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Food Safety Interventions

A Review of Food Safety Interventions and Evaluation in Food Service Establishments

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introduction

Introduction

The public health and economic implications for foodborne illness in industrialized nations can be costly. Food service establishments (FSEs) are major settings for foodborne pathogen exposure in developed countries due to high consumption of food prepared outside homes. To reduce foodborne illness risks, many health authorities implement food safety interventions in FSEs in order to modify food preparation behaviour and service practices.[1] The goal of this project is to assess existing knowledge and research, explore issues of implementation, and identify research gaps related to interventions in FSEs.

FSEs include any facility from which food and drink is prepared and served for immediate consumption, either on premises or elsewhere (takeout).[2-4] The term "food service establishment" encompasses a wide range of operations, including restaurants, cafeterias, bakeries, and bars; meanwhile, food retailers such as supermarkets and grocery stores do not fall into such a category.[4] While non-commercial food provision from community events and gatherings are excluded, institutional facilities are included (prisons, hospitals, staff cafeteria, and schools).[5,6]

Across Canada, regional health authorities, funded by the provincial or territorial government, manage food safety interventions for local FSEs.[7] As a result of regional autonomy, there is no standardized national food service inspection and enforcement system. Therefore, food safety interventions currently tend to be regional, context-specific, and difficult to compare across jurisdictions.[7]

Different intervention strategies in the form of policies, enforcement, and education are deployed to reduce risks of potential foodborne hazards. Health authorities can select, prioritize, and implement food safety interventions. Since numerous options for food safety interventions in FSEs (Table 1) are available, health authorities tend to incorporate multiple strategies to enhance effectiveness and efficiency.

Measuring Intervention Effectiveness

Food safety interventions are often difficult to evaluate. Some elements of food safety can be quantified and standardized, whereas others may be context specific and hard to compare. Furthermore, the success and feasibility of a public health intervention cannot be measured

by efficacy alone. When an intervention is put into practice, financial and social consequences of the intervention must be considered. Two major categories of indicators, based on hygiene performance and public health outcome, respectively, are often used to measure the effectiveness of interventions (Table 2).[8] While numerous intervention options are theoretically available, a health authority's activities and interventions are determined by context specific factors such as resources, history, size of jurisdiction, staff and client knowledge, and evidence on best practice.

Evidence Review

The overall objective is to review the evidence related to the effectiveness of food safety interventions in food service establishments. Based on a model created by the National Collaborating Centre for Healthy Public Policy (NCCHPP), the evidence reviews in each chapter, where applicable, also explore issues related to intervention implementation (Figure 1).

The interventions assessed were selected from an inventory of possible food safety interventions (Table 1) based on responses from environmental public health practitioners across Canada. A review has been completed for each topic listed below; each one includes a summary of aspects of the intervention and a literature review synthesizing existing evidence.

Restaurant Inspection and Enforcement

Does an increase in level of enforcement improve food safety? Is there evidence to support the inclusion of an education component during inspection? What are the best practices for inspection (e.g., frequency, methodologies, results communication)?

Restaurant Inspection Disclosure System

Is posting restaurant inspection results effective in improving food safety? Are there benefits to posting results in a visible location (e.g., restaurant front) vs. online?

Food Handler Training and Education

Is certification of more than one (or all) food service employee(s) effective? What evidence is there to support the certification of food service managers? What evidence is there to support the benefits of on-site educational formats?

Managerial and Engineering Interventions

What evidence supports regulations (e.g., like those in the US) that prohibit bare-hand contact with ready-to-eat foods? What evidence supports engineering interventions in food service establishments? How effective are managerial and engineering interventions in practice (with efficacy demonstrated in research)?

Gaps and Limitations

There is currently limited scientific evidence on the effectiveness of restaurant inspection and education. Overall, restaurant disclosure systems appear to be beneficial in promoting food safety culture among food service establishments. However, results are still inconclusive regarding its actual effect in reducing food-borne illness. Kitchen manager training seems to improve food safety compliance during inspection, while mandatory food handler training policies do not result in any significant improvements in food inspection performance. There is a currently a lack of scientific studies on the effectiveness of engineering and managerial food safety interventions, and while interventions targeting food safety culture appear promising, they remain inconclusive.

Table 1. Inventory of possible food safety intervention policies and examples

Type of Intervention	Examples
Routine inspection	Number of inspection visits and methodologies
Hazard Analysis Critical Control Point (HACCP)	Mandatory creation of a food safety plan and tracking of food safety (use of HACCP)
Risk-based inspection	Inspection frequency based on risk level of premises

Table 1 (continued)

Type of Intervention	Examples
Field reporting technology	Electronic hand-held device for inspection reporting (Columbus, Ohio)
Food handler training	Mandatory food handler certification for staff, certified kitchen manager training
Education during inspection visits	Serving Safe Food Alberta, developing standard operation procedure for establishment
Engineering and equipment use	Mandatory glove use, hand sanitization facilities
Managerial intervention	Sick leave / reporting policies, designated food handling assignments to reduce cross contamination
Inspection results disclosure program	Online database of inspection results, Grade card program (Los Angeles), DineSafe (Toronto), Scores on the Doors (UK)
Award and recognition for hygiene compliance	Elite smiley face (Denmark), Elite star award (Canada Bay, Australia)
Internal quality assurance	Quality assurance program for inspection visits
Outbreak surveillance	Reportable Disease Information System [RDIS] (Ontario), Integrated Public Health Information System [IPHIS] (British Columbia)
Community partnerships	Partnership with ethnic restaurant associations (Columbus, Ohio)

Table 2. Indicators for measuring food safety intervention effectiveness

Indicators Using Hygiene Performance				
Type	**Indicator**	**Source**	**Strengths / Relative ease of use**	**Limitations**
Inspection scores	Raw inspection score	Inspection report	- Readily available from enforcement database	- Cannot be generalized due to regional differences - Raw score alone is not predictive of outbreaks
Violations	Number of cited critical violations in restaurants	Inspection report	- Readily available - Good indication of operation and attitude of management - Most critical violations are better indicators of outbreaks than overall violations	- Classification of violation different across regions - Dependent on inspector observing the violation during inspection (i.e., personal hygiene)

Table 2 (continued)

Indicators Using Hygiene Performance				
Type	**Indicator**	**Source**	**Strengths / Relative ease of use**	**Limitations**
Violations	Difference in number and type of observed violations between restaurants with outbreaks and control (non-outbreak)	Surveillance system & inspection report	- Identify specific factors that interventions need to address	- More used in epidemiology than in intervention studies - Many outbreaks are often misclassified into sporadic cases
Violations	Comparison of the trends (before and after intervention) in contributing factors associated with food-borne outbreaks and cases.	Inspection report	- Readily available from enforcement database - Focuses only on aspects of food safety that are related to foodborne illness	- No standards as to which violations are considered contributing factors - Sometimes not all contributing factors are included in inspection reports
Indicators Using Public Health Outcomes				
Type	**Indicator**	**Source**	**Strengths / Relative ease of use**	**Limitations**
Reported illness	Changes in number of foodborne outbreaks	Surveillance system	Data over long time period often available	- Outbreaks can be attributed to different factors[1] - Lack of specificity and misclassification in outbreak detection[1] - Ecological bias from using aggregate data
Reported illness	Changes in foodborne illness outbreak trends	Surveillance system	- Data include pathogen type for observing individual trends[2] - Can be specified into specific pathogens (i.e., Norovirus, Hepatitis A)	- Measure often confounded by food contamination at production source (i.e., mass outbreaks) - Difficult to attribute to level of training of staff
Reported illness	Comparing establishments having outbreaks based on exposure factor (i.e., intervention, training, policy change)	Surveillance system & inspection report	- Retrospective case control design allows calculation of odds ratios - Require manual abstraction of outbreak data (lack of database)	- Outbreak can be the cause of multiple factors and exposures - Potential selection bias
Reported illness	Changes in reported foodborne illness cases	Surveillance system	- Data is usually accessible - Easy to collect (active reporting and updating)	- High underreporting of cases (sampling bias) - Intervention may alter reporting behaviour

Table 2 (continued)

Indicators Using Public Health Outcomes				
Type	**Indicator**	**Source**	**Strengths / Relative ease of use**	**Limitations**
Reported attitude and reported behaviour	Changes in attitude or behaviour in food safety practice	Research (i.e., survey, focus group)	- Not readily available - Identifies barriers to food safety practices	- Requires extra resources to acquire data - Hard to pool results from different studies due to different variables
Reported attitude/ behaviour	Self-reported perceived changes in food hygiene by inspector, consumer, and/or operator	Research (i.e., survey, interview, focus group)	- Not readily available	- Subjective measures (not generalizable)
Field observation	Investigator's observed changes in food safety practice	Research (tape recordings, field observation)	- Not readily available and difficult to operate - Best at capturing changes in behaviour and practice	- Requires consent from operators and staff (privacy issues) - Announced observations may alter behaviour - Resource intensive to analyze and interpret results - Based on length of observation, may only capture a snapshot of daily operations
Microbiological sampling	Changes in level of foodborne pathogens as a result of intervention	Field samples (from environment and food)	- Requires active sampling; not always conducted during inspections - A more objective, scientific approach than visual inspection	- Resource and labour intensive - Requires large-scale sampling to assess changes in food hygiene[6]
Other	Correlation between the number of foodborne illness outbreaks and the implementation rate of intervention (i.e., % of staff certified, number of annual inspections)	Surveillance system, inspection reports, agency evaluation data	- Allows observation of dose-response relationships - Can sometimes identify saturation point - Not always readily available from enforcement agencies	- May be confounded by interactions with other concurrent interventions - Can only be used for interventions targeting rates of change (i.e., % of workers trained, overall rate of increase in inspection score) - Usually requires a natural experiment setting to become feasible

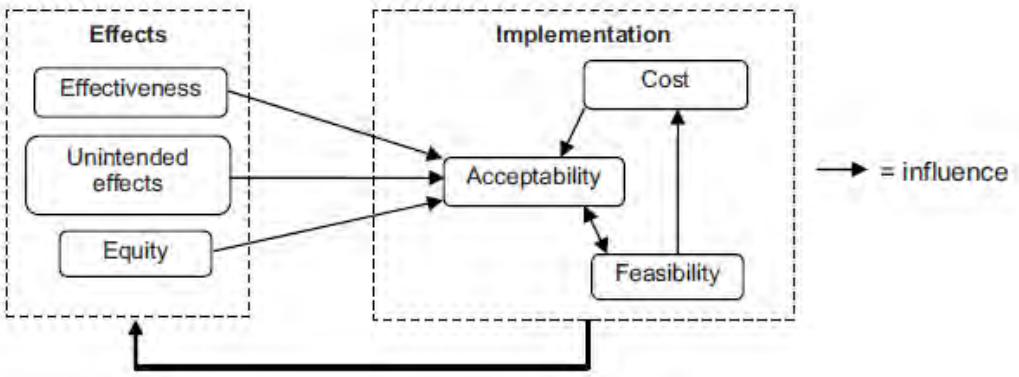

Figure 1. Relationship between the six dimensions for analyzing public policies

Source: Morestin F, Gauvin F-P, Hogue M-C, Benoit F. Method for synthesizing knowledge about public policies. Montreal, QC: National Collaborating Centre for Healthy Public Policy; 2010; http://www.ncchpp.ca/docs/MethodPP_EN.pdf.

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chapter 1

Effect of Routine Inspection on Improving Food Hygiene at Food Service Establishments

Brian Lee

Introduction

Although there is a need for food service establishments (FSE) to comply with food safety regulations, good food hygiene practices and compliance with regulations may sometimes require additional operating expenses; some operators are tempted to downplay food hygiene compliance to maximize revenue.[1] Routine restaurant inspection is a common form of food safety enforcement in developed countries.[2] While substantial resources are often allocated to these programs, the cost effectiveness of routine inspection is often questioned. Food safety education provided during routine inspections is also a primary approach to support safe food handling practices and compliance with regulations at FSEs. However, limited evidence is available on the effectiveness of routine restaurant inspection on reducing foodborne illness. The objective of this chapter is to provide policymakers and enforcement agencies with a review of the benefits and limitations of routine inspection. This document will also present the challenges and evidence gaps that should be addressed in future research.

Background

Enforcement policies are often classified into two major approaches: compliance and deterrence enforcement.[3] The two forms of enforcement are often implemented in combination to maximize food safety compliance. Types of food safety enforcement may range from verbal and written warning to monetary fines and closure. While the traditional enforcement model is based on correcting non-compliance, some health authorities have opted to provide incentives to those who meet food safety standards with recognition or fine exemption.

While inspection protocol varies across health authorities, the inspections are conducted by trained regulatory professionals who validate a FSE's compliance with applicable food safety regulations.[4] Routine inspections are usually unannounced and conducted with some regularity, while follow-up inspections typically occur only when an establishment fails to meet minimum food safety requirements but does not impose immediate food safety risks.[5,6] In addition to monitoring compliance, inspections also serve as an opportunity for food safety promotion and education. Other strategies, including incentives for self-regulation and on-site education, are also employed to improve enforcement efficiency.

Evidence of Food Safety Enforcement in Improving Food Hygiene

Enforcement alone may not improve food safety compliance among small and medium enterprises (SMEs). A UK report suggests that the ineffectiveness might be the result of insufficient guidance on food safety requirements.[7] Yapp (2004) found that this shortcoming could be remedied when enforcement was delivered with educational interventions.[7] Activities such as food hygiene seminars, newsletters, and verbal advice were shown to significantly improve personal hygiene compliance. However, the report suggested that education activities had no effect on structural hygiene compliance, including condition of equipment and

facilities as well as placement of sanitation facilities. The study also found that level of deprivation (i.e., lower socioeconomic status) did not affect food safety compliance.

In Minneapolis, a retrospective cohort study found that pre-announced inspections had food safety benefits for food safety establishments.[8] Reske (2007) observed that routine inspection performance in some aspects of food hygiene (i.e., holding temperature) was significantly better for establishments that previously received announced inspection visits.[8] Announced inspections may also serve to identify particular deficiencies in food safety knowledge among operators. Since operators were more likely to prepare their establishments for an announced inspection, any observed violations cited were possibly unknown to them.[8]

Case Example: Serving Safer Food Alberta (SSFA)

A pilot program in Alberta suggests that the combination of inspector-initiated education and hazard analysis and critical control points (HACCP; for more information, see Food Handler Training Review) may lead to greater food hygiene compliance.[9] Established in 2009 in Edmonton and Calgary, "Serving Safer Food Alberta" is an on-site education and HACCP training program to promote food safety.

Preliminary evaluation results indicate positive program feedback from both operators and public health inspectors.[10]

Limitations of Routine Restaurant Inspection

Routine inspections, although widely adopted around the developed world, suffer from several limitations. The ability of a routine inspection to accurately capture an establishment's level of food safety compliance is limited by financial and human resources. A study in Maryland suggests that a larger workforce of full-time trained inspectors in the health authority may be associated with lower incidence of foodborne illness.[11] Inspections are often effective in identifying and communicating risks to the operators, but they may be less effective in promoting sustained behavioural changes in food safety.[12]

While routine inspections are perceived to be beneficial in reducing sporadic foodborne illnesses, inspection scores may not be strong predictors of outbreaks.[13] Jones (2004) found that the inspection scores of restaurants from which outbreaks occurred were not significantly different from those without outbreaks.[13] The literature also suggests that inspector characteristics (i.e., years of training and experience, their relationship with operators) may influence inspection results.[12,14]

Evidence from microbiological studies suggests that visual inspection scores may be capable of capturing the majority of food safety violations but sometimes fail to detect risks that are only visible on the microbiological level. Tebbutt (1991) failed to find significant associations between visual inspection scores and microbiological end-product and environmental samples.[15] Whereas significant variability in visual inspection was observed between authorities, microbiological scores do not vary significantly.[15] Another similar UK study also found no significant correlation between inspection rating and microbiological level in retail cooked meat products.[16]

The goal of food safety compliance may also be interpreted differently by the regulators and clients. Typically, public health officers encourage food establishments to strive for optimal food safety compliance.[3] However, there is little incentive for businesses to exceed the minimum requirements and maintain them after inspection, especially when no recognition or incentive is given.[17]

Challenges and Evidence Gaps

Assessing the effectiveness of routine inspection is especially difficult due to the lack of available evidence. While research findings are available, studies focus on a particular inspection protocol as opposed to a holistic approach.[18,19] Moreover, evaluation of routine inspection is often conducted internally by local health departments and is not readily available for public and academic access.[20]

The successes of routine food establishment inspections are heavily reliant on meeting the contextual needs of individual health authorities.[21] While there is no perfect system, many jurisdictions experience similar challenges in conducting inspections. The historical, cultural, and judicial contexts especially play an important role in inspection policies and finance. Limited financial resources and high demands may reduce the frequency and educational quality of inspection visits.[4] Partner-ships between researchers and health

authorities / enforcement agencies may facilitate monitoring, evaluation, and research.

Determining the ideal inspection frequency (e.g., number of routine inspections per year) is also difficult due to a number of reasons. The literature does not provide any definitive evidence in increasing inspection frequency beyond one annual visit.[19,22-24] The ideal number of annual inspections may be context specific to each jurisdiction.[2]

Finding an effective indicator for food safety continues to be a challenge for both researchers and public health agencies. While many types of indicators are available, those involved are impaired by a number of limitations. There is a need for future research to improve existing methodologies and determine indicators that are reliable, accurate, and easy to collect.

Conclusions and Recommendations

The lack of evidence in the literature leaves many questions about the effectiveness of food safety enforcement unanswered. Education programs, in conjunction with inspection, appear promising; however, further studies on inspection methods and protocols are required. Inspection programs are heavily context and jurisdiction specific, thus evidence synthesized locally will facilitate practice that is best suited to a region's needs.

To improve practice, local/regional health authorities will need resources to monitor and evaluate food safety inspection protocols and programming. Resource sharing and collaborations between local health authorities and academic researchers may generate new evidence and improve the effectiveness of inspection programs. Cross-jurisdictional comparisons may be improved with resources allocated for the creation and use of common language, datasets, and indicators.

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The Effectiveness of Disclosing Restaurant Inspection Results on Improving Food Safety

Brian Lee

chapter 2

Key Findings

- Four major types of restaurant inspection disclosure programs have been attempted: 1) hard copy disclosure through the local health unit; 2) online disclosure; 3) media disclosure; 4) on-site food premises disclosure.
- Limited evidence is available on the effectiveness of online disclosure for improving food safety.
- The only available study on media disclosure and seven of eight studies on on-site food premises disclosure demonstrate improvements in hygiene compliance.
- In some instances, there was the suggestion that on-site food premises disclosure programs were associated with reduction in foodborne illnesses (but inconclusive) and improved consumer confidence in restaurant safety.
- Overall, owners and operators of food service establishments were receptive to an on-site food premises disclosure program, and a survey of public health units found that the majority were satisfied with cost effectiveness. Unintended effects of on-site food premises disclosure programs were changes in inspector grading behaviour (e.g., tendency to give a higher grade when compliance scores were borderline) and an increase in self-reported foodborne illness cases.
- Evaluation of disclosure programs is difficult due to the lack of clear indicators of program success and due to the effects from other interventions that can mask the effect of the disclosure program.
- There is a need for research to examine the “best practices” for on-site disclosure both in terms of content of the display and placement and a need to examine the effectiveness of disclosure programs in rural settings.
- Consultation with stakeholders prior to implementation is vital for the success of a disclosure program in improving food safety.

Introduction

Consumer confidence in dining safety is heavily based on its trust in government enforcement and regulations.[1] Media investigations in Los Angeles and Toronto revealed poor restaurant hygiene compliance and lack of follow-up enforcement.[2] The resulting public outrage prompted the implementation of disclosure programs. Disclosure programs provide summarized restaurant hygiene reports for easy public access and improve transparency of hygiene enforcement among food service establishments (FSEs). Ultimately, disclosure programs aim to reduce foodborne illness among consumers by providing the necessary restaurant hygiene information so they can make informed dining choices.[3]

The effectiveness of restaurant disclosure systems has not been thoroughly and collectively assessed. While some on-site disclosure programs report public health successes and public support,[4,5] some health authorities question the program’s applicability to other health regions.[6-8] Stakeholders are also concerned with issues of program implementation. To assess the effectiveness and feasibility of disclosure systems, this chapter was guided by a policy analysis tool proposed by the National Collaborating Centre

for Healthy Public Policy. The tool considers effectiveness, unintended consequences, equity, acceptability, cost, feasibility of implementation, and ultimately the influence of the policy.

Background of Disclosure Programs

The role of restaurant inspection disclosure systems is to inform members of the public about the results of food safety inspections. Restaurant inspection disclosure programs often involve five major stakeholder groups: the enforcement body (often a public health authority), the food establishment, the consumer, the media, and various lobbying groups.

Disclosure of routine inspection results may occur through any combination of four different channels: 1) hard copy obtained or reported through local health authorities; 2) online through internet sites; 3) summary through the news media; and 4) on-site display in food premises.[9] On-site disclosure utilizes different display formats including letter grade, color-codes, star-grades, and smiley face systems (see Table 1).

Methods

A literature search of both peer-reviewed sources and grey literature was conducted up to July 10, 2012 on Web of Science, Science Direct, Academic Search Premier, and Google Scholar. Keywords used in the search can be found in Appendix A. Existing evidence on the effectiveness of restaurant inspection disclosure systems was compiled using this selection criterion: the retrieved document must be either a full/summarized evaluation report or study that examined the effectiveness of any restaurant inspection disclosure system as a food safety intervention. Based on the NCCHPP public policy analysis framework, a logic model was constructed in this chapter (Figure 1) to describe the intermediate and ultimate outcomes as well as their corresponding outcome indicators.[10]

Results and Discussion

The literature search retrieved 14 documents that matched the selection criterion. Eight articles were retrieved from peer-review journals and five from grey literature sources. No article on the effectiveness of local health authority disclosure programs was found, while one peer-reviewed study examined the public health effects of disclosure through the media and online respectively.[11,12]

Online Disclosure

The Salt Lake Valley Health Department (2012) evaluated the effectiveness of its implementation of a restaurant inspection website on reducing critical food-borne illness risk factors in 2009.[12] The health department found that increased public interest led to improvements in restaurant inspection scores.[12] Operators also became more proactive in training their staff to reduce foodborne illness risk factors; two major restaurant chains located within the health authority requested meetings with the health department to improve their inspection performance.

Media Disclosure

In the only study on media disclosure, Almanza (2002) indicated that overall inspection scores significantly improved when inspection results were disclosed through the media.[11] Average inspection scores among Tippecanoe County food premises rose after inspection scores were reported twice per week in the local newspaper.[11] Moreover, the number of inspection-related complaints significantly decreased after the disclosure system was implemented.

On-Site Disclosure

Inspection Performance on Hygiene Compliance

All five studies that examined inspection scores observed improvements after disclosure programs were implemented[13-17]; improvements as high as 15% in inspection scores were seen on the first set of routine inspections after the program started.[16] After the introduction of Scores on the Doors, a national on-site disclosure program in the UK, score improvements were generally higher for previously poor-performing premises[16]; however, some well-performing food premises experienced deterioration in scores.[16] In another study in Toronto, rates of both critical and non-critical hygiene violations also appeared to decrease as a result of on-site disclosure programs in Toronto.[8] In Denmark, Toronto, New York, and Los Angeles, the percentage of establishments that complied with inspection

requirements also increased significantly (see Appendix B for examples of disclosure program visual displays).[3,14,17,18] After 18 months of implementing its disclosure system, the City of New York observed decreases in major food safety violations including those related to the presence of rodents and inadequate food holding temperature.[17] Premises in Toronto that received cautionary conditional passes (yellow signs) experienced greater improvements in food handling practices than those with passing scores (green signs).[3] Jin (2009) found that higher income neighbourhoods in Los Angeles demonstrated greater hygiene improvements compared to lower income neighbourhoods.[15]

A study in Norwich, UK, indicated no significant difference in hygiene scores between the pre-disclosure program and the first visit after implementation.[19] However, the author suggested a potential lag effect, as significant improvements in hygiene scores were found during second inspection visits. Two studies explored the difference between voluntary and mandatory on-site disclosure systems. Jin (2003) did not observe any difference in inspection scores, but the author commented that the results may be biased due to impending transition to mandatory disclosure.[14]

Public Health Outcomes

There were only two studies found that considered the effects of on-site disclosure on food safety. Simon (2005) found that the foodborne illness-related hospitalization rate in Los Angeles County decreased for three consecutive years (an average of 13.1% annually) after the grade card system was introduced.[20] Similarly, the City of New York, compared to its previous year, observed a 14% reduction (175 cases) in reported *Salmonella* cases in 2011;[17] this reduction was found to be much greater compared to its neighbouring health regions. (Incidence rates of other types of foodborne illness were not reported.) However, critics of Simon's study argued that the benefits may be overestimated due to potential biases and confounders regarding the classification of foodborne related hospitalization cases and background improvements in food hygiene.[21] On the contrary, the City of Toronto observed a 40% increase in reported foodborne illness cases after its disclosure program was introduced.[22] Average annual reported cases increased primarily due to a 400% increase in self-reported general food poisoning. Nevertheless, significant reductions were shown in more severe foodborne illnesses including *Salmonellosi*s, Hepatitis A, and Verotoxin-Producing *E. coli*.[22] Serapiglia (2007) proposed that the increase in reported food poisoning cases in Toronto was partly attributed to increased public awareness.[22]

Capacity, Acceptability, and Equity

Most health authorities from the UK found the costs of the disclosure scheme acceptable.[16] Aside from program development costs, 36 out of the 46 health authorities surveyed (78%) experienced no additional increases in operational costs.[16] Public health inspectors in Toronto, New York, and the UK expressed that improvements in food hygiene compliance led to decreases in re-inspections.[3,16,17] However, some UK local authorities found that additional time and resources devoted to the disclosure system hampered enforcement efforts in other (unspecified) important areas of food hygiene.[16]

Based on local evaluation reports, the stakeholders of disclosure programs generally expressed positive feedback.[3,16] Local health authorities reported that increased public attention and transparency led to positive engagement between inspectors and FSEs.[13] Survey results also suggested that most restaurant operators in the UK, Toronto, and Denmark supported disclosure programs.[3,16,23] The Scores on the Door disclosure scheme in the UK elevated staff morale and increased their food hygiene awareness.[6]

Restaurant operators and consumers in New Zealand preferred the letter grade system over a gauge system in terms of communicating accurate and interesting results to the public (Figure 2).[24] Whereas businesses tend to favour schemes with more grade levels, the general public prefers ones with fewer scoring categories.[16] Consumers in Toronto indicated that posted inspection grade cards were their primary resource for food premises hygiene information.[3] Los Angeles also found that its grade card system is the most recognized program in its department of public health.[4] Surveys conducted by local authorities in Los Angeles, Toronto, and Denmark reported continual increases in consumer confidence after disclosure programs were implemented. The vast majority of consumers in Los Angeles (91%), Denmark (94%), and Toronto (97%) expressed interest in maintaining their disclosure programs.[3,16,23]

Owners of FSEs expressed that improvements should be made to accommodate different food service types (e.g., sit-in restaurants vs. mobile food carts).[16] Toronto restaurant operators also

commented that the conditional pass (yellow sign) was not well understood by the public.[3] Beyond a color grade, the Toronto's Dinesafe display cards did not provide details about restaurant hygiene, including frequency, magnitude, and nature of hygiene infractions.

Unintended Effects

Initially, some operators worried that disclosure programs might yield negative economic consequences.[16] However, in some cases, the launch of disclosure systems appeared to have some economic benefit for the restaurant industry. While most FSEs were unaffected, approximately 20% of the restaurant owners reported increases in sales.[3] The City of New York reported a 9.3% increase in restaurant revenue, compared to the 2.1% and 2.7% increase observed in the previous two years, due to improved consumer confidence.[25] Jin (2003) discovered that restaurant revenue in Los Angeles was independent of hygiene performance until disclosure systems were introduced.

Jin (2009) found that franchise restaurants experienced significant improvements in hygiene performance due to the elimination of reputation free-riding (i.e., when a franchise restaurant's reputation is based more on its parent company than its individual performance).[15] Disclosure system implementation was also associated with rare cases of illicit behaviour. The economic incentives of high hygiene grades motivated some premises to post fraudulent grade cards and, in some cases, conceal their visual displays from potential customers (Appendix C).[26,27]

Jin (2003) also observed changes in inspection grading patterns as a result of disclosure systems. Inspection scores spiked at grade cut-offs after disclosure systems were introduced (Figure 3). It was suggested that inspectors may be more inclined to give the higher grade when a FSE score was near cut-offs due to the perceived economic and reputation consequences.[14] As a result, the grade that appeared on scorecards may not truly reflect the restaurant's level of hygiene compliance.

Limitations

One of the major challenges in evaluating foodborne illness intervention is the lack of reliable indicators for measuring the effectiveness of food safety interventions. Although both hygiene and health outcome indicators are utilized during evaluation, all indicators have inherent limitations.[28] For instance, some indicators are influenced by local inspection protocols and cannot be generalized to other health authorities.[27] Inspection protocol and scoring schemes vary across jurisdictions which increases difficulty in comparing results.[29,30] Although the level of public awareness or engagement was considered, this was not taken into account. For instance, local program evaluations on the disclosure program in the UK reported high public approval, but public awareness on the program was low.[16]

Disclosure programs were commonly paired with other changes in food safety enforcement practices.[3,14] The interaction between food safety interventions can potentially lead to a misrepresentation of the effects of disclosure systems. External factors such as food safety improvements in technology and hygiene policies confounded the studies' findings.[31,32] Arthur (2009) suggested that such background improvements in food safety might explain a proportion of food safety improvements attributed to disclosure systems.

Evidence Gaps

Future research and program evaluations on disclosure systems should incorporate different combinations of food safety indicators to measure program success. There is a need to disentangle the interactive effects between food safety interventions. There is also limited evidence regarding changes in enforcement behaviour as a result of disclosure systems. Previous studies had explored business and consumer preferences on display designs and grading schemes.[33] However, there is insufficient evidence on best practices for disclosure program implementation. Furthermore, the feasibility and effectiveness of disclosure systems in non-metropolitan communities has not yet been explored. While disclosure through online databases is becoming a standard practice for communication of inspection results, evidence of its effectiveness is not available.

Conclusions and Recommendations

Although there is no definitive evidence on the success of disclosure programs in reducing foodborne illness, most studies suggest that posting inspections in food service establishments results in improved food hygiene awareness, practice, and

compliance as well as positive engagement and communication between food safety regulators and operators. Further research is needed to determine what conditions involving restaurant disclosure can result in improved food safety. In particular, there is a lack of information on equity considerations and comparative cost effectiveness of the programs.

Accurate record keeping, monitoring, and evaluation of programs and policies will help determine which combination of intervention strategies will best fit the particular context of a regional authority to enhance effectiveness and efficiency and improve food safety.

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Table 1. Overview of the major types of restaurant inspection disclosure schemes

Disclosure System	Inspection Scheme	Grading Scheme	Program Scheme
Letter Grade Card System[13] Examples: Los Angeles (1998) New York (2010) Singapore (1997)	LA: Demerit system (top score = 100) Point deduction based on number and severity of violation(s)[29] NY: Merit system (top score = 0) Point addition based on number and severity of violation(s)	LA: Categorize scores into letter grades (A, B, C) and scores below 70 are displayed numerically NY: Categorize scores based on grade	Supplementary full inspection report available online 24-hour hotline to receive public complaints on establishments
Color-coded System[30] Examples: Toronto (2001) Sacramento (2003)	Infraction-based system Based on presence and severity of infraction(s) (minor, significant, critical)	Color based on presence and severity of infraction Green (Pass), Yellow (Conditional Pass), Red (Conditional Pass or Closure)	Supplementary full inspection report available online Re-inspection within 24-48 hours for yellow rating
Star System[16,34] Example: Canada Bay [AU] Norwich [UK]	UK: Merit system (top score = 0) Point addition based on number and severity of violation(s)	UK: number of stars based on point score; highest grade varies across region (3 or 5 stars) Canada Bay: 5-star grade system based on fulfilment of star grade requirements	Canada Bay - online posting of rating only - voluntary display of certificate which outlines basic principles for achieving the assigned grade
Smiley Face System[23] Example: Denmark (2001)	4-point scoring system for each violation category (top score = 1) Only worst score for each category is recorded	Smiley grade based on the worst category score from the inspection Elite smiley face awarded for outstanding businesses	Re-inspection required if happy smiley is not achieved, at the expense of the owner Supplementary full inspection report available online

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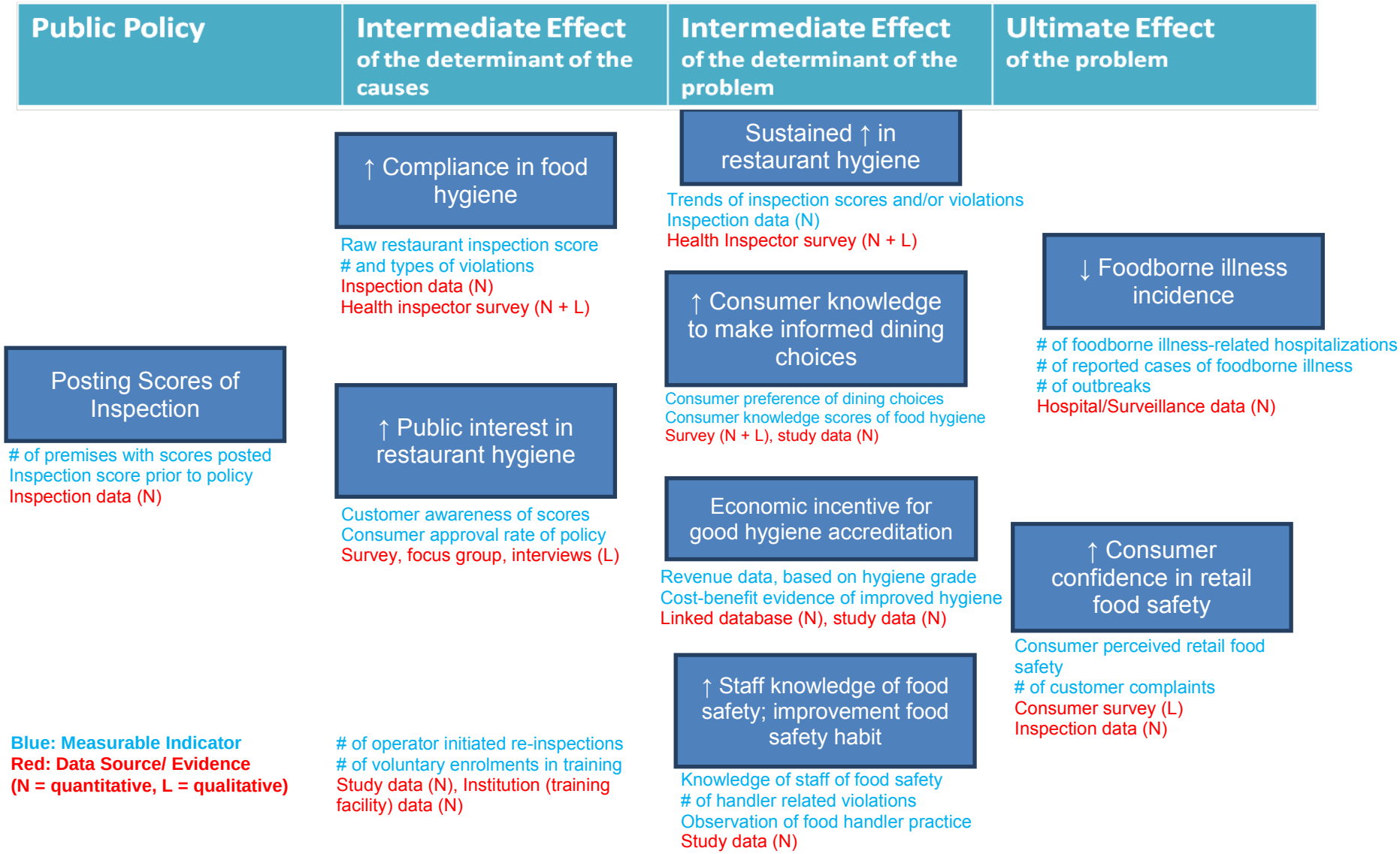
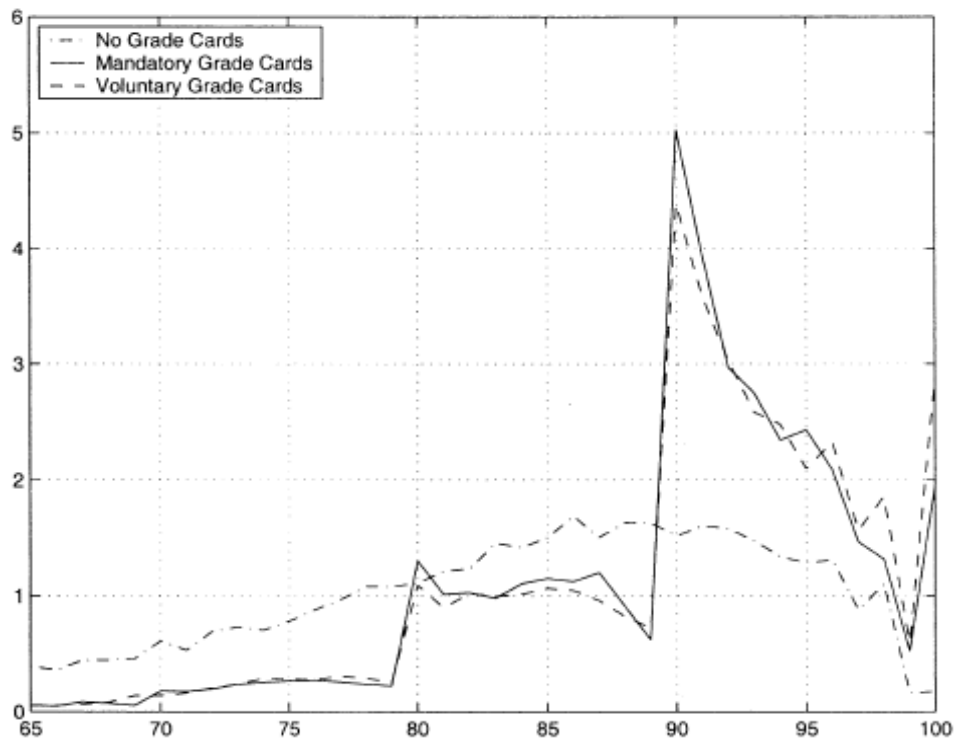


Figure 1. Logic model for disclosure system's effect on food safety

Figure 2. Examples of restaurant hygiene disclosure cards using a letter grade (left) and gauge (right) scoring system

Source: Fillion K, Powell DA. Designing a national restaurant inspection disclosure system for New Zealand. J Food Prot. 2011;74(11):1869-74.



Distributions of Hygiene Scores under Different Disclosure Regimes
The figure is no different from a histogram (or an unsmoothed nonparametric density). Units on the vertical axis are meaningless.

Figure 3a. Impact of on-site disclosure system on inspection score distribution

Source: Jin GZ, Leslie P. The Effect of Information on Product Quality: Evidence from restaurant hygiene grade cards. Q J Econ. 2003;118(2):409-51*

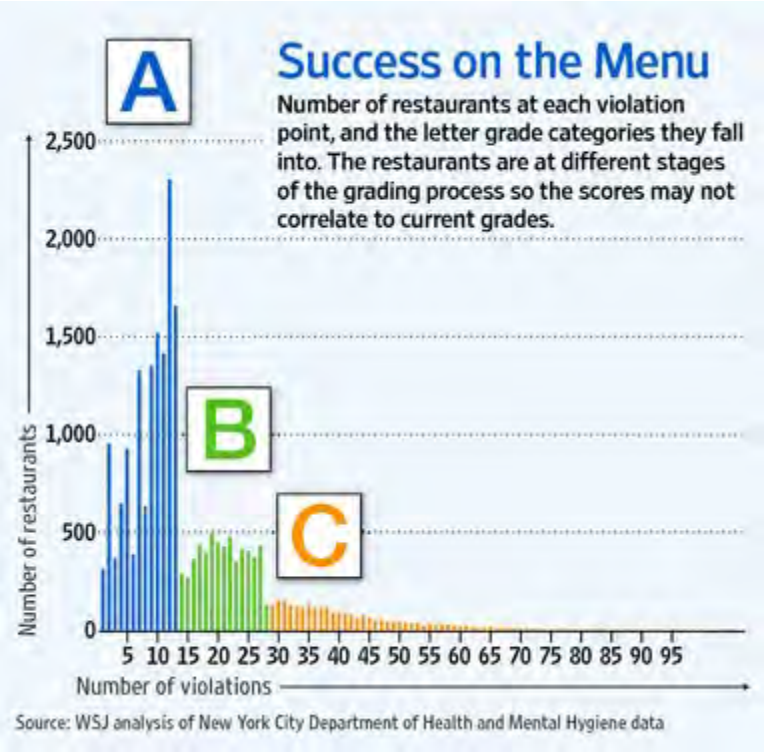


Figure 3b. Distribution of inspection scores after a grade card system was introduced in New York

Source: Reddy, S, Schellmann, H. Many eatery high marks are close call. Wall Street Journal. 2011 Jul 15;. http://online.wsj.com/article/SB10001424053111904888304576472323664531488.html.

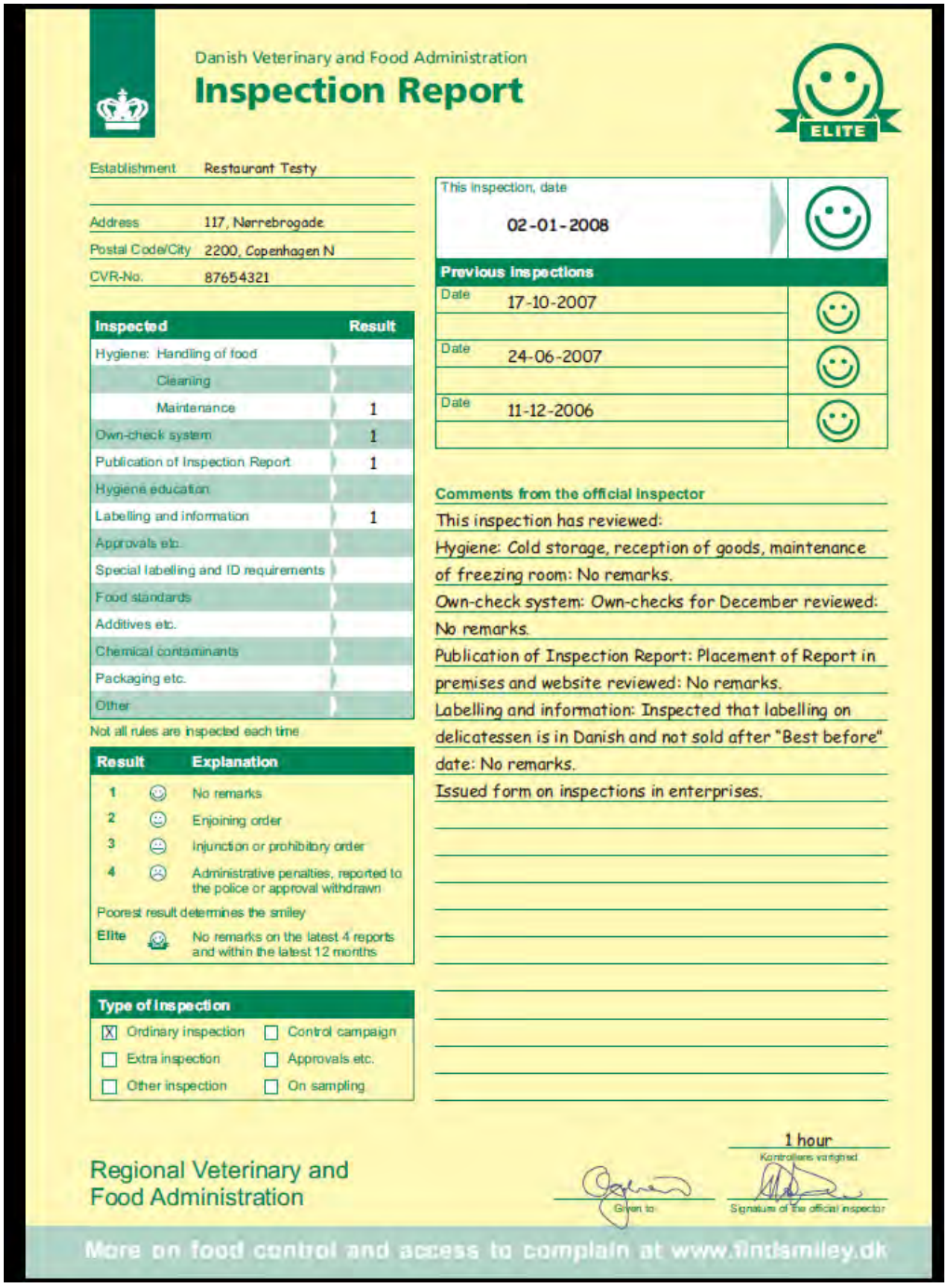
Appendix A: Search Terms

("Food Safety" OR "Food Hygiene" OR "Restaurant Intervention" OR "Restaurant Program") OR ("Food Service Establishment" AND ["Safety" OR "Hygiene" OR "Intervention"]) OR ("Kitchen" AND ["Hygiene" OR "Safety" OR "Intervention"])

AND

("Disclosure" OR "Disclose" OR "Score" OR "Grade" OR "Grading" OR "Grade card" OR "Letter Grade" OR "Hygiene Award" OR "Color Code" OR "Smiley" OR "Online") OR ("Inspection" AND ["Distinction" OR "Recognition" OR "Award" OR "Star" OR "Reward" OR "Color" OR "Media" OR "Newspaper" OR "Magazine" OR "radio" OR "Television"])

Appendix B: Examples of Disclosure Program Visual Displays



Danish Veterinary and Food Administration

Inspection Report

ELITE

Establishment: Restaurant Testy

Address: 117, Nørrebrogade

Postal Code/City: 2200, Copenhagen N

CVR-No.: 87654321

This inspection, date: 02-01-2008

Previous inspections

Date: 17-10-2007

Date: 24-06-2007

Date: 11-12-2006

Inspected	Result
Hygiene: Handling of food	
Cleaning	
Maintenance	1
Own-check system	1
Publication of Inspection Report	1
Hygiene education	
Labelling and information	1
Approvals etc.	
Special labelling and ID requirements	
Food standards	
Additives etc.	
Chemical contaminants	
Packaging etc.	
Other	

Not all rules are inspected each time

Result	Explanation
1	No remarks
2	Enjoining order
3	Injunction or prohibitory order
4	Administrative penalties, reported to the police or approval withdrawn

Poorest result determines the smiley

Elite: No remarks on the latest 4 reports and within the latest 12 months

Type of inspection

- [X] Ordinary inspection
- [ ] Control campaign
- [ ] Extra inspection
- [ ] Approvals etc.
- [ ] Other inspection
- [ ] On sampling

Comments from the official inspector

This inspection has reviewed:
Hygiene: Cold storage, reception of goods, maintenance of freezing room: No remarks.
Own-check system: Own-checks for December reviewed: No remarks.
Publication of Inspection Report: Placement of Report in premises and website reviewed: No remarks.
Labelling and information: Inspected that labelling on delicatessen is in Danish and not sold after "Best before" date: No remarks.
Issued form on inspections in enterprises.

1 hour

Kontrollens varighed

Given to:

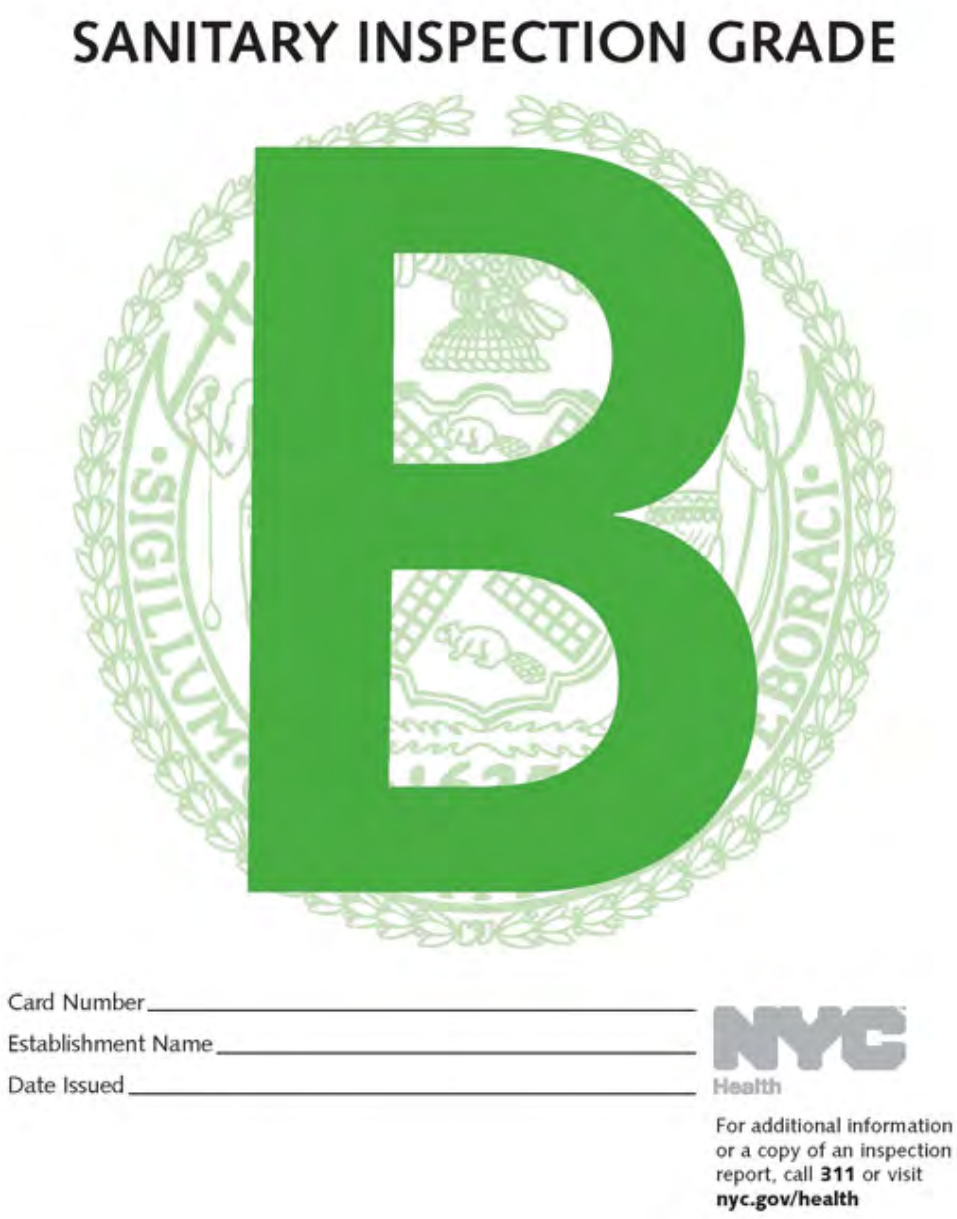
Signature of the official inspector

Regional Veterinary and Food Administration

More on food control and access to complain at www.findsmiley.dk

Denmark's Smiley System

Source: Ministry of Food Agriculture and Fisheries: Danish Veterinary and Food Administration. Smileys keep food safety high in Denmark. Glostrup,



New York's Grade Card System

Source: WNYC Radio, http://parmenides.wnyc.org/media/photologue/photos/Grade%20Card_B_v2.jpg

Toronto's DineSafe Disclosure System

Source: City of Toronto,
http://www.toronto.ca/health/dinesafe/images/notice_conditional.png

Appendix C: Examples of How Restaurants Attempt to Conceal Their Inspection Grades

Source: Swalec A. Poor health grades hidden by some Greenwich Village restaurants. DNAinfocom: Manhattan Local News. 2011 Aug 15. http://www.dnainfo.com/new-york/20110815/greenwich-village-soho/poor-health-grades-hidden-by-some-west-village-restaurants-dnainfo-finds.

Source: Johnston G. DOH Fines 804 restaurants for hiding their grades. Gothamist. 2011 Jun 15; http://gothamist.com/2011/06/15/doh_fines_804_restaurants_for_hidin.php

chapter 3

The Effectiveness of Specific Food Handler Training Programs on Improving Food Safety

Brian Lee

Key Findings

- Evidence regarding the effectiveness of mandatory food handler and manager training programs is inconclusive. Training of all food handlers in a food service establishment may lead to both improvement and regression in different areas of food safety. In addition, training cost is a major barrier to implementing kitchen manager training and mandatory food handler training policies.
- Public health professionals should not disregard mandatory food handler training policies entirely as existing study findings are compromised by a variety of limitations and methodological issues.
- HACCP-based interventions, once implemented, appear to be effective at reducing the risk of foodborne illness at food service establishments, although there are cost considerations especially for small- and medium-sized businesses.
- On-site and demonstrative methods for food handler training are well accepted among inspectors and food handlers, but evidence of effectiveness is inconclusive and limited.
- Rather than focusing only on food handler training, program planners must also invest in strategies that encourage a food safety culture among food service establishments.
- Future studies should develop and evaluate new approaches to investigate potential interventions that translate food safety knowledge into sustained food hygiene compliance.

Introduction

Lack of food safety knowledge among food handlers is often cited as a major barrier to food safety compliance.[1-3] Prior to the establishment of formal food handler training programs, job experience and mentorship were major sources of food safety knowledge.[4] While many larger, corporate food service establishments (FSEs) provided systematic training,[5] most staff in smaller establishments did not receive formal food safety education upon employment.[3] To address this deficiency, some regional authorities implemented mandatory food safety training policies for kitchen managers and staff.

Food handler training programs aim to educate participants on basic food safety knowledge and food hygiene practices. Training curricula often include the basic epidemiology of foodborne illnesses; information regarding foodborne pathogens, time and temperature control for specific hazardous ingredients, safe handling and storage of food, and proper sanitation; and an introduction to Hazard analysis Critical Control Point (HACCP).[6] Certified training is offered either by government affiliated agencies (i.e., FoodSafe in BC and Yukon) or accredited private institutions (i.e., ServSafe in the US). Many chain and franchise food service establishments incorporate food hygiene education as a component of their standard job training.[7]

In Canada and the United States, food handler training regulations often differ among regional authorities. Some jurisdictions require establishments to employ at least one trained/certified staff to be present at all times, whereas other regions do not; the staff is usually, but not necessarily, in a supervisory role.[8-12] In order to become certified, the applicant must pass a certification exam that is approved by the local health authority. A summary of current food handler training requirements in Canada can be found in Table 1. Currently, no health authority in Canada requires mandatory food handler training for all food handlers in FSEs. In the US, the states of Florida, South Dakota, and Washington require some type of food safety certification for all food handlers (e.g., ServSafe training).[11,12] While some jurisdictions only require one-time certification, some require recertification every three to five years.[8] Some US health authorities require additional food safety training for food handlers in supervisory roles.[12] Food handler certification varies in cost, from approximately $30 to more than $100 dollars.[8,12,13] Most programs involve a one to two day workshop or face-to-face lecture, but self-directed online training is also available in some jurisdictions at a reduced cost.[14]

On-site or demonstrative food handler training is sometimes offered in a kitchen setting. The trainer often provides training using hands-on demonstration of safe food handling procedures.[15] The students are then asked to replicate such procedures and receive feedback from the instructor. Due to the extra time and student-instructor interaction required, the student-to-teacher ratio in these classes is typically much lower than lecture-based classes.

Overall Effectiveness of Food Handler Training

A review conducted by the Region of Peel Public Health suggests that evidence of a benefit from mandatory or voluntary food handler training is insufficient.[16] However, the authors recommend ongoing monitoring of food safety training activity and pertinent literature for future consideration. Another review conducted by Egan et al. (2007) on food handler training effectiveness indicates that although food handler training appears effective, the authors suggest that current evidence is inconclusive due to study limitations.[6] Seaman and Eves (2010) interviewed food handlers, managers, and training providers on their perception of food handler training. Despite understanding the benefits of food handler training, few managers encourage employees to get training and only 60% actively support hygiene improvements proposed by trained employees.[17] In addition, the effectiveness of certified kitchen manager (CKM) training in food safety is often debated due to conflicting evidence in the literature published from 1980 to 1990.[18,19]

Purpose

The existing reviews mentioned above do not exclusively review the effectiveness of training programs in which food handler training is required of all food handlers. To our knowledge, there are also no recent reviews on effectiveness of certified kitchen manager training, HACCP programs, and on-site demonstrative food handler training. Therefore, the purpose of this chapter is to determine the effectiveness of food handler training by reviewing studies where data is based upon settings where food handler training is required for all food handlers and also for CKM training, the HACCP program, and demonstrative training as food safety interventions for FSEs.

Methods

A literature search of both peer-reviewed and grey literature was conducted up to July 10, 2012 on Web of Science, Science Direct, Academic Search Premier, Ingenta and Google Scholar. Public search engines including Google and Bing were also used. Keywords used in the search can be found in Appendix A. The literature search did not include any date exclusion.

Articles were included in this chapter based on the following selection criterion: the study must evaluate the effectiveness of mandatory food handler training for all food handlers, CKM training, HACCP program, or demonstrative training as a food safety intervention for FSEs. The references of the retrieved documents were reviewed to identify potential articles that were not captured during the literature scan. This review does not address knowledge retention and benefits of recertification, which are discussed elsewhere.[20,21]

Our analysis considered quantitative evidence such as changes in inspection scores and foodborne illness incidence rates, and qualitative evidence such as program acceptability and perceived effectiveness by stakeholders. Limitations of the studies included in this review are also discussed. Criteria including presence

of unexplained confounders, sample size, study period, study design, availability of compliance data, and research findings were used.

Results and Discussion

The nineteen peer reviewed articles matched the inclusion criteria and no grey literature documents were included (Table 2). Six of the articles were intervention studies on mandatory food handler training for all food handlers and seven articles examined effectiveness of manager certification programs. With the exception of Noble (2009),[22] all studies were conducted outside Canada (US, Spain, and the UK). Four articles were included for evaluating HACCP programs. One article and one graduate thesis regarding on-site/demonstrative food handler training was also included.

Effectiveness of Mandatory Food Handler Training

Three of six studies demonstrated a reduction in food safety noncompliance as a result of implementing mandatory food handler training. In one study, Kansas state health officials issued mandatory training through multiple phases during which 30%, 60%, and 90% of food service establishment employees must undergo food handler training.[11] There was a decrease in the number of critical violations after the implementation of the food handler training program, but a greater improvement was observed in structural violations (i.e., placement of hand washing sinks or the adequacy of plumbing) that are presumed not to be directly related to food handler behaviour.[11] Similarly, Noble et al. (2009) observed a significantly lower number of food safety infractions per inspection visit for a pizza chain in the City of Toronto after implementing mandatory food handler training.[22] Restaurants in Florida also experienced a decrease in food safety critical violations in bare-hand food handling, storage in contaminated environments, raw cooked food, and liquid/semi-solid mix of potential hazardous foods.[10] However, in the same study, there was also an increase in critical violations for temperature-holding.

Murphy et al. (2011) took an indirect assessment approach by comparing hygiene performance of independent restaurants with that of chain establishments.[23] It was assumed that FSEs that are part of restaurant chains have higher standards in food hygiene and that implementing mandatory food handler training would allow independent FSEs to have similar standards for food hygiene. However, results suggest that independent restaurants still have significantly more critical violations after mandatory training when compared to larger chains.[23] Another study that compared mandatory training for all food handlers, versus training for shift managers only, did not find significant differences in hygiene performance[24]; the group that had mandatory training for all food handlers was only more compliant with 5 of the 31 food hygiene criteria being observed.

Only one study used foodborne outbreak rates to assess the effectiveness of mandatory food handler training; Hammond et al. (2005) reported a decrease in the average number of annual foodborne outbreaks (250 to 194) and total annual cases of foodborne illness (1,413/yr to 1,194/yr).[10] Nevertheless, the authors also cautioned that overall improvement in food safety enforcement and technology might have led to an overestimated study result.

Effectiveness of Certified Kitchen Manager Training

In addition to the curriculum offered in basic food handler training, certified manager training also includes information on HACCP plan implementation as well as management strategies to monitor and maintain food hygiene (e.g., cleaning rosters, temperature log, food safety plan).[25] Compared to food handler training, certified manager training is perceived by some regional authorities to provide greater impact on restaurant hygiene.[6] Since managers tend to have influence on the food hygiene behaviour of their employees, staff are more likely to exercise proper food hygiene practices if such actions are enforced and encouraged by management.[23] Improving the food safety knowledge of managers is believed to have a positive impact on the establishment's food safety culture.[26]

Four of seven studies found that restaurants with a certified kitchen manager present during inspection have improved inspection performance and lowered odds of critical violations.[19,26-28] Cotterchio et al. (1998) suggests that hygiene improvements are greater in the groups in which manager training is mandatory.[28] However, the authors noted that study subjects who were enrolled in mandatory training would face enforcement consequences for subsequent non-compliant inspection. Hence, they may have been more motivated to improve their food hygiene than the control group.

A study in 1986 suggested that manager training was ineffective in improving inspection scores.[18] However, as noted by the author, a low, differential participation rate and a biased sample might have confounded the study results. Furthermore, the largest study on this topic, conducted in eight US states, reported no significant difference between inspection scores of food premises that had certified managers (90.67) and those without certified managers (89.77).[29]

Effectiveness of FSE-Based HACCP Programs

The HACCP system is adopted by food production and processing industries to systematically minimize foodborne illness risks. Based on seven guiding principles, a HACCP plan identifies steps in the food handling process that are critical to ensuring food safety and provides controls to maximize food safety.[4] HACCP policies encourage establishments to assess their food handling procedures and to monitor them on a regular basis.[30]

HACCP programs for the food service industry are still in developmental stages and limited evidence is available regarding their effectiveness for food safety. Soriano et al. (2002) found a lower incidence of contaminated retail food products after HACCP policies were introduced in Valencia, Spain.[31] Similarly, Cenci-Goga et al. (2005) examined the effectiveness of HACCP programs on a Spanish university restaurant.[32] A significant reduction in the incidence of *S. aureus, E. coli, and B. cereus* was observed after a HACCP system was implemented.[32]

The implementation of HACCP in the food service industry comes with various challenges.[4] A study in South East England found that kitchen managers view existing HACCP programs as overly complicated and burdensome for food service employees. The high demand for documentation and food safety knowledge may deter HACCP plan compliance. Managers agreed that HACCP programs were effective in improving kitchen food safety, but successes are dependent on employee culture.[4] The cost of a HACCP program is thought to be small but inequitably distributed. Smaller establishments may need to invest relatively more resources on new monitoring equipment and experience greater labour loss due to the need for additional staff training. Almanza et al. (1998) evaluated the time and cost associated with implementing a HACCP system in a grill-type food service establishment.[33] The study found that approximately 29 minutes were required to complete a HACCP checklist. Based on a model of four routine HACCP checks per day, a food establishment would spend $6,697 per year in labour costs (data from 1998) to maintain and comply with HACCP standards.[33]

Effectiveness of On-Site or Demonstrative Training

Two studies on demonstrative training did not report significant improvements in inspection performance. Both studies compared food safety knowledge and inspection performance between food handlers who received demonstrative training (treatment) and a control group. In a study in Salt Lake County, health inspectors provided demonstrative training to kitchen managers immediately after routine inspection to amend any observed critical violations.[34] DeLegge (2009) found that while both treatment and control groups demonstrated improvements in subsequent inspections, no significant differences in improvement were observed between the groups.[34] In a similar study in Winnipeg, on-site training was offered to food handlers of a temporary food-service event.[15] Mancini et al. (2012) did not observe any statistical significance in food inspection scores between pavilions whose food handlers received on-site food safety training and those without on-site food safety training.[15] However, the author suggests that this was due primarily to small sample size and limited power in

Case Example: Train-the-Trainer Method for Food Handler Training

The "Train-the-Trainer" method has been adopted by business corporations in an effort to provide cost-effective education and training to staff. Employees with supervisory or management roles are first trained in course content and provided with the necessary training skills to relay the acquired knowledge to their subordinates.[35] The resulting "new" trainers continue to train others and are more inclined to take ownership of the initiative to promote sustainable changes to the organizational culture.[36] In some retail corporations, trained front-line staff are evaluated based on their deliverables to assess the effectiveness of training. Since their trainers can be identified, specific interventions can be made to correct potential shortcomings.[35]

Martin and Hrivnak (1999) examined the effectiveness of using the train-the-trainer method for HACCP education and observed significant improvements in food hygiene practice. More than half of the participating food service managers noted that they conducted HACCP training to employees because of the train-the-trainer program.[37] Similarly, in a study on occupational safety training, Stokols et al. (2001) indicated that firms that adopted a train-the-trainer method were associated with higher levels of regulatory compliance compared to those employing conventional training methods.[38]

the study. Nevertheless, all workers who received on-site training were in favour of this mode of training and recommended that all workers receive on-site food safety training.

Acceptability, Cost, and Equity of Food Handler Training

To assess the potential impact of mandatory food handler training policies, we reviewed evidence for the four major policy realms: effectiveness, acceptability, cost, and applicability. A list of stakeholders of food handler training programs, as well as their perceived benefits, costs, and any unintended effects is shown on Table 3. No direct evidence was available on the acceptability, cost effectiveness, and equity of food handler training programs. Barriers to food safety compliance have been documented and while mandatory training bears minimal cost to enforcement, there are barriers to implementing and regulating training programs and accrediting training agencies.[39] Wright and Feun (1986) found that the cost of training could be a major barrier to participation by FSEs.[18] The restaurant and/or its staff are required to bear all or most of the financial responsibilities. In cases where certification is mandatory, the financial burden was greater in independent restaurants compared to franchise establishments.[24] Restaurants with high employee turnover need to continually invest resources to train new staff, resulting in additional training costs and loss of productivity.[24] Operators have perceived that manager training is the most efficient approach for food safety education, but cost-benefit evidence is not currently available.[10]

Unintended Effects

As a result of the mandatory certification policy in Florida, the high demand for training facilitated changes in program implementation. Lecture-style training was shortened to four hours but retained a 75% passing rate.[12] However, this shift in curriculum led to a reduction in interactive exercises.[27] To increase accessibility, the state contracted out training programs to private institutions. Restaurant associations were usually in charge of operating training programs and offered enrolment discounts to member establishments.[12] Most restaurant associations generated profit from the training and a portion of the revenue is reinvested into improving the training programs.

Although many fast food chains in the US have implemented stricter food safety policies and training programs, their impact on foodborne illness risk prevention is limited. For example, an undercover investigation by the media revealed that most fast food chains had more than one observable critical food safety violation per FSE.[40] Based on MSNBC's report, the investigation suggested that efforts to improve food safety at the corporate level were insufficient if employee habits and attitudes were not modified.

Limitations

The quality of evidence in the literature is compromised by several limitations in methodology.

Social and Behavioural Factors

Part of the observed successes in food handler training studies may be attributed to overall food hygiene advancements. In particular, technological advances in the food service industry may be attributed to an overestimation of the effectiveness of an intervention. Averett et al. (2011) found that although mandatory certification policy improves food handler hygiene over time, improvements in structural violations occurred at a significantly higher rate.[11]

Food safety training has been shown to improve food safety knowledge, but a variety of factors influence the translation of such knowledge into practice. As a follow-up to their previous study, Frash et al. (2010) concluded that employee attitudes and self-efficacy were major contributing factors to training application.[41] Similarly, Salazar et al. (2006) indicated that food safety training, as well as job satisfaction, motivated staff to apply the acquired hygiene knowledge.[42] Most studies were unable to control for behavioural factors and failed to capture the true effect of these programs. Howells et al. (2008) examined barriers to food hygiene compliance and suggested that the barriers were the same between those with ServSafe training and those without.[3]

Quality and Type of Training Varies

Most studies could generalize their findings only to the studied region. While most US states adopt the national ServSafe program, some provide training that is standardized only at the state level.[12] Canadian food handler training programs vary across provinces. Differences in the mode of instruction (e.g., in-person, online) and provider (e.g., private, government) may

also affect the quality of training and knowledge application. Hedberg et al. (2006) conducted a case control study to identify risk factors for foodborne outbreaks.[1] Compared to those who were trained in private organizations, managers certified by state or local health agencies were employed at FSEs that had lower odds of foodborne outbreaks in their restaurants.[1] Even when mandatory training policies are coupled with standardized certification, different modes of instruction (e.g., in-person vs. self-taught) may lead to different levels of knowledge uptake.[24]

Methodological Weaknesses

Some studies indicate that selection bias exists. Due to economical and time constraints, participation rates are often low, regardless of the study method used.[18,43] Those who chose to participate are potentially more concerned with food hygiene (especially when a cost is involved) and are more motivated to improve in food safety.[43] The lack of a reliable indicator to assess effectiveness of intervention also limits the studies' quality of evidence. While inspection score is often used as an indicator for food safety, it is subjective and may not represent the establishment's day-to-day food hygiene. Furthermore, Egan et al. (2007) proposes that evaluating training programs in isolation undermines other vital contributing factors of successful programs.[6]

Evidence Gaps

New approaches to examine mandatory food handler and manager training may help to address limitations of the current evidence. Future research should further explore potential interventions that remove behavioural and social barriers to using acquired food safety knowledge in practice. Extended follow-up of interventions is needed to evaluate effectiveness. Studies indicate that food hygiene improvements may regress as early as two years after training.[18,19] However, there is currently no evidence of the effect of recertification on improving/maintaining food safety.

The cost effectiveness of food handler training, as well as its economic impact on establishments, should also be further examined. Moreover, evidence of the financial and human resources needed for enforcing mandatory training policies is not currently available. Evidence of the efficacy of on-site and demonstrative training is still limited, and further examination on its cost effectiveness is needed.

Conclusion

There remains inconclusive evidence regarding the effectiveness of mandatory food handler and manager training policies. While mandatory food handler training increases food safety knowledge, the effect on improving food hygiene and food safety is not consistently observed. However, this is not to say that public health professionals should disregard mandatory training policies entirely. Existing study findings are compromised by methodological issues. Insufficient food safety knowledge is only one of many barriers to food safety compliance. Motivation and incentives for behavioural change are important and necessary components to improve safe food handling environment.[44] Rather than focusing only on mandatory training, program planners must also invest in strategies that encourage a food safety culture among food service establishments. Moreover, researchers recommended that food safety education should be provided to all food handlers, regardless of how it is delivered.

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Table 1. Current Food Handler Training Policies in Canada by Province/Territories

Province/Territory	Food Handler Training Policy	Required Level of Handler Training	Certification Information
Alberta	Training required by legislation	For establishments with > 5 food handlers, 1 certified supervisor must be present For establishments with < 6 food handlers, 1 certified supervisor needed but not needed to be present	Approved certification exams or Alberta provincial exam
British Columbia	Training required by legislation	The operator must be certified; when the operator is absent, at least 1 certified employee must be present	Approved certification exams or FoodSafe provincial exam
Manitoba	Province: Training recommended Winnipeg: Required by legislation	No level specified for Province Winnipeg: the person in charge and 1 out every 5 employees on duty at one time must be certified	Provincial: Certification must be posted Winnipeg: City-certification exam
New Brunswick	Training regulation phased in starting April 2012	One person in management level and another staff member in his/her absence	Mandatory certification started in April 2012
Newfoundland and Labrador	Training recommended	No requirement	No mandatory certification at the moment
Northwest Territories	Training required by legislation	One person per shift during operation must be certified	Approved certification exams or local exam
Nova Scotia	Training required by legislation	The operator and 1 employee who represents the operator in his/her absence must be certified	Approved certification exams or provincial exam
Nunavut	Training recommended based on NWT regulations	No requirement	No mandatory certification at the moment
Ontario	Province: Training recommended. (Regulation on training policy is currently under review) Brantford, Toronto, Hamilton: training required by legislation	Brantford: Managers of food service establishments must be certified within 60 days of employment Toronto: At least 1 certified food handler working in a supervisory position must be certified and present in high and medium risk food premises during operation	Approved certification exams or local health unit exam No standard provincial examination
Prince Edward Island	Training recommended	No level specified	No requirement for exam or certification

Table 1 (continued)

Province/Territory	Food Handler Training Policy	Required Level of Handler Training	Certification Information
Quebec	Training required by legislation	One certified food handler must be present in each work shift	MAPAQ exam by MAPAQ approved trainer Third party programs and trainers are now accepted for the employee and management level
Saskatchewan	Training required by legislation	Unless exempted by the Medical Health Officer, 1 certified food handler must be present during operation	Approved certification exams or provincial exam
Yukon Territories	Training recommended	No level specified	No mandatory certification at the moment

Source: TrainCan Inc. Provincial Regulations. 2011 [cited Oct 13, 2011]; http://www.traincan.com/index-provrequirements.asp

Table 2. Evidence on the Effectiveness of Mandatory Food Handler Training

A. Mandatory Food Handler Training for All Food Handlers			
Intermediate Effects			
Indicator: Knowledge and Behaviour Observation			
Source	**Sample Population**	**Evidence**	**Limitations**
Pilling (2008)	Kansas, Missouri; Iowa	- Restaurants with mandatory staff training had significantly lower composite, handwashing, and thermometer usage knowledge scores than restaurants with only shift manager training - Minimal difference in observed food hygiene behaviour; mandatory staff training group had higher compliance than manager training group in only 5 of 31 food hygiene categories	- Lack of a control group (no mandatory training) - Low response rate (31/1, 298); potential sampling bias
Indicator: Critical Violations			
Source	**Sample Population**	**Evidence**	**Limitations**
Hammond (2005)	67 counties in Florida	- Improvements in violations of 4 contributing factors: bare-hand food handling; storage in contaminated environment; raw cooked food; liquid/semi-solid mix of potential hazardous food - Increases in # of violations in 3 contributing factors: insufficient time/temperature due to cooking; insufficient time/temperature due to hot holding; polluted sources	- High staff turnovers affected true representation of “full certification of staff” - Quality of training not assessed
Murphy (2011)	Orange County, Florida	- Significant difference between large chain and independent restaurants in critical violations ($p<0.05$); no difference between small chain (< 10) and independent restaurants	- Used indirect method to assess effectiveness of mandatory certification - Did not refine classification of restaurant (fast food vs. fine dining)

Table 2 (continued)

Indicator: Critical Violations			
Source	**Sample Population**	**Evidence**	**Limitations**
Averett (2011)	Kansas City, Missouri	- ↓ in overall critical violations - ↓ is higher for establishments that are in existence throughout the study period	- ↓ is higher for structural violations vs. food handler related violations (25.7% vs. 13.2%) - Potential lag time of effect due to gradual implementation of mandatory training policy
Noble (2009)	Toronto, Ontario	- Pizza chains with mandatory training (0.4) had lower infraction/inspection ratio than chains without any certified handlers (0.9) - No difference when stratified by violation types, with the exception of sanitation of contact surface ($p<0.06$)	- Intervention group all belonged to one company
Mancini (2012)	Winnipeg, Manitoba	- Number of critical violations for pavilions in which staff who received on-site, demonstrative training was not significantly different from those with regular training - Staff with on-site training preferred this mode of training delivery than classroom-based; staff believed that on-site training enhanced knowledge retention and motivation for food hygiene compliance	- Very small sample size
Ultimate Effects			
Indicator: Reported Foodborne Illness Cases			
Source	**Sample Population**	**Evidence**	**Limitations**
Hammond (2005)	67 counties in Florida	- ↓ in total foodborne illness outbreaks (250.25/yr to 193.67/yr) - ↓ in total foodborne illness cases (1,413/yr to 1,194/yr)	- Outbreak can be due to other factors - No standard protocol for case reporting

Table 2 (continued)

B. HACCP				
Source	**Sample Population**	**Study Design**	**Evidence**	**Limitations**
Soriano (2002)	University restaurants in Valencia, Spain (n=19)	Microbiological analysis of ready-to-eat food items after HACCP program was implemented (*E. coli, Salmonella spp., and Clostridium perfringens*)	- Lower incidence of food items exceeding safety levels - 2 establishments incorrectly implemented its HACCP program	- Food handler training was also provided along with HACCP
Cenci-Goga (2005)	One university restaurant in Italy	Comparison of microbiological levels of served products before and after implementation of HACCP	- Microbiological level of food items decreased after HACCP was implemented	- Only one location was analyzed in the study
Eves (2005)	Food outlets in SE England (n = 7)	Interviews with management to identify barriers to implementing and operating HACCP as well as its perceived benefits	Barriers to implementation and operation: - Time constraints due to monitoring and paperwork - Convincing staff to adopt a food safety culture to monitor HACCP - Additional costs to business - Lack of staff knowledge on HACCP - Staff valued inspector recommendations over restaurant manager Perceived benefits: - Preventing potential outbreaks that damage business - An evidence-based program to promote diligence	- Limited generalizability (most participants are hotels)
Almanza (1998)	Two grill-type food establishments in US	Cost analysis of implementing pilot HACCP programs in two grill-type food establish ments	- The average time needed to complete each HACCP checklist was 29.2 min - Based on weekly salary of $475 (50 hr work week, four checklist completions per day), the cost of maintaining an HACCP program was estimated to be $18.45 USD per day	- Can only generalize to grill or similar type of establishment (difference in HACCP plans) - Only two establishment were used in the study

Table 2 (continued)

C. Certified Kitchen Manager Training			
Indicator: Knowledge Assessment			
Source	**Sample Population**	**Evidence**	**Limitations**
Frash (2006)	Alabama, Arizona, California, Delaware, Georgia, Indiana, Michigan, Minnesota	- Certified managers had significantly higher scores than those not certified	- Limited generalizability: 23% response rate (46% of surveys from 3 states) - Limited number of questions
Indicator: Inspection Score			
Source	**Sample Population**	**Evidence**	**Limitations**
Cotterchio (1998)	Boston, Massachusetts	- ↑ in inspection score (73 to 84) for all groups (mandatory, voluntary, control) - Score in mandatory group becomes the same as voluntary/control group at endpoint (83 vs. 84 and 83) - Rate of increase in mandatory group is higher than voluntary group	- Biased by legal pressure for mandatory group to improve hygiene (threat of closure)
Kneller (1990)	McLean County, Illinois	- Overall inspection score increased by 3.8 pts - Improvement observed for 18 months after training; signs of decline of scores at 19 months, but still significant vs. baseline	- Only 51% of certified personnel at endpoint of study - Outbreaks occurring during study period might have altered behaviour
Wright (1986)	Oakland County, Michigan	- Pre-test inspection score = 81%, post = 85% - No significant difference in score between treatment and control group at endpoint - Training group exhibited improvements in 1st and 2nd inspection, but regressed in 3rd inspection	- High non-response rate may lead to selection bias (motivation of attending training not known; cost barrier of $75 to training despite $25 discount) - Small sample size
Frash (2006)	Alabama, Arizona, California, Delaware, Georgia, Indiana, Michigan, Minnesota	- Average inspection scores from restaurants with manager training (90.67) are not significantly different from those without (89.77) after controlling for inspector, age, type of establishment, and ownership form	- Limited generalizability: 23% response rate (46% of surveys from 3 states) - Did not look at transfer of knowledge from manager to employee

Table 2 (continued)

Indicator: Critical Violations			
Source	**Sample Population**	**Evidence**	**Limitations**
Cotterchio (1998)	Boston, Massachusetts	- ↓ in % of establishments with critical violations in most categories in mandatory group (food holding temperature, sanitization of equipment, insects and rodents) - No change in voluntary and control group	
Cates (2009)	79 counties and 5 municipalities in Iowa	- Presence of CKM is associated with lower odds of critical violations (OR = 0.82, p<0.01) - Less likely to have critical violations categorized in personnel, food source handling, ware-washing facility and equipment, other operations - No difference in violations in food temperature/time control and plumbing/water/sewage	- Experience of kitchen manager as potential confounder
Kassa (2010)	Toledo/Lucas County, Ohio (high risk) restaurants/institutions)	- Premises with CKM has fewer critical violations than those that do not (1.75 vs. 2.08, p<0.05) - Large chain restaurants have fewer critical violations than individual or small chains (1-7 outlets)	- Characteristics of premises with CKM may confound results - Small sample via convenience method; unable to stratify results by restaurant characteristics
Binkley (2008)	Tippecanoe County, Indiana	- Certification not significantly associated with number of violations but at p=0.056 (11.8 vs. 12.7) - Number of years of experience is positively correlated with inspection scores	- A pilot study (lack of sample power, n=480) - High non-response rate from non-certified manager

Table 2 (continued)

D. On-Site or Demonstrative Training			
Intermediate Effects			
Indicator: Inspection Score			
Source	**Sample Population**	**Evidence**	**Limitations**
DeLegge (2009)	Utah	- Improvements in inspection scores identified for all groups - No significant difference in improvements between intervention and control groups	- Sample of facilities included only those assigned to the highest risk category of the local health department's risk assessment system
Indicator: Critical Violations			
Source	**Sample Population**	**Evidence**	**Limitations**
Mancini (2012)	Winnipeg, Manitoba	- Number of critical violation for pavilions in which staff who received on-site, demonstrative training was not significantly different from those with regular training - Staff with on-site training preferred this mode of training delivery than classroom-based; staff believed that on-site training enhanced knowledge retention and motivation for food hygiene compliance	- Very small sample size

Table 3. Stakeholder Groups of Mandatory Training Policies

Stakeholders	Role	Perceived Benefits	Perceived Costs	Unintended Effects
Government and/or enforcement body	Provide standards for training curriculum/accreditation[13] Enforcement on non-complying food premises[13]	Improve food safety compliance with food handlers related factors[45]	Require additional resources to regulate training institutions Enforcement to ensure restaurant compliance with policy[46]	Privatizing training to meet demands[47] Need to track recertification of food handlers (if needed)[46]
Food establishment owner & management	Ensure that staff are all certified with food safety training[28]	Improved inspection performance means reduced risks of non-compliance related consequences (closure, fine, etc.)[10]	May cover partial or entire cost of food handler training for staff[18] Labour loss from staff attending training (paid/unpaid)[18]	Arrangement to provide in-house food safety training for chain restaurants[12]
Food establishment staff	Attend training session to become certified[10,19]	Increased food safety knowledge[48]	Training cost may be out-of-pocket (equity issues) Potential income loss from attending training (unpaid)	Improvement in some areas may lead to neglect in other food safety areas (non-critical violations)[10]
Consumer	Potentially acts as co-enforcer (reporting any non-compliances to enforcement bodies)[49]	Potential increased food safety in retail food premises[50]	Additional expense by owners may be reflected in increased food prices	
Training institution (public/private/in-house)	Operate and manage training programs[47]	Revenue generated from increased training enrolment	Accreditation and operation costs[13]	High demand for training may dilute training quality Offering potentially subpar instructional methods to meet needs (classroom/online)[47]

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Appendix A: Search terms

("Food Safety" OR "Food Hygiene" OR "Restaurant Intervention" OR "Restaurant Program") OR ("Food Service Establishment" AND ["Safety" OR "Hygiene" OR "Intervention"]) OR ("Kitchen" AND ["Hygiene" OR "Safety" OR "Intervention") OR (["Manager" OR "Management" OR "Handler" OR "Staff"] AND ["Kitchen" OR "Food Service Establishment" OR "Restaurant"]) OR ["Hazard Analysis of Critical Control Points" OR "HACCP"]

AND

("Training" OR "Certification" OR "Certified" OR "Education" OR "Train" OR "Demonstrate" OR "Course" OR "Class" OR "Instruct" OR "Instruction" OR "FoodSafe" OR "ServSafe")

The Effectiveness of Engineering and Managerial Interventions on Improving Food Safety

Brian Lee

chapter 4

Key Findings

- Evidence on effectiveness for most managerial and engineering interventions is often unavailable, even for those that are widely practised.
- Glove use can be effective in reducing foodborne illness risks by acting as a barrier for preventing contamination from the hands to food. However, inadequate and improper glove use impairs the efficacy of this intervention in real-world settings. Implementing proper glove-use policies and ensuring compliance is essential to prevent an elevated risk of cross-contamination during glove use.
- Hand washing water temperature does not appear to affect food safety. However, as part of the hand washing process, the use of paper towel for hand drying is found to be more effective than electric air hand dryers when considering factors such as user preference, microbial removal, and prevention of cross-contamination.
- Food safety communication tools, such as posters and calendars, are effective in improving food hygiene compliance.
- Paid sick leave appears to be a viable managerial intervention, but no evidence of its effectiveness in a food service establishment setting is available.

- Interventions relating to restaurant design have been identified through surveys of consumers, food handlers, and operators of food premises, but studies on their use and impact on food safety improvement are scarce or unavailable.
- More evidence is needed on the effectiveness of interventions that promote a food safety culture in food service establishments.

Introduction

In food service establishments (FSEs), food safety is often improved by reducing foodborne illness risks.[1] Ideally, ensuring personnel understand and practice hygienic food handling is the most efficacious way to improve food safety. While health authorities validate and enforce compliance with food safety regulations, the responsibility of attaining and maintaining high food safety standards rests on the operators and staff of FSEs.[2] However, because food hygiene is influenced by human behaviour and curtailed by barriers such as the need for operational efficiency, other interventions must be considered to help support food safety at FSEs.[3] Through engineering and managerial efforts, new equipment and operating policies have been designed to minimize foodborne illness risks. While some of these tools have been adopted by FSEs, their effectiveness has not undergone evaluation.[4] The purpose of this chapter is to assess evidence from the literature on the effectiveness of engineering and managerial interventions that serve to improve food safety in FSEs.

Types of Interventions

Engineering interventions typically involve the modification or use of equipment or facilities to

enhance food hygiene. Managerial interventions may also entail the use of new equipment, but they emphasize operational and administrative changes that influence food hygiene. Some examples of engineering and managerial interventions can be found on Table 1.

Methods

A literature search for peer-reviewed and grey literature was conducted up to July 10, 2012 on Web of Science, Science Direct, Academic Search Premier, Ingenta, Google Scholar, Google, and Bing. Keywords used in the search can be found in Appendix A. Existing evidence on the effectiveness of managerial or engineering interventions was compiled using the following selection criteria: the retrieved document must be either a full or summarized evaluation report or study that examined the effectiveness of engineering or managerial interventions which serve to improve food safety in FSEs.

Results and Discussion

The literature search retrieved eight documents that matched the selection criterion. Three articles examined the efficacy of glove use in improving food hygiene; two were conducted in an experimental setting and one in a field setting. One article was retrieved on the effect of hand washing water temperature on hand hygiene and two reviews were retrieved on the effect of hand drying methods for hand hygiene. Among managerial interventions, only one study regarding the use of food safety infosheets met the inclusion criteria. No studies on the effect of paid sick leave for food service employees were found in the literature, but a comparable study in nursing homes was retrieved.

Engineering Control

Glove Use

The efficacy of glove use as an engineering intervention was extensively examined in controlled environments.[5-8]

Montville et al. (2001) compared the rate of transfer (RoT) of *Enterobacter aerogenes* (used as a nonpathogenic surrogate for *Salmonella*) between gloved and bare hands when preparing chicken and lettuce. Participants were asked to perform three food handling tasks that evaluate use of a glove and its ability to act as a barrier for cross contamination. The three tasks were as follows: cut chicken without gloves, then subsequently cut lettuce with gloved hands; cut chicken with gloved hands, then subsequently cut lettuce with a clean pair of gloves; cut chicken with gloved hands, then subsequently cut lettuce after removing the gloves. The RoT varied greatly across all treatment groups; for example, the lowest RoT resulted from bacteria inoculated on hands to lettuce when gloves were used, which varied from 0.0003% to 0.0545%.[5] Nevertheless, the use of gloves was found to yield the lowest RoT. The RoT, however, was as high as 97% in the group that cut chicken with gloved hands, then subsequently cut lettuce after removing the gloves. The author suggests that the high RoT was the result of improper glove removal and the absence of hand washing when changing gloves.

Fendler et al. (2002) assessed the effectiveness of using different hand-washing and glove-use regimens in preventing *E. coli* contamination when handling ground beef.[9] Compared to handling food using bare hands with hourly hand washing (using antimicrobial soap), the palm (inside) of a gloved hand (changed hourly) with no hand washing resulted in a lower average bacterial count (e.g., 3.51 vs. 2.88 log CFU after three hours).[9] However, the difference became insignificant when an alcohol-based hand sanitizer was used immediately after proper hourly hand washing. For example, changes in the average microbial level of the hands were similar using the regimen of hourly hand washing with sanitizer use (0.80 log CFU after three hours) compared with hourly glove changing with hand washing between glove changes (0.86 log CFU after three hours). The findings indicate that proper glove use (e.g., regularly changing gloves, washing hands between glove changes) can reduce the average microbial level on the hands compared to hourly hand washing alone (0.86 log CFU vs. 3.51 log CFU after three hours), but the outside of gloves become relatively more contaminated than bare hands. The authors caution that there is a need for careful selection of effective hand-washing and glove-use regimens to ensure hygienic food handling.

Only one study was found that examined the effect of glove use in a real FSE setting.[6] Lynch (2005) compared the foodborne pathogen count on flour tortillas in a fast food chain that were handled by workers with or without gloves.[6] The study did not observe any significant difference between the two groups, primarily due to low microbe detection rate in samples; *E. coli* was detected in only 1 of 371

samples.[6] They observed poor glove use practices (e.g., extended use, reuse, absence of glove changes) and suggested that glove use could potentially increase risk of microbial contamination, especially if food handlers are not attentive to good glove use practices.

Although existing studies demonstrate that proper glove use can reduce the risk of foodborne illness, they often emphasize that good glove-use practices are not always apparent at FSEs. For example, glove use may promote a false sense of security which often increases behaviour that may lead to elevated food hygiene risks.[8,9] Food handlers who used gloves may also be less likely to wash their hands or comply with proper hand-washing procedures.[8,10] In addition, proper glove use requires frequent replacement of gloves to reduce cross-contamination risks. However, the associated inconvenience and costs often became a major barrier to proper glove use practices.[9] Todd (2010) previously conducted a review on glove use and concluded that glove use would only be effective in practice if it were used in combination with hand washing and/or hand sanitizers.

Hand Washing Water Temperature

The effectiveness of proper hand-washing and sanitization procedures on reducing the risk of food-borne illness has been extensively studied.[11] Yet, only one study was found on hand washing water temperature and hand hygiene, and it showed that the temperature of the water used is not associated with bacterial removal when hand soap is used.[12] However, the authors also suggest that a comfortable water temperature encourages employees to comply with thorough hand washing behaviour, an important consideration for workers who are required to frequently wash their hands (e.g., healthcare workers, food handlers).[12]

Hand Drying Methods

Existing literature suggests that the method of hand drying may have an effect on hand hygiene, but differences in methodology have resulted in diverse findings.[11,13,14] Considerations for the method of hand drying typically include user preference, drying efficiency (e.g., degree of dryness, speed), microbial removal, and prevention of cross-contamination (e.g., onto other surfaces, into the air).[11,14] Other factors may include irritation, noise, effect on the environment, and cost.[14]

For example, a European market research survey (n = 2000) indicates that 63% of respondents prefer to use paper towels to dry their hands and 28% of respondents may choose not to dry their hands if the method of hand drying is not perceived as "suitable."[15] Furthermore, Snelling (2011) found that hand drying using a paper towel was more effective in bacterial removal than using either a conventional warm air hand dryer or ultra-rapid hand dryer.[16] The authors noted that although both conventional and ultra-rapid dryers can achieve similar performance in bacterial removal, the required drying time of conventional dryers used in the study was longer (35s) than the drying time of the ultra-rapid dryer (10s).[16] Typical time spent drying hands under an air dryer vary, but averages of approximately 13 to 25 seconds have been reported in the literature.[17,18] Yamamoto (2005) suggested that hand drying using a warm air dryer is comparable to the use of paper towel, but only if no rubbing action was conducted during the drying process.[19] However, Redway and Fawdar (2008) suggested this would likely result in longer drying times.[13] Still, a study conducted by Gustafon et al. (2000) did not observe any significant difference in bacterial removal among four conventional hand drying methods (cloth towel, paper towel, mechanical dryer, and room air evaporation).[20] Ultimately, reviews on hand washing and hand drying by Todd et al. (2010), as well as Huang et al. (2012), recommend the use of single-use paper towels over electric hand dryers.[11,14]

Managerial Control

Food Safety Communication Tools

Food safety info sheets are letter-size posters that are typically located in conspicuous locations such as washing stations.[21] Using both concise, easy-to-understand language and attention grabbing visuals, the info sheets are intended to serve as a communication tool that educate food handlers about food safety. Chapman (2010) tested the effectiveness of food safety info sheets by placing them in visible areas of FSEs. After implementing info sheets for eight weeks, FSEs observed significantly reduced cross-contamination incidents and increased hand washing attempts.[21] However, the level of risky food handling behaviour remained high during peak operating hours. Other similar communication methods, such as a food safety calendar, were also used but evidence of their effectiveness was not published.

Paid Sick Leave

The literature indicates that the presence of a food handler infected with a foodborne pathogen in FSEs is a major contributor to foodborne illness outbreaks.[3,22,23] Previous case studies have indicated that when managerial policy and practices are poor, employees may be forced to work while ill.[4] While most food service employees, especially those working as part-time, rarely receive sick leave, there has been a growing movement in the US that advocates for a mandatory paid sick leave ordinance. No evidence relating to the food safety benefits of paid sick leave among food handlers was found, but parallel evidence of the effectiveness of sick leave policies is available from employees working in nursing homes.[24] Li et al. (1996) found that the rate of respiratory and gastrointestinal illness in nursing homes was significantly lower in those that provided paid sick leave, compared to those that did not.[24]

Many business owners have also been concerned with the negative economic impact of a mandatory sick leave ordinance when it was first proposed.[25] However, no significant negative economic and employment impact was observed in San Francisco's food service industry after mandatory paid sick leave was implemented.[26] Drago and Lovell (2011) found paid sick leave policies in the food industry rarely resulted in reduction in employee benefits including bonuses and paid vacation time.[26] While most FSE owners did not notice revenue decrease as a result of complying with a paid sick leave ordinance, no improvements in revenue were reported.[26] Furthermore, the implementation of a paid sick leave ordinance is not thought to significantly affect employment numbers in the accommodation and food service industry.[25]

Limitations

Most engineering interventions in the literature were conducted in an experimental setting. As a result, most between-subject behavioural confounders were minimized to allow comparison between experiment groups. However, this may cause a reduction in external validity. While the interventions discussed in this review may prove to be efficacious, robust conclusions are constrained by the multitude of factors that affect human behaviour and the business of operating a food service establishment.[4]

Only one published study that examined the effectiveness of glove use in an actual FSE setting was found. This study greatly lacked statistical power due to the lack of detection of bacteria on the tortilla samples.[6] Moreover, the study did not examine food ingredients that were more vulnerable to contamination (i.e., meat products) due to the potential complexity in study design.

Evidence Gaps

Although several engineering intervention studies have been conducted, there are other engineering interventions that could benefit from further examination. Some of these are related to restaurant design, workflow, and availability of equipment that promotes potential food safety improvements in food premises. For example, a commonly cited factor relating to hand hygiene of food handlers is the placement, availability, and maintenance of hand-washing stations, but no evaluation studies were found.[27] Similarly, inadequate space in the food premises and lack of equipment to perform tasks such as cleaning, sanitizing, and use of food thermometers in FSEs have also been documented as barriers to food safety improvement.[28] In the same way, it may be useful to evaluate the food safety impact of food barriers (i.e., sneeze guards) commonly used in FSEs, especially in those where buffets are served.[29] Finally, surveys of consumers and operators of food premises have implied that an open kitchen design would likely contribute to food safety improvements by affecting the behaviour of food handlers, but no such intervention study had been done.[30,31]

Several studies investigated the importance of food safety culture in promoting food hygiene compliance. Food service employees believed that factors that influence organizational culture such as direct and indirect incentives (i.e., promotion and acknowledgement), positive mentoring by supervisors, and availability of hand washing facilities may encourage food hygiene compliance.[32-34] There is also a need for approaches that allow operators to provide ongoing support for food safety training of staff.[35] However, these studies commonly use convenience samples and measure self-reported food safety attitudes. Future studies and evaluation should focus on the effectiveness and practicality of these interventions in the field.

Conclusions and Recommendations

In experimental settings, the use of gloves may reduce contamination risks when combined with adequate hand washing and replacement of gloves.

However, in practice, improper use of gloves and inadequate glove-use policies can lead to an elevated risk of cross-contamination and foodborne illness. Unless adequate compliance with proper glove use is achieved, FSEs should not make the use of gloves mandatory. Food safety info sheets may be a cost-effective method for promoting a food safety culture in FSEs, but no conclusions on its efficacy can be made without more evidence. Paid sick leave appears to be a viable managerial intervention, but no evidence of its effectiveness in a food service establishment setting is available.

Evidence for both engineering and managerial interventions can benefit from studies that use indicators from FSEs in the field. Although findings about food handlers' attitudes to managerial controls are available, evidence on their effectiveness in reducing foodborne illness risks are scarce. FSE operators often share the primary responsibilities and costs of managerial and engineering interventions. Deciding which intervention to adopt is heavily influenced by the operator's knowledge of the costs and benefits for each intervention. Public health authorities can assist food premises operators by providing information on the considerations for effective use of engineering and managerial interventions.

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Table 1. Examples of Engineering and Managerial Interventions in Food Service Establishments

Engineering Intervention	
Intervention	**Examples**
Hand hygiene	Glove use, hand sanitizer, hand dryer
Kitchen design	Open kitchen, ventilation, location and size of facilities
Barriers	Sneeze guards, food shields
Processes	Food specific cutting boards
Managerial Intervention	
Intervention	**Examples**
Sick worker management	Paid sick leave policies
Food safety culture	Food safety infosheet, employee coaching
Food safety plan	HACCP, food handling bookkeeping, MenuSafe
Minimizing cross contamination	Shift allocation

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AND

("Engineering" OR "Managerial" OR "Management" OR "Design" OR "Equipment") OR ("hand washing" OR "hand drying" OR "sick leave" OR "rotation" OR "cutting board" OR "sneeze guard" OR "glove" OR "communication)

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