

## A B S T R A C T

*Purpose:* To summarize evidence on the effectiveness of public health interventions regarding food safety at restaurants, institutions, homes and other community-based settings.

*Method:* This systematic review of published and unpublished studies involved a comprehensive literature search, screening for relevance, quality assessment of relevant studies, data extraction and synthesis.

*Results:* The interventions identified in 15 studies included in this review were grouped into three categories: inspections, food handler training, and community-based education. The evidence suggests that: routine inspection (at least once per year) of food service premises is effective in reducing the risk of foodborne illness; food handler training can improve the knowledge and practices of food handlers; and selected community-based education programs can increase public knowledge of food safety.

*Discussion:* There is some evidence for the effectiveness of multiple public health interventions on food safety. Future research needs include evaluation of HACCP and community-based education programs.

## A B R É G É

*Objet :* Résumer les résultats de la recherche sur l'efficacité des interventions de santé publique relative à la salubrité des aliments dans les restaurants, les établissements, les foyers et autres milieux communautaires.

*Méthode :* Cette revue méthodique d'études publiées et non publiées a exigé une analyse exhaustive de la documentation, une évaluation de sa pertinence, une évaluation de la qualité des études retenues, l'extraction des données et leur synthèse.

*Résultats :* Les interventions identifiées dans 15 des études comprises dans cette analyse ont été divisées en trois catégories : inspections, formation des préposés à la manipulation des aliments et éducation communautaire. Les données indiquent que l'inspection régulière des services d'alimentation, au moins une fois par an, contribue à réduire le risque de maladies d'origine alimentaire, que la formation professionnelle peut améliorer les connaissances et les pratiques des préposés à la manipulation des aliments et que certains programmes d'éducation communautaire peuvent améliorer les connaissances du public sur la salubrité des aliments.

*Discussion :* Certaines données de recherche montrent l'efficacité des interventions multiples des autorités en santé publique sur la salubrité des aliments. Les besoins futurs en recherche comprennent l'évaluation du système HACCP (système de l'analyse des risques - point critique pour leur maîtrise) et des programmes d'éducation communautaire.

# Effectiveness of Public Health Interventions in Food Safety: A Systematic Review

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It has been well established that foodborne diseases are an important contributor to human morbidity and mortality, as well as increased health care and private sector costs.<sup>1,2</sup> The projected cost for the estimated 2.2 million cases of foodborne illnesses in Canada each year is approximately \$2 billion.<sup>1</sup> Furthermore, Todd<sup>1</sup> estimates that 31 deaths in Canada each year are attributable to foodborne illness. Throughout the 1980s, there has been no significant reduction in the number of foodborne incidents in Canada,<sup>3</sup> nor in Ontario, leading some investigators to question the effectiveness of existing food safety strategies.<sup>4</sup>

A systematic review of the effectiveness of food safety interventions was commissioned by the Ontario Ministry of Health to assist in reshaping

the 1989 Program Standards for the Food Safety Mandatory Core Program. The systematic review sought to answer the following research questions: (a) "What are the documented interventions that public health staff can use to ensure that food is prepared, stored and served/sold in a safe manner consistent with accepted local public health practices?"; (b) "Are these interventions effective?"; and (c) "Are there reliable measures of the effectiveness of

food safety interventions?"<sup>5</sup> This paper summarizes the evidence on the effectiveness of food safety interventions applicable to public health practice (question b).

## METHODS

### Literature search

A systematic search of published and unpublished studies was conducted during January and February 1997, in which only English language studies were retrieved. To identify relevant published studies, the following nine databases were searched online: Medline, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Engineering Information Compendex (EI Compendex), National Technical Information Service (NTIS), Science Citation Index (SCI), Current Contents, Uncover, Educational Resources Information Centre (ERIC), and Applied Science and Technology Abstracts (ASTA). Databases were searched for studies published in 1975 and onwards. Boolean searching was used to combine 84 key words with an "and/or/but" proviso. The rationale for using boolean searching was to use the computer as much as possible (rather than the researchers) to screen out irrelevant articles (e.g., studies dealing with primary food processing/manufacturing). Key words were categorized by: topic (e.g., food safety, food handling, food inspection), outcomes (e.g., foodborne illness, compliance, sanitation), strategies (e.g., training, inspection, enforcement) and target (e.g., food handlers, community, home).

A hand-search of the last five years of the *Journal of Environmental Health* and the *Canadian Journal of Public Health* was performed to ensure that the key words chosen were suitable to obtain all relevant articles.

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No additional articles relevant to the study were found. In addition, the last 10 years of *Public Health and Epidemiology Report Ontario (PHERO)* and *Environmental Health Review* were hand-searched since these periodicals are not indexed on computer databases.

Unpublished studies were identified using four strategies: (1) a computer search of the Ontario Ministry of Health's Public Health Research Database, (2) computer search of student theses at Ryerson's School of Environmental Health, (3) direct request of all Directors of Environmental Health in Ontario health units and all provincial epidemiologists in Canada, and (4) key informants knowledgeable about food safety research.

### Relevance and quality assessment

Studies were included in the review if they met all the following inclusion criteria: (1) the study described a food safety intervention or program, (2) the intervention was within the scope of public health practice in Ontario, and (3) the study used outcome measures to assess the effectiveness of the intervention. Two readers reviewed 60 articles and demonstrated a high level of agreement regarding the decision to include/exclude each study ( $\kappa > 0.8$ ). One reader screened the remaining 108 articles for inclusion/exclusion.

A quality assessment tool was developed, pretested and then used to standardize the rating process among the five reviewers. The internal validity of each study was assessed based on three major criteria: (1) comparability of the intervention and the comparison groups [e.g., Was potential for bias due to selection, history, maturation, resentful demoralization and compensatory rivalry adequately addressed?], (2) assessment of the interventions [e.g., Was the intervention applied consistently and as intended to everyone? Was the comparison group blinded and protected from contamination?], and (3) assessment of the outcomes [e.g., Was there potential for bias in the outcome measurement due to testing, instrumentation, regression to the mean, or validity and reliability concerns?]. Criteria were rated as "no concerns", "minor concerns" and "major concerns". Studies were designated as "strong" if there were no

major concerns and no or few minor concerns that would seriously alter the results. A designation of "moderate" indicated no major concerns, but at least one minor concern. A "weak" designation indicated one or more major concerns. One primary and one of four secondary reviewers assessed all studies independently. When the reviewers disagreed in their initial ratings, consensus was reached on the final quality rating.

A data extraction tool was developed and pretested to ensure that information was extracted (from the strong or moderate studies) in a consistent manner by two independent reviewers. Information was collected on study design, comparability of the intervention and comparison groups, description of the intervention, outcome measures and generalizability. Where discrepancies occurred, discussion was held and consensus reached.

## RESULTS

### Study characteristics

A total of 168 potentially relevant studies were retrieved, which included 127 published and 41 unpublished studies. Application of the inclusion/exclusion criteria resulted in the retention of 34 relevant evaluation studies (23 published, 11 unpublished) for quality assessment.

For the 34 evaluative studies assessed, 10 examined only inspections-based interventions, 20 evaluated only food handler training interventions, two evaluated both training and inspection, and two examined community-based education interventions.

Only 4 of the 34 studies assessed were randomized controlled trials (RCT). Six other studies were controlled trials (CT) without random allocation of study participants. One study used a cohort design and another was a case-control study. Thirteen studies were pretest/post-test studies (without a control group). Seven studies were cross-sectional, one was ecological and one was a time series design.

The quality assessment revealed a limited number of studies with good evidence of effectiveness. Of the 34 evaluative studies assessed, 1 was rated as strong, 14 were moderate, and 19 were weak. Table I provides a summary of the designs, participants, interventions, outcomes and

methodological weaknesses for the 15 strong or moderate quality studies.

### Study outcomes

#### *Inspection/Risk Assessment*

Five studies<sup>8-12</sup> evaluated the effectiveness of inspection of food service premises (primarily restaurants). Irwin et al.<sup>10</sup> observed that violation rates of inspection criteria in restaurants were significantly associated with outbreaks, thereby validating their use in inspections. Corber et al.<sup>9</sup> found no difference in inspection scores between restaurants scheduled to receive 6, 9 or 12 inspections per year. Bader et al.<sup>8</sup> observed that premises inspected four times per year produced better inspection scores than those inspected only upon public complaint (or once in two years). Kirshner<sup>11</sup> found no significant difference in inspection scores of restaurants receiving 2, 4 or 6 inspections per year. Mathias et al.<sup>12</sup> determined that time intervals since the last inspection which were greater than one year were significantly associated with poorer inspection scores, however, time intervals of fewer than 3, 4-6, or 7-12 months since the last inspection were not significantly different from each other.

No studies were found that adequately evaluated inspection programs based on Hazard Assessment Critical Control Point (HACCP) protocols, as implemented by staff of public health units. A few papers that described HACCP interventions,<sup>21-25</sup> and two papers<sup>26,27</sup> that discussed feasibility aspects, were retrieved.

Two studies examined risk assessment, a component of an inspection strategy for food premises which categorizes (after inspection) each food premises according to its potential for foodborne disease. Briley and Klaus<sup>6</sup> observed that restaurants designated as high risk (inspected every 1-2 months) changed to a lower risk rating, whereas medium and low risk premises (inspected approximately every 4 or 12 months, respectively) did not. One important criteria for risk assessment in the Briley and Klaus study was previous inspection score. In a Canadian study<sup>7</sup> with a different method of assessing risk categories, about 10% of low risk food premises had changed to medium risk upon reassessment one year later.

**TABLE I**  
**Summary of Effectiveness Studies on Food Safety Interventions**

STUDY (Country)	DESIGN (Quality Assessment)	INTERVENTION	OUTCOMES	COMMENTS
<b>Risk Assessment</b> Briley & Klaus, 1985 <sup>6</sup> (U.S.A.)	Cohort (moderate <sup>a,b,c</sup> )	Inspections every 1-2, 3, 4-5, 6-12 months depending on risk level (score) per premise.  <i>Intervenor:</i> Public health inspectors <i>Setting:</i> Restaurants (n = 42) <i>Target:</i> Restaurant owner/operator	In the high risk group, a significant number of restaurants changed to lower risk designation (p < 0.05) after receiving inspections every 1-2 months. No significant reduction in risk scores in lower risk premises with lower inspection frequencies.	Generalizability limited due to small sample size per risk category. Selection bias possible.
Sandford & Amorim, 1996 <sup>7</sup> (Canada)	Cross-sectional (moderate <sup>a,b,c</sup> )	Inspection of previously designated "low risk" food service premises to assess current risk rating.  <i>Intervenor:</i> Public health inspectors <i>Setting:</i> Low risk food service premises (n = 427) <i>Target:</i> Premise owner/operator	9% of previously designated "low risk" premises changed from low to medium risk category.	Generalizability limited by non-random sample selection.
<b>Inspection (only)</b> Bader et al., 1978 <sup>8</sup> (U.S.A.)	RCT (moderate <sup>a,b,c</sup> )	Inspections 4 times per year or only after public complaint  <i>Intervenor:</i> Public health inspectors <i>Setting:</i> Food service establishments (schools, restaurants & caterers) (n = 392) <i>Target:</i> Food service establishment owners & operators	Inspection scores for premises inspected 4 times/year better than those inspected only after complaint.	"Problem" establishments excluded from study.
Corber et al., 1984 <sup>9</sup> (Canada)	RCT (strong <sup>b</sup> )	Inspections 6, 9 or 12 times per year  <i>Intervenor:</i> Public health inspectors <i>Setting:</i> Food service establishments (n = 392) <i>Target:</i> Food premise supervisors & food handlers	No significant difference in inspection scores based on frequency of inspections.	Generalizability limited by insufficient information on characteristics of premises included in study.
Irwin et al., 1989 <sup>10</sup> (U.S.A.)	Case control (moderate <sup>a,b,c</sup> )	Comparison of violations of inspection criteria in restaurants with outbreaks to those without.  <i>Intervenor:</i> Public health inspectors <i>Setting:</i> Restaurants with outbreaks (n = 28); matched controls without outbreaks (n = 56) <i>Target:</i> Restaurant owners and operators	Significant association between violations of many inspection criteria and outbreaks (OR 15.8, 95% CI 2.0 - 124.1).	Provides evidence of ability of inspection criteria to predict outbreaks, thus validating their use in inspections.
<b>Inspection &amp; Training</b> Kirshner, 1991 <sup>11</sup> (Canada)	RCT (moderate <sup>b,c</sup> )	Inspections 2,4 or 6 times per year. Food handler training through on-site education with audiovisual aids.  <i>Intervenor:</i> Public health inspectors <i>Setting:</i> Food service establishments <i>Target:</i> Food handlers, owners, operators	No significant difference in inspection scores based on frequency of inspection (p > 0.5).  On-site education sessions not effective in reducing infraction scores.	"Problem" establishments excluded from study.
Mathias et al., 1995 <sup>12</sup> (Canada)	Cross-sectional (moderate <sup>a,b</sup> )	Time intervals since last inspection were 0-3, 4-6, 7-12 and > 12 months. Past food safety training.  <i>Intervenor:</i> Public health inspectors <i>Setting:</i> Non-franchise restaurants (n = 630) <i>Target:</i> Restaurant supervisors & food handlers	Inspection scores significantly poorer in restaurants last inspected more than a year before.  Restaurants in which staff completed food handler training courses had better inspection scores than those without.	Good generalizability due to random selection of restaurants within 21 different health units across 3 provinces.
<b>Training (only)</b> Cook & Casey, 1979 <sup>13</sup> (U.S.A.)	Non-random CT (moderate <sup>a,b,c</sup> )	Food safety training: three 5-hour sessions; manual; 6 homework assignments; examination.  <i>Intervenor:</i> Food service educator from restaurant association <i>Setting:</i> Food service establishments (n = 20 with training; n = 35 control) <i>Target:</i> Food premise managers	No significant difference in inspection scores of the intervention vs. control group.	Generalizability limited due to non-random sample selection and lack of information on establishment characteristics.

TABLE I — continued

Dalrymple, 1994 <sup>14</sup> (Trinidad)	Pretest/post-test (moderate <sup>a,b,c</sup> )	Food safety lecture  <i>Intervenor:</i> Public health inspector <i>Setting:</i> Education institution <i>Target:</i> Food handlers (n = 75)	Significant increase in knowledge scores after food safety training (p < 0.0001).	Generalizability limited due to non-random sample selection and lack of control group.
Kneller & Bierma, 1990 <sup>15</sup> (U.S.A.)	Time series (moderate <sup>a,b,c</sup> )	Food safety training: 15 contact hours classroom training; examination.  <i>Intervenor:</i> Public health inspectors <i>Setting:</i> Food service establishments (n = 60) <i>Target:</i> Food service managers	Inspection scores significantly better (p < 0.01) after food safety training and certification.	Used multiple pre- (n = 483) and post-certification inspection scores (n = 539) to compensate for normal variation in inspection scores.
Lawrie 1988 <sup>16</sup> (Canada)	Cross-sectional (moderate <sup>a,b,c</sup> )	Food safety lectures provided in 2nd year of 4-year hospitality program.  <i>Intervenor:</i> Instructors at educational institution <i>Setting:</i> Hospitality and Tourism Program at post-secondary institution <i>Target:</i> Students (n = 155)	Food safety knowledge scores highest in 2nd and 3rd year, after training, compared with knowledge in 1st year prior to food safety training.	Generalizability limited due to cross-sectional design; sample receiving intervention different from sample without food safety training.
Rinke et al., 1975 <sup>17</sup> (U.S.A.)	Pretest/post-test (moderate <sup>a,b,c</sup> )	Two food safety training methods: live instruction; taped instruction.  <i>Intervenor:</i> University instructors <i>Setting:</i> University residence <i>Target:</i> University residence food handlers (n = 31 “live”; 29 “taped” instruction)	Both groups significantly (p = 0.01) improved their knowledge score over pretest. Groups did not differ on post-test.	Generalizability limited due to small sample size and application to single facility.
Soneff et al., 1994 <sup>18</sup> (Canada)	RCT (moderate <sup>a,c</sup> )	Food handler training consisted of either a workshop and manual, or manual only.  <i>Intervenor:</i> Dietitians (auditors), registered dietitian nutritionist (workshop presenter) <i>Setting:</i> Adult care facilities <i>Target:</i> Staff of adult care facilities	A combined educational approach (workshop presentation and manual) demonstrated significant improvements in food safety knowledge scores.  Negligible benefits of providing a manual alone.	Limited generalizability due to insufficient information about characteristics of premises.
<b>Community-based Education</b>				
Pivarnik et al., 1994 <sup>19</sup> (U.S.A.)	Pretest/post-test (moderate <sup>a,b,c</sup> )	Food safety awareness training: four 60-minute lessons; interactive; audiovisual aids.  <i>Intervenor:</i> Paraprofessionals from Food & Nutrition Program <i>Setting:</i> Elementary schools (n = 11) <i>Target:</i> Children (n = 561)	Significant increase in knowledge scores after intervention (p < 0.05).	Good generalizability in that program delivered at multiple schools and in ethnically and racially diverse areas.
Radostits et al., 1993 <sup>20</sup> (Canada)	Pretest/post-test (moderate <sup>a,b,c</sup> )	Food awareness training: 2-hour guided supermarket tour; in-store demonstrations.  <i>Intervenor:</i> Nutritionist & health inspector <i>Setting:</i> Food store <i>Target:</i> Public (shoppers; n = 57)	Significant increase in knowledge after intervention. Improvements in self-reported behaviour.	Generalizability limited due to non-random sample selection and implementation at single location.

**Note**

**Quality Assessment Criteria:**  
a) minor concern with comparability of the intervention and comparison groups (random allocation, matching or adjustment of confounding variables)  
b) minor concern with reproducibility of intervention (documentation, program fidelity, contamination of comparison group)  
c) minor concern with soundness of outcome assessment (validated measurement tools, applied reliably)

*Food Handler Training*

Evaluation studies of food handler training provide evidence for the effectiveness of training programs in increasing knowledge of proper food safety practices, and in

some cases, improving actual food handling operations on the food service premises (based on improved inspection scores). Of the eight evaluative studies assessed,<sup>11-18</sup> six showed a positive change

in post-test measures (compared with pretest measures) after participation in a training intervention. In a study by Soneff et al.,<sup>18</sup> improvements between pre- and post-intervention inspection scores were



noted in the group that participated in a workshop, but not in the group that received only a food safety manual. Two studies<sup>11,13</sup> did not show any improvements in inspection scores after training. All eight evaluative studies were of moderate quality.

#### Community-based Education

Community-based education interventions include promotion of public awareness, public disclosure of violations, awards, development of school curricula and peer education. Of the 12 potentially relevant studies retrieved, 3 were evaluation studies, of which 2 were assessed as moderate and 1 as weak.

One moderate study,<sup>20</sup> which evaluated the effectiveness of a supermarket food safety educational tour, noted improvements in food safety knowledge and self-reported practices after the intervention. The other moderate study,<sup>19</sup> which evaluated a food safety curriculum for elementary students, demonstrated an increase in knowledge scores after the curriculum was introduced.

#### DISCUSSION

This systematic review provides evidence that at least one routine inspection per food service premises per year is likely to reduce the risk of foodborne illness, as determined through improved inspection scores. This result is consistent with the critical appraisal of the literature by Riben et al.<sup>28</sup> While the individual studies on which this evidence is based are of moderate or strong quality, there is concern about the generalizability of the findings in these studies to the current situation in Ontario. The studies included in this review differed from each other in their inspection protocols (different protocols were likely used in different jurisdictions; protocols likely differed in the 1980s versus 1990s, and differed in Canada versus the United States). Furthermore, most studies did not differentiate between high-, medium- and low-risk premises. Consequently, it is not possible to make evidence-based recommendations for the *optimal* inspection frequency for premises in different risk categories.

The inspection studies reviewed did not assess the effectiveness of HACCP inspections as conducted by public health staff in Ontario health units. It is possible that HACCP inspections may be more effective than routine inspections since they specifically address critical control points or risk factors epidemiologically implicated in foodborne illness.<sup>21,29-32</sup> While the literature supports at least one *routine* inspection per food service premises per year, this does not preclude additional inspections, based on what is deemed necessary to bring a premises with poor safety conditions and practices into compliance with acceptable food safety standards.

Based on studies<sup>30,31</sup> that have linked the occurrence of foodborne illness with common risk factors, there is evidence to support the use of risk assessment to classify food service premises into differential risk categories, based on: food property risks (e.g., meat products more risky than bread), population risk (e.g., type and size), establishment history (e.g., past infractions), and food service operational risks (e.g., complexity of cooking, cooling, handling, storage steps).<sup>6</sup> There is some evidence to support that risk assessment should be conducted annually for each premises.<sup>7</sup>

This literature review provides evidence for the effectiveness of food handler training programs, in conjunction with certification, to improve the knowledge and practices of food handlers. In establishing a training program, consideration should be given to targeting both managers and food handlers, and to making the educational experience active (such as with a workshop) rather than passive (such as with dissemination of resource materials only).

Based on burden of illness data,<sup>1,33</sup> community-based food preparation (whether in the home or associated with community events such as church gatherings) continues to be an important setting for foodborne illness that adversely affects a large number of people each year. The development of community-based food safety interventions is a complex undertaking because it involves diverse target audiences (e.g., homemakers, extended families, volunteer cooks), many different settings (e.g., schools, community centres, churches),

diverse strategies (e.g., school curricula development, workshops, dissemination of resources, peer education), and many different ethnocultural groups (each with their own food preparation practices). Although the literature contains a growing body of studies that describe innovative, community-based education strategies, the effectiveness of most of these strategies has not been formally evaluated.

In summary, there is evidence for the effectiveness of multiple public health interventions to ensure food safety. It is important to emphasize the need for ongoing high-quality research to inform decision making. Many of the studies identified in this literature review process were of poor quality and therefore not useful in establishing practice guidelines.

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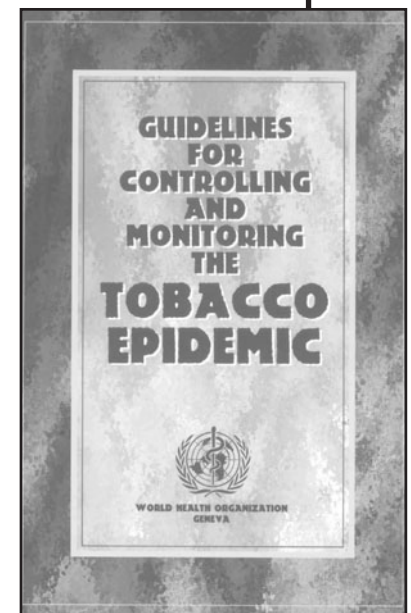
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# Guidelines for Controlling and Monitoring the Tobacco Epidemic

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