Assessing the Potential Health Hazards of Purchasing Prepared Foods from Unregulated Private Online Sellers

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Abstract

Background

Social media and home-based businesses have taken the internet by storm as large online platforms such as Facebook Marketplace and Instagram have provided an outlet for private online sellers to sell food prepared in their home kitchens to the general public. Home-based sellers are currently unregulated, due to the sheer number of sellers and lack of manpower and resources at health authorities. With the increasing number of unregulated online food sales and the increasing popularity of purchasing foods from online platforms, the hazards associated with food prepared in home kitchens ought to be investigated. Because Potentially Hazardous Foods particularly increase the risk of foodborne illness, the number of listings containing them ought to be quantified.

Methods

154 listings of unregulated online food sales from urban and rural British Columbia, Canada on Facebook Marketplace were analyzed. Foods were categorized into PHFs and non-PHFs using a categorization tool based on food safety guidelines and legislation. Data collection was completed with Microsoft Excel and statistical analyses using the NCSS 2022 software.

Results

Of the 154 listings, 82% of listings from urban BC sold PHFs and only 18% sold non-PHFs, whereas 74% of rural BC listings sold non-PHFs, while only 26% of posts sold PHFs. In urban BC, 39% of postings sold foods containing meat, poultry, eggs or seafood, while 61% of postings did not, whereas 14% of postings in rural BC sold foods containing meat, poultry, eggs or seafood, while 86% of postings did not. Statistically significant associations were found between the

amount of urban online PHF listings and rural online PHF listings ($p = 0.0000$), as well as between the amount of urban online listings of meat, poultry, egg or seafood-containing foods and rural online listings of meat, poultry, egg or seafood-containing foods ($p = 0.0000$).

Conclusion

Based on the analysis of unregulated online food listings from urban and rural BC, Canada sold on Facebook Marketplace, a large proportion of food listings from urban BC were complex or ethnic foods containing Potentially Hazardous Foods, which significantly contrasted from the low number of PHF-containing food listings from rural BC. PHFs pose a higher risk of foodborne illness, especially if they are prepared in an unregulated, unpermitted home kitchen. Currently, enforcement and regulatory intervention for unregulated online sellers is only complaint driven (1). Data from this research could be used to guide or support policies and decisions related to regulatory enforcement and online seller education programs.

Keywords: Potentially Hazardous Foods (PHFs), online, food sales, foodborne illness, health hazards, food safety

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Introduction

In the last decade or so, social media and home-based businesses have taken the internet by storm as large online platforms such as Facebook Marketplace and Instagram have provided an outlet for private online sellers to sell food prepared in their home kitchens to the general public. Customers have access to nearly anything from sausages, pizza dough and sauces, to ethnic foods like Relyenong bangus (stuffed milkfish) right at their fingertips (2). These home-based businesses are popular for their cheaper prices, the abundance of options, wide range of cuisines, and for the appeal of homemade foods (3).

Home-based sellers are currently unregulated, due to the sheer number of sellers and lack of manpower and resources at health authorities. There are various risks and potential health hazards associated with home-based food preparation, including foodborne illnesses. It is estimated that each year, 200,000 to 700,000 individuals experience foodborne illness in British Columbia, costing BC taxpayers $200 to $600 million per year (4). Illegal food sales also take business from

approved restaurant businesses (3), which unlike home-based businesses, are properly permitted and licenced, inspected, and conform to regulations, all of which are critical to maintaining food safety and public health.

Literature Review

The New Wave of Online Food Services

Restaurant businesses were one of the hardest-hit industries during the COVID-19 pandemic, as they were affected by government-mandated lockdowns and dine-in restrictions (1). Under public health measures, restaurants have been operating at reduced capacity and have been forced to close early (5). Many were also ordered to close to contain the spread of the virus (6).

With limited availability of walk-in services, customers turned toward online options. A study on "the impact of COVID-19 on the food industry and e-commerce" conducted by Dalhousie University found that the proportion of Canadians reported to have purchased food online once a week increased from 29.6% before the pandemic, to 45.4% during the pandemic (7). The study surveyed 7,290 Canadians on their behaviour over a 6-month period during the COVID-19 pandemic and as many as 49.4% of respondents reported that they intend to purchase food online at minimum once a week post-pandemic (7).

With the increased demand for online food services, the potential public health risks associated with non-permitted online food sales are worth examining.

BC Public Health Act and Food Premises Regulation

As defined in the BC Public Health Act (2008) which will be abbreviated below as PHA, and the Food Premises Regulation B.C. Reg. 210/99, which will be abbreviated below as FPR, these unregulated, non-permitted online sellers are operators of a regulated activity and are operating food service establishments (8,9). Consequently, their homes or home kitchens where they are preparing these foods are food premises in which they are processing foods and serving them to the public (9). Stated in Part 3, Division 1, Section 8(1) of the FPR, "a person must not operate a food service establishment unless the person holds a permit issued under this section" (9). As such, private home-based online sellers operating without any permit, license, or any approval to operate are unregulated and in contravention of the listed Regulations.

Public Health Significance of Potentially Hazardous Foods (PHFs)

Unregulated premises may pose a risk to public health, as many foods being sold on these platforms are potentially hazardous foods (PHFs), meaning foods capable of supporting the growth or toxin production of disease-causing microorganisms (10–12). Such foods include eggs, milk or dairy products, poultry, meat, fish, shellfish, sprouts and tofu products (10–12). PHFs are also defined as foods with a pH of greater than 4.6 and foods with a water activity of 0.85 and above, which are favourable to the growth of pathogenic organisms (11,12). Therefore, PHFs are especially susceptible to temperature abuse and require "proper temperature control – either refrigeration at 4ºC (40ºF) or less, or hot holding above 60ºC (140ºF)" in order to prevent or limit the proliferation of those disease-causing microorganisms (9,11).

As prescribed in Part 1, Section 2.1(1)(b) of the FPR, potentially hazardous foods are health hazards (9). Improper handling of PHFs such as temperature abuse, has been known for causing foodborne illness (12), which around 4 million Canadians suffer from each year (11). Older adults, young children, pregnant women, and those with compromised immune systems are especially vulnerable (11). As such, it is essential that these microbiological hazards be controlled through the rigorous application of critical limits for time, temperature, pH, and water activity, to protect public health (12). Without FoodSafe training and a food safety plan, home-based food handlers may not have the knowledge or skills to control and monitor these critical limits. And because these PHFs are being sold to the public as opposed to being consumed in a private household, it can possibly lead to widespread illness in the community.

The Potential Health Hazards Associated with Home-Based Food Preparation

Aside from the inherent risk of handling PHFs, numerous potential health hazards exist from preparing food in a home kitchen. Home-based food handlers have no food safety plan or sanitation plan, which are required of permitted food service establishments, as per Sections 23(2) and 24(1) of the FPR, to prevent the occurrence of a health hazard and to ensure that the operation of the establishment is safe and sanitary (9). Following regulatory requirements and sanitation plans approved by public health professionals ensures that a minimum standard of cleaning is maintained

in the facility. In a home, the level of cleanliness maintained is variable and subjective to the individuals living in the home.

In the study by Wills et al. (2015) that investigated 20 UK households and their domestic kitchen practices using a practice-based approach, certain participants were found to base their assessments of cleanliness against "self-defined levels of social acceptability" (13). This meant that certain practices or lack of practices deemed 'normal' in one household was completely unacceptable in another household (13). For example, what was considered 'cleaning' ranged from tidying or clearing a surface, such as removing crumbs with one's hands, to make it aesthetically more pleasing, to applying infection control to remove potentially harmful bacteria (13).

Furthermore, FoodSafe certification and food handler training, as required by Section 10(1) of the FPR for food service establishments (9), is not enforced in unlicensed home-based businesses, so the extent of these operators' food safety knowledge is unknown. According to a study by Worsfold (1997), which used direct observation to collect data on food safety behaviour in 108 subjects' homes, 60% of subjects used the same cutting board for all operations and 25% of subjects did not clean and sanitize cutting boards between food operations, both of which increase the risk of cross-contamination and foodborne illness (14). A study conducted by Kennedy et al. (2011) conducted microbiological sampling and results detected *E. coli* in 35.0% of beef salad samples and 31.7% of the beef burger samples, while *C. jejuni* was detected in 13.3% of chicken salad samples (15). Sampling also detected *E. coli* on 26.7% of participants hands post food preparation (15), suggesting the occurrence of cross-contamination and poor hand hygiene practices during household food preparation and the potential for transmission of pathogens onto food, which can result in foodborne illness upon ingestion.

Various unreliable methods are used to assess food safety in the household, including relying on senses like smell to assess the freshness of food and feeling whether something is cold in the refrigerator rather than using a thermometer (13). Such lack of thermometer use was similarly addressed in a collaboration project between Fraser Health and Vancouver Coastal Health, which surveyed 1,000 residents of the Lower

Mainland in British Columbia, regarding their food safety practices (4). Over 80% of residents responded that they did not use thermometers to assess whether food is adequately cooked (4). As previously mentioned, temperature control is a key control measure for the safe handling of PHFs (11,12), therefore, the lack of thermometer use suggests hazardous practices.

In addition to the risks of home-based food handling, the operation of unregulated businesses also lacks a very key component to food safety, namely, inspections by certified health inspectors. Inspections are one of many food safety interventions implemented by many health authorities to modify food preparation behaviour and reduce the risk of foodborne illnesses (16). Nonetheless, the NCCEH states that limited scientific evidence exists on the effectiveness of inspections and education on reducing foodborne illness (16).

Besides operating without a permit, which violates Section 8 of the FPR, home-based food sales contravene Part 2, Section 4(1)(d)(i) of the FPR which requires that food premises be separate from living quarters (9). Private kitchens or living quarters are not generally constructed to fulfill commercial requirements for food preparation and food protection from contamination and are therefore not suitable to be used as commercial food premises (11). Day-to-day living occurs in that space, as the kitchen space is not restricted to food preparation. As Wills et al. (2015) found, aspects of domestic life including laundry, childcare, pet care, art and craft activities, and school and office work often take place in the kitchen. Subjects in the study were found to touch pets or electronics during food handling, without handwashing in between (13), exposing food to microbiological contamination and potentially disease-causing microorganisms.

Materials and Methods

Description of Materials and Standard Methods

Marketplace, the e-commerce platform on the social media platform Facebook was used as a research tool to search for listings of food privately sold online. The search word “food”

was used, in conjunction with the filter function to refine results. Since this research aimed to compare the differences in foods sold online between rural and urban geographical areas, two separate searches were conducted with location adjusted to Vancouver, British Columbia, Canada with a radius of 40 km to represent urban British Columbia and location adjusted to the Okanagan area of British Columbia, with a radius of 40 km to represent rural British Columbia.

The content of each post including the location, name, description, and ingredients of each food product was recorded onto a spreadsheet in Microsoft Excel. Such information helped to determine whether the food was a potentially hazardous food or not. The term "potentially hazardous food", also known as "PHF" refers to foods capable of supporting the growth and toxin production of disease-causing microorganisms and are thus prone to temperature abuse and require proper temperature control (9–12). The PHF/non-PHF categorization tool in Table 1 outlines the food and its products that are PHFs, which were categorized under "yes" for data analysis and food and its products that are non-PHFs, which were categorized under "no" for data analysis.

The identification of PHFs was guided by the use of Table 1, which was created using the Food and Drug Administration Food Code (1999), Food Retail and Food Services Code (2016), and Safe Food Australia (2016). The number of PHFs, which are prescribed as health hazards (9), will be used to assess the hazardousness of home-based food preparation, as mishandling them can result in foodborne illness when pathogenic microorganisms or toxins reach critical levels (10).

Table 1. PHFs vs Non-PHFs Categorization Tool

PHFs:	Non-PHFs:
▪ Raw/cooked meat or poultry ✓ Burgers, kebabs, curries, pate, meat pies ▪ Raw/cooked eggs ▪ Protein-rich foods: beans, nuts, tofu ✓ Batter, mousse, quiche ▪ Dairy products: milk, dairy-based desserts ▪ Bakery products filled w/ cream or custard ▪ Seafood (except live seafood) ✓ Sushi ▪ Sprouted seeds ▪ Prepared fruits and vegetables ✓ Cut melons, salads, unpasteurized juices ▪ Cooked rice ▪ Fresh and cooked pasta ▪ Foods containing any of the above ✓ Sandwiches, pizza, rice rolls	✗ Biscuits and crackers ✗ Plain breads and plain cakes ✗ Confectionary ✗ Dried fruit and dried goods ✗ Fruit cake and fruit juices ✗ Bottled marinades, pasta sauces, salsas ✗ Fermented dried meats ✗ Salted dried meats ✗ Hard cheeses ✗ Honey ✗ Jam ✗ Nuts in the shell ✗ Peanut butter ✗ Pickled foods ✗ Raw whole fruits and vegetables ✗ Salad dressing ✗ Sauces ✗ Unopened canned foods ✗ Yoghurts

Amongst PHFs, foods containing meat, poultry, eggs or seafood are of particular concern as they are often contaminated with pathogens at the source, even before the food handling process begins. For instance, seafood is susceptible to surface and tissue contamination from marine waters and in particular, bivalves are filter-feeders that may concentrate pathogens, including *Vibrio,* present in the seawater (17). As such, proper food handling is especially crucial to eliminate pathogens and so the number of postings containing any meat, poultry, eggs or seafood and whether they were listed in urban or rural BC was additionally analyzed. Any postings selling foods containing any of either one of meats, poultry, eggs or seafood was categorized as "yes" for data analysis, and any postings selling foods that do not contain any of either meat, poultry, eggs or seafood was categorized as "no" for data analysis. Categorization was completed by using the name of the food sold in the listing, any provided description or photos in the post or any obvious ingredients.

Inclusion and Exclusion Criteria

154 listings analyzed between January 7th to January 26th of 2022, selling edible human foods on Facebook Marketplace that appeared in the results using the search word "food" and the adjusted location of within a 40 km radius of Vancouver, BC (urban) and within a 40 km radius of Okanagan, BC (rural) were included in analysis. Any results selling items inedible to humans, such as cookbooks and Tupperware were excluded. To avoid selection bias, results that could not be easily identified were also excluded. Any listings reselling store-bought commercial products, or any duplicates of listings already included in analysis were excluded.

Ethical Considerations

Because this study involved social media accounts, which were password-protected, it is assumed that users had an expected level of privacy for content that they had posted (18). As such, this research required review and approval from the Research Ethics Board (18). To minimize the invasion of privacy, names of the sellers were not attached to their postings and will not be revealed to the public or any regulatory authorities. The main goal of this research was to analyze the foods being privately sold online and not the people who are selling these foods. No information from the private profiles of these sellers was viewed, analyzed, or published in the results of the research.

Statistical Analysis & Results

Description of Data & Descriptive Statistics

The secondary data collected for statistical analysis consisted of "yes" or "no" and "urban" or rural", which were categorical, non-numerical, dichotomous nominal data. Additional information collected for descriptive statistics including name of food and ingredients was nominal as well. Pie charts were used to represent descriptive data such as counts and percentages. For example, Figures 1 and 2 are a visual comparison between the percentage of listings selling PHFs in urban and rural BC.

An overwhelming 82% of postings from urban BC sold PHFs and only 18% sold non-PHFs. These findings were almost completely opposite from rural BC, where a majority of postings, 74%, sold non-PHFs, while only 26% of posts sold PHFs. Similarly, Figures 3 and 4 compare the percentage of listings selling meat, poultry, eggs or seafood-containing foods in urban and rural BC. In urban BC, 39% of postings sold foods containing meat, poultry, eggs or seafood,

while 61% of postings did not, whereas 14% of postings in rural BC sold foods containing meat, poultry, eggs or seafood, while 86% of postings did not.

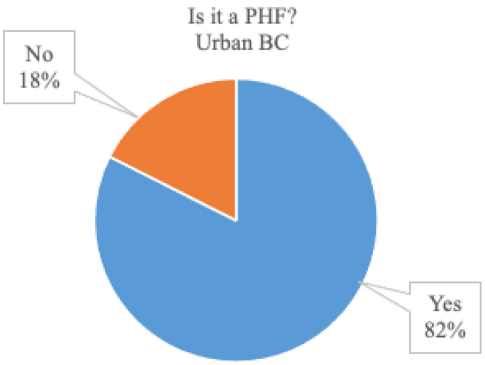

Figure 1. Percentage of postings selling PHFs in urban BC

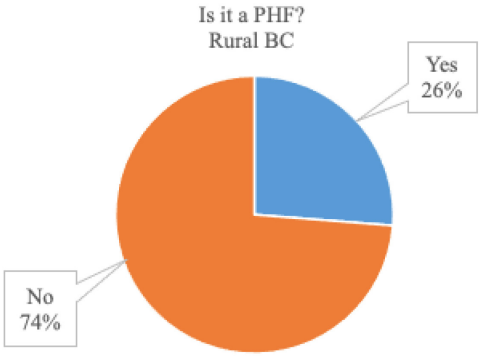

Figure 2. Percentage of postings selling PHFs in rural BC

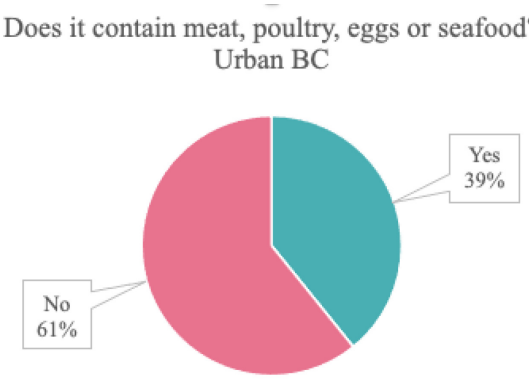

Figure 3. Percentage of postings selling meat, poultry, eggs or seafood-containing food in urban BC

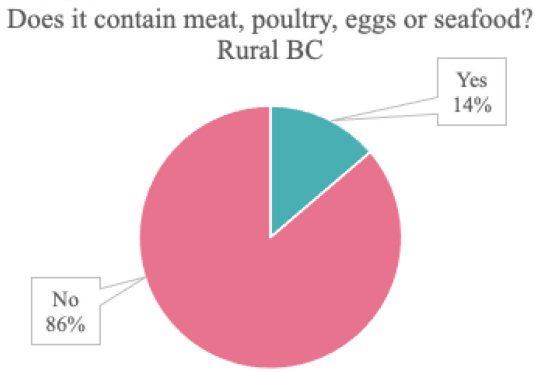

Figure 4. Percentage of postings selling meat, poultry, eggs or seafood-containing food in rural BC

Inferential Statistics

A chi-square test, which is a non-parametric test was used to assess whether there was an association between the number of PHFs being sold privately online in rural BC

compared to urban BC. It is a two-tailed test as there is no evidence to suggest whether urban or rural BC would have more PHFs being privately sold online. The null and alternative hypotheses are stated in Table 2.

Table 2: Hypotheses and Results

Hypotheses	Test Used	Result	Conclusion
H_0: There is no association between the amount of urban online PHF listings and rural online PHF listings. **H_a**: There is an association between the amount of urban online PHF listings and rural online PHF listings.	Chi-square test	p = 0.0000	Therefore reject H0, the null hypothesis, and conclude that there is a statistically significant association between the amount of urban online PHF listings and rural online PHF listings.
H_0: There is no association between the amount of urban online listings of meat, poultry, egg or seafood-containing foods and rural online listings of meat, poultry, egg or seafood-containing foods. **H_a**: There is an association between the amount of urban online listings of meat, poultry, egg or seafood-containing foods and rural online listings of meat, poultry, egg or seafood-containing foods.	Chi-square test	p = 0.0000	Therefore reject H_0, the null hypothesis, and conclude that there is a statistically significant association between the amount of urban online listings of meat, poultry, egg or seafood-containing foods and rural online listings of meat, poultry, egg or seafood-containing foods.

The statistical packages NCSS 2022, Microsoft Excel for Mac Excel Version 16.53 were used. NCSS 2022 is a software separate from Excel and provides a complete collection of statistical and graphic tools to visualize and analyze data (19). Power was not given by the statistical analysis tools NCSS 2022 or Microsoft Excel for Mac Version 16.53, so beta could not be calculated.

Discussion

The primary objective of this research was to quantify the number of PHFs sold in urban BC compared to rural BC, in relation to the inherently increased risk of foodborne illness. Additionally, to suggest whether a certain geographic area may require increased regulatory intervention for unregulated online food sales. Particularly concerning types of PHFs were foods containing meat, poultry, eggs, and seafood, which is why the secondary objective was to quantify and compare the number of listings selling such foods in urban and rural BC. Based on the results of this research, there is an indication of a significant association that exists between the amount of urban online PHF listings and rural online PHF listings. This is supported by Figures 1 and 2, which show that 82% of listings from urban BC contained PHFs, while only 26% of listings from rural BC contained PHFs.

A significantly higher percentage of listings selling PHFs in urban BC could be related to the fact that most of the urban BC listings were ethnic foods such as curries, cooked rice and noodle dishes, or complex foods containing a wide range of ingredients. This is in contrast with listings in rural BC, which mostly consisted of baked goods, confectionery, and whole or preserved fruit and vegetable products, which are not PHFs. A higher percentage of ethnic food sales in urban BC compared to rural BC does not necessarily indicate that ethnic peoples are more likely to conduct unregulated food sales, as it could be attributed to the fact that urban BC, which includes more densely populated cities such as Vancouver, Burnaby and Surrey, consist of a significantly higher visible minority population, in comparison with rural BC, which includes the Okanagan region and mainly Vernon. As per the 2016 Census by Statistics Canada, 48.9% of Vancouver, 63.6% of Burnaby, and 58.5% of Surrey consisted of a visible minority population, compared to only a 5% visible minority population in Vernon (20). Nonetheless, this higher percentage of ethnic food sales could suggest that ethnic foods are more common amongst unregulated food sales in urban BC.

Aside from containing PHFs, the preparation of ethnic foods may be associated with a higher risk of foodborne illness, as ethnic-operated premises have a history of increased rates of critical violations and inspections, in comparison with non-ethnic-operated premises (21). Ethnic foods have also been implicated in multiple food recalls and

foodborne outbreaks due to adulteration, contamination of pathogens, toxins, chemicals, and undeclared allergens (22). *Salmonella, E. coli O157, Listeria,* and *Vibrio* outbreaks have been linked to ethnic raw fish preparations, cooked ready-to-eat foods, cheeses, seafood, and others ethnic foods across the world (22). As such, ethnic foods and unregulated ethnic food sellers, which as indicated by the results of this research are more prevalent in urban BC, may require additional attention when it comes to regulatory intervention to ensure food safety.

A significantly higher percentage of listings selling PHFs and foods containing meat, poultry, eggs and seafood, as well as a majority of listings selling ethnic or complex foods could support a policy or decision for increased intervention in unregulated online sales in urban BC, as compared to unregulated online sales in rural BC. Nevertheless, since this study only analyzed a small sample of 154 listings within a short period of one month, it cannot be concluded that this data absolutely supports a greater need of intervention for urban BC.

While PHFs do inherently pose a higher risk of foodborne illness, it must not be that disregarded that certain foods may still pose a risk to foodborne illness even if they are not PHFs. For example, honey was sold in seven posts from rural BC. While honey is not a PHF, pasteurized and unpasteurized honey can contain the pathogenic toxin-producing bacteria *Clostridium botulinum*, which causes Botulism in young infants who are fed honey (23). Whole fruits and vegetables are also not PHFs, yet, they are oftentimes consumed without a cook step and if mishandled or contaminated with pathogens during production, harvest, transport, or storage can result in foodborne illness upon consumption (24).

As this study only examined online food sales from British Columbia, the results can only be directly extrapolated to the BC population. As similar existing studies examining online food sales were not found, results could not be compared with findings of previous research. This study can provide a foundation or example for future studies that also aim to analyze and online food sales.

Limitations

This study is limited in scope, in terms of analyzing unregulated online food sales, as it only utilizes listings from one social media platform, from a small handful of cities. As such, these results may not be representative

of listings in the entire province. Comparing data from other social media platforms, if possible, would have increased external validity. Data was only collected over a short period of one month, due to time restrictions. A longer period of data collection ideally over at least 3 months would have strengthened the internal validity of this research.

The use of the categorization tool in Table 1 to categorize listings into PHFs and non-PHFs was an approach to standardize the categorization process, however, there was still subjectiveness involved, as it relied on the researchers' ability to identify foods based on images, when limited information was provided by the seller. As previously mentioned, any listings that could not easily identified were excluded from the data set, however, there remains a possibility that the categorization for certain listings could have been inaccurate.

To improve this study, the researcher could have interviewed the online sellers and confirmed the ingredients and how it was prepared, which could improve the internal validity of the method and the accuracy of results. Another method could be to purchase the foods sold in the listings and physically identify the ingredients in person as opposed to on the internet. This method was not possible for this study as time and funding were limited.

Knowledge Translation

Currently, investigations regarding illegal home kitchens are only complaint driven (1). Environmental Health Officers follow up with cases once a complaint causes them to be aware of an individual producing food in an unapproved location for public consumption (1). Due to the hazardous nature of PHFs (9,11) and the potential risk of improper food handling in home kitchens resulting in foodborne illness (13–15), this research could inform policy decisions or policy makers, or inform the need for increased intervention with unregulated online food sales, especially in urban BC, where the prevalence of PHFs amongst unregulated online food sales is significantly higher. A possibility could be for health authorities to dedicate more funding and human resources to investigations. This may potentially involve creating full-time positions to investigate new cases of illegal home-based sales and use progressive enforcement and education to work with home-based sellers to achieve compliance

with regulations. As results have shown a higher prevalence of PHFs amongst unregulated ethnic foods sales, related institutions such as the BC CDC or NCCEH could develop additional resources and guidelines to help health professionals conduct food safety assessments on ethnic foods.

This knowledge can also be translated into a health promotion program that involves posting public notices on these selling platforms, encouraging sellers to acquire FoodSafe certification and informing sellers and customers of the requirement for a permit to sell food to the public. The notices could include a link to a webpage or guidelines on how to get licensed and FoodSafe training. Due to the sheer number of sellers, it is not feasible to contact and work with all existing sellers and investigate each posting on online platforms. A health promotion program would be able to reach larger populations. As this data provides information on the types of foods currently being sold online, it could also be used to provide ideas or a starting point for future studies.

Future Research

Based on this project, recommendations for future student projects are:

- Survey home-based online food sellers to assess their food safety knowledge
- Survey customers who buy from unregulated food sales
    - Ask what they buy and categorize the food into PHFs and non-PHFs

Conclusion

With the increasing number of unregulated online food sales and the increasing popularity of purchasing foods from online platforms, the risk of foodborne illness associated with food prepared in unregulated home-based kitchens ought to be investigated. Based on the analysis of 154 food listings from urban and rural BC, Canada sold on Facebook Marketplace, a large proportion of food listings from urban BC were complex or ethnic foods containing Potentially Hazardous Foods, which significantly contrasted from the low number of PHF-containing food listings from rural BC. PHFs pose a higher risk of foodborne illness, especially if they are prepared in an unregulated, unpermitted home kitchen. Such information could be used to guide or support policies and decisions related to regulatory enforcement and online seller education programs.

Acknowledgments

The lead author would like to acknowledge Dale Chen and Kevin Freer, the supervisors for this project, for providing advice, support, and guidance throughout this project. The lead author would also like to thank Lorraine McIntyre for her input during the development of this study.

Competing Interests

The author declares that they have no competing interests.

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