and 2022.</p> <p>Mean violation score for code 306 was significantly higher in 2022 as compared to 2019. Power for this test is 0.9864 suggesting that the test has 98.64% probability of detecting a statistically significant difference between the means if such a difference exists.</p>

Discussion

The primary objective of this research was to determine whether there exists a statistically

significant difference in the proportion and severity of pest related violations within the FHA following the COVID-19 pandemic. The data

shows a notable increase in the overall number of violations classified under code 304 (“Premises not free of pests”) and 305 (“conditions favoring pests”) and a decrease in number for violations for code 306 (“Premises not maintained in a sanitary condition”), from 2019 to 2022. However, it is noteworthy that only violation codes 304 and 306 displayed statistically significant associations with the year of inspection. The observed increase in the number of violations related to code 305 (“Conditions favouring pests”) from 2019 to 2022 was not statistically significant.

Additionally, this study aimed to assess differences in mean violation scores for codes 304, 305, and 306 in the context of the COVID-19 pandemic.

The mean violation scores for violation codes 304 and 306 were significantly higher in 2022 compared to 2019 suggesting that severity of the violations related to “premises not free of pests” and “premises not maintained in unsanitary conditions” increased in 2022 (post-pandemic).

These results suggest that these specific violations may have been influenced by the impact of the COVID-19 pandemic on operation and maintenance of restaurants. The observed increase in finding evidence of pests during restaurant inspections post pandemic is consistent with reports from local pest control companies, which have noted an increase in complaints related to rodent sightings (Parsons et al., 2021). This trend could be attributed to various factors, such as BC’s ban on 2nd generation rodenticides, rapid growth in construction activities in BC’s lower-mainland and rising temperatures, which create favorable conditions for pest proliferation (Global News, 2023; Integral, 2021; Radio Canada, 2019).

Despite a significant decrease in the number of violations related to general sanitation (violation code 306), the severity of these violations increased following the pandemic. These findings could have been impacted by the challenges faced by the food service industry such as, reduced revenue, staffing shortages and supply chain disruptions, in addition to the decrease in frequency of inspections during the pandemic. These factors may have led to a corresponding decline in operators' commitment to maintenance and sanitation of their premises. However, the empirical evidence suggests otherwise. Previous studies on the impact of COVID-19 pandemic on food premises sanitation suggest that increased knowledge and awareness of the transmission of COVID-19 may have prompted operators to prioritize and incorporate workplace sanitation (Menu Canada's foodservice magazine, 2021; Nakat & Bou-Mitri, 2021; Smith et al., 2022).

Furthermore, the data identified regional differences in the prevalence of pest-related violations within the FHA. Specifically, the data showed that Fraser North exhibited the largest increase in the proportion of violations related to code 304, 305, and 306 from 2019 to 2022, whereas Fraser East exhibited a decrease in both 305 and 306 violations. This information is crucial for EHOs working in these specific regions as inspections resume to pre-pandemic levels. These regional differences highlight the need for localized and context-specific interventions to improve food safety and sanitation practices. Further research could explore the reasons for these regional differences and provide targeted

interventions to reduce the prevalence of pest-related violations across the FHA.

Limitations

Several limitations were identified during this study that could affect the reliability and generalizability of the findings. Firstly, while efforts were made to only include data that was relevant to the research questions and the proposed sample population, it is possible that data for premises that do not entirely match the research criteria may have been inadvertently included. Secondly, this study focused exclusively on inspection data from routine inspections. As a result, the study's findings can only be applied to routine inspections and do not consider complaint-based inspections, which present a significant opportunity to examine specific pest and sanitation-related violations. Thirdly, the inspection data used in this study was collected by various EHOs and may therefore be subject to variations in data collection methods due to differences in personal knowledge and discretion during inspections, and when issuing violations and hazard ratings. As a result, the results of this study may not be representative of inspections conducted in other health authority jurisdictions. It is also worth noting that this study's findings are limited to the data analyzed, which only included routine FEI inspections conducted within the FHA. Therefore, caution should be taken when generalizing these results to other Health Authorities as well as other facilities. Further research could investigate the observed trends across a broader range of locations and industries to gain more comprehensive insights into the

impact of the COVID-19 pandemic on pest-related violations and workplace sanitation practices.

Knowledge Translation

The knowledge gained from the research would provide opportunities to initiate enhanced surveillance of food premises in geographic regions most affected by pest and sanitation related issues. For example, similar data could be collected for years 2023 and 2024 to determine ongoing trends. In support of these advancements, food safety programs and guidelines could provide specific recommendations for addressing pest-related violations, such as training programs for food establishment staff on pest control and sanitation, and incentives for implementing effective pest management plans. The findings could also be beneficial to policymakers when considering updating existing guidelines to strengthen the requirements for food establishments to maintain a pest-free environment.

Furthermore, the findings of this study could be used to inform and educate food safety practitioners and restaurant operators. Innovations in pest control technology, such as smart traps and remote monitoring, could also be promoted to support effective pest management practices. The knowledge generated from this study could inform future practice, programs, policy, guidelines, and innovation in food safety and pest control practices.

Future Research

The following are recommended ideas for future research:

- Evaluating the impacts of COVID-19 on pest related violations in different health authorities.
- Determine trends of violations in Food Processing Establishments.
- Evaluating the impacts of COVID-19 on inspection frequency within FHA.
- Conducting interviews with EHOs within FHA, or other health authority regarding inspection experiences, opinions, and processes during COVID-19 inspections.

Conclusion

The findings of this study provide evidence that the COVID-19 pandemic has had a significant impact on the prevalence of pest-related violations within the FHA, specifically on violation codes 304 and 306. The observed increase in violation code 304 is of particular concern, and the trend should be monitored closely to prevent any potential negative impact on public health. If premises operators are found to be resistant to compliance or behaviour changes regarding pests, specific education strategies that are suitable and equitable to the learner could be implemented to address potential knowledge or skill deficits. Furthermore, higher proportions of pest-related violations in Fraser North as opposed to other regions in FH requires further exploration of potential factors behind the observed differences. The data generated

could be beneficial to the operators and the health authority. Lastly, these results could be used to inform future research on pest management practices and to help develop more effective pest control strategies in the context of public health emergencies such as pandemics.

Acknowledgements

The lead author would like to acknowledge the supervisor of this project, Amardeep Kambo for his guidance and support during this study. Also acknowledged FHA's Mr. Alex Kwan for supporting this study and providing resources and data.

Competing Interest

The author declares that they have no competing interests while conducting this study.

References

- BC Food premises regulation, (1999). Retrieved from https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/11_210_99
- Besharah, A., BCIT School of Health Sciences, Environmental Health, & Heacock, H. (2015). Dinesafe Toronto: an evaluation of the placard system. *BCIT Environmental Public Health Journal*. <https://doi.org/10.47339/ephj.2015.117>
- Vancouver Board of Trade. (2020). *Slow and fragile recovery requires a bold plan*. <https://www.boardoftrade.com/50-news/2020/1834-slow-and-fragile-recovery-requires-a-bold-plan>

- Bole, D. K. (2021). *Common Pest Hot Spots in Restaurants and How to Eliminate Them* | 2021-08-20 | *Food Safety*. Food Safety Magazine . <https://www.food-safety.com/articles/7313-common-pest-hot-spots-in-restaurants-and-how-to-eliminate-them>
- Cseke, P., BCIT School of Health Sciences, Environmental Health, Heacock, H, Sidhu, B., McIntyre, L., & Wilcott, L. . (2014). Inspecting inspection reports, does the type of restaurant change the risk?. *BCIT Environmental Public Health Journal*. <https://doi.org/10.47339/ephj.2014.153>
- DeRosa Katie. (2021, March 29). *COVID-19: "Circuit breaker" restrictions for B.C. target indoor dining, fitness and faith services*. Vancouver Sun. <https://vancouversun.com/news/local-news/new-covid-restrictions-bc-restaurant-dining-suspended>
- Dickson, C. (2022, February 15). *B.C. lifts most COVID-19 restrictions as long as masks and vaccine cards are used* . CBC News. <https://www.cbc.ca/news/canada/british-columbia/covid-restrictions-update-1.6352614>
- Donkor, E. S. (2020). Cockroaches and Food-borne Pathogens. *Environmental Health Insights*, 14. <https://doi.org/10.1177/1178630220913365>
- Fraser Health. (2022a). Food facility & inspection information. https://www.healthspace.ca/Clients/FHA/FHA_Website.nsf/Env-Frameset
- Food facilities inspection reports and violation tickets - Fraser Health Authority*. (2022b). Fraser Health. <https://www.fraserhealth.ca/health-topics-a-to-z/food-safety/food-facilities-inspection-reports-and-violation-tickets#.Y0eAouzMITU>
- Food Retail and Food Services Code*. (n.d.).
- Frye, M. (2021). *Guide to Pest Management in New York State Food Handling Establishments* www.nysipm.cornell.edu
- Global News. (2023). *B.C.'s rodenticide ban could be having unintended consequences*. Retrieved from: <https://globalnews.ca/news/9613386/rodenticide-ban-more-rats-bc/>
- Goddard, E. (2020). The impact of COVID-19 on food retail and food service in Canada: Preliminary assessment. *Canadian Journal of Agricultural Economics*, 68(2), 1–5. <https://doi.org/10.1111/cjag.12243>
- Government of Canada. (2016). Yearly food-borne illness estimates for Canada. Retrieved from <https://www.canada.ca/en/public-health/services/food-borne-illness-canada/yearly-food-borne-illness-estimates-canada.html>
- Hamidi, K. (2018). How do Rodents Play Role in Transmission of Foodborne Diseases? *Nutrition & Food Science International Journal*, 6(2).
- Haradhan, M. (2017). Two criteria for good measurements in research: Validity and reliability. *Annals of Spiru Haret University*. https://mpr.ub.unimuenchen.de/83458/1/MPR_A_paper_83458.pdf
- Heacock, H. (2022a). *Module 2: Research Design and Data Collection* [PowerPoint presentation]. Retrieved from D2L.
- Heacock, H. (2022b). *Module 4: Introduction to Inferential Statistics* [PowerPoint Presentation]. Retrieved from D2L.
- Heacock, H. (2022c). *Module 4a: One-Sample, Two-Sample, Paired T-Test* [PowerPoint presentation]. Retrieved from D2L.
- Heacock, H. (2022d). *Module 4b: Chi Squared* [PowerPoint Presentation]. Retrieved from D2L.
- Integral. (2021). *Why rats have become a big problem for Vancouver restaurants*. Integral Pest Services. Retrieved November 23, 2022, from <https://integralpest.com/why-rats-have-become-a-big-problem-for-vancouver-restaurants/>
- Johnson, S., Bragdon, C., Olson, C., Merlino, M., & Bonaparte, S. (2016). Characteristics of the Built Environment and the Presence of the Norway Rat in New York City: Results From a Neighborhood Rat Surveillance Program, 2008-2010. *Journal of Environmental Health*, 78(10), 22–29.

- Kiyokawa, Y., Tanikawa, T., Ootaki, M., & Parsons, M. H. (2022). Social distancing measures differentially affected rats in North America and Tokyo. *Journal of Pest Science*, 95(1), 79–86. <https://doi.org/10.1007/S10340-021-01405-Z/TABLES/2>
- Microsoft Office 365. (2022). Microsoft Excel [Computer software]. Retrieved from <https://products.office.com/en-ca/excel>
- Lim, S. Y., Harun, U. B., Gobil, A. R., Mustafa, N. A., Zahid, N. A., Amin-Nordin, S., Umi, U. K., Jamaluddin, T. Z. M. T., Mohamed, N. A., Zulkefli, N. A. M., & Shohaimi, S. (2021). Measuring customer satisfaction on the cleanliness of food premises using fuzzy conjoint analysis: A pilot test. *PLoS ONE*, 16(9 September). <https://doi.org/10.1371/journal.pone.0256896>
- Managing rat and mouse pests - Province of British Columbia*. (n.d.). Retrieved October 12, 2022, from <https://www2.gov.bc.ca/gov/content/environment/pesticides-pest-management/managing-pests/animals/rodents>
- Menu Canada's foodservice magazine. (October 2021). Top tech trends: defining operations in Canadian restaurants and bars. <https://www.menumag.ca/2021/10/07/top-tech-trends-redefining-operations-in-canadian-restaurants-and-bars/>
- Murray, M. H., Byers, K. A., Buckley, J., Magle, S. B., Maffei, D., Waite, P., & German, D. (2021). "I don't feel safe sitting in my own yard": Chicago resident experiences with urban rats during a COVID-19 stay-at-home order. *BMC Public Health*, 21(1). <https://doi.org/10.1186/s12889-021-11095-y>
- Nakat, Z., & Bou-Mitri, C. (2021). COVID-19 and the food industry: Readiness assessment. *Food Control*, 121. <https://doi.org/10.1016/j.foodcont.2020.107661>
- NCSS 2022 Statistical Software (2022). NCSS, LLC. Kaysville, Utah, USA, <https://www.ncss.com/>
- Parsons, M. H., Kiyokawa, Y., Richardson, J. L., Stryjek, R., Byers, K. A. 4, Himsworth, C. G., Corrigan, R. M., Deutsch, M. A., & Ootaki, M. (n.d.). Rats and the COVID-19 pandemic: Early data on the global emergence of rats in response to social distancing. *Jason Munshi-South*, 10. <https://doi.org/10.1101/2020.07.05.20146779>
- Parsons, M. H., Richardson, J. L., Kiyokawa, Y., Stryjek, R., Corrigan, R. M., Deutsch, M. A., Ootaki, M., Tanikawa, T., Parsons, F. E., & Munshi-South, J. (2021). Rats and the COVID-19 pandemic: Considering the influence of social distancing on a global commensal pest. *Journal of Urban Ecology*, 7(1). <https://doi.org/10.1093/jue/juab027>
- Pest control for restaurants*. Orkin. (2022, October 31). Retrieved November 23, 2022, from <https://www.orkincanada.ca/commercial/industry/restaurants-food-services/>
- Public Health Act, SBC 2008, c 28. Retrieved from <https://canlii.ca/t/531m8>
- Restaurants Canada*. (2020, April). COVID-19 Has Cost the B.C. Foodservice Sector 121,500 Jobs since March 1 <https://www.restaurantscanada.org/industry-news/covid-19-has-cost-the-b-c-foodservice-sector-121500-jobs-since-march-1/>
- Resurgence of rats and mice in Vancouver facilities*. Westside Pest Control. (2020, November 11). Retrieved November 23, 2022, from <https://westsidepestcontrol.com/resurgence-of-rats-and-mice-in-vancouver-facilities/>
- Rosenberg-Douglas, K. (2020). *As Chicagoans eat at home because of COVID-19, rats used to dining out on restaurant scraps follow the food supply*. <https://www.proquest.com/blogs-podcasts-websites/as-chicagoans-eat-at-home->
- Smith, J., BCIT School of Health Sciences, Environmental Health, & Heacock, H. (2022). Food premises inspection violations and inspection frequency during COVID-19 in Vancouver Island Health Authority. *BCIT Environmental Public Health Journal*. <https://doi.org/10.47339/ephj.2022.213>
- Turcott, M. (2021). Defending Nature Against Rodenticides Defending Nature Against Rodenticides. *Centre for Law and the Environment* . <https://commons.allard.ubc.ca/clehttps://commons.allard.ubc.ca/cle/>

Watts, M., Ritchie, L. E., Brown, J. R., Fekete, M., Ranger, J., Newell, S., Longo, M., Sullivan, P. J., Oleksiuk, P., Putyra, M., & Wetter, C. (2020, March 24). *Provincial governments restrict business operations in the fight against COVID-19*. Osler.
<https://www.osler.com/en/resources/regulations/2020/provincial-governments-restrict-business-operations-in-the-fight-against-covid-19>

What is Integrated Pest Management (IPM)? UC IPM. (n.d.). Retrieved November 23, 2022, from <https://www2.ipm.ucanr.edu/What-is-IPM/>