A Review of Food Safety and Quality Improvement Mechanisms: Implications For Food Safety Culture in the Food and Drink Manufacturing and Processing Industry.

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Introduction

As prevalence of foodborne disease in the global population persists[1], food safety management is a priority for stakeholders in the food chain. Food safety culture (FSC) is reported to underpin a robust food safety management system, therefore businesses within the food sector have a need to assess and improve FSC. To achieve this, effective improvement mechanisms are required and research suggests that bespoke and targeted interventions may be more effective[2].

During the past 25 years, a number of food safety intervention review publications have been undertaken in a variety of food-related sectors resulting in recommendations for food service establishments[3,4] and for public health food safety interventions[5,6]. Undertaking evaluations of previous studies can identify successful and unsuccessful improvement strategies, including utilisation of targeted food hygiene interventions in public health improvement[6].

Identifying successful intervention strategies may help influence successful FSC improvement strategies in FDMP environments. To date, there have been limited studies relating to food safety and quality improvement within the food and drink manufacturing and processing (FDMP) sector and related areas.

Aims

This study has aimed to evaluate the development, implementation and evaluation of food safety and quality improvement interventions within the food sector.

Methodology

A systematic literature search was undertaken according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology[10] to systematically identify relevant intervention studies. The design of the review is displayed in Figure 1.
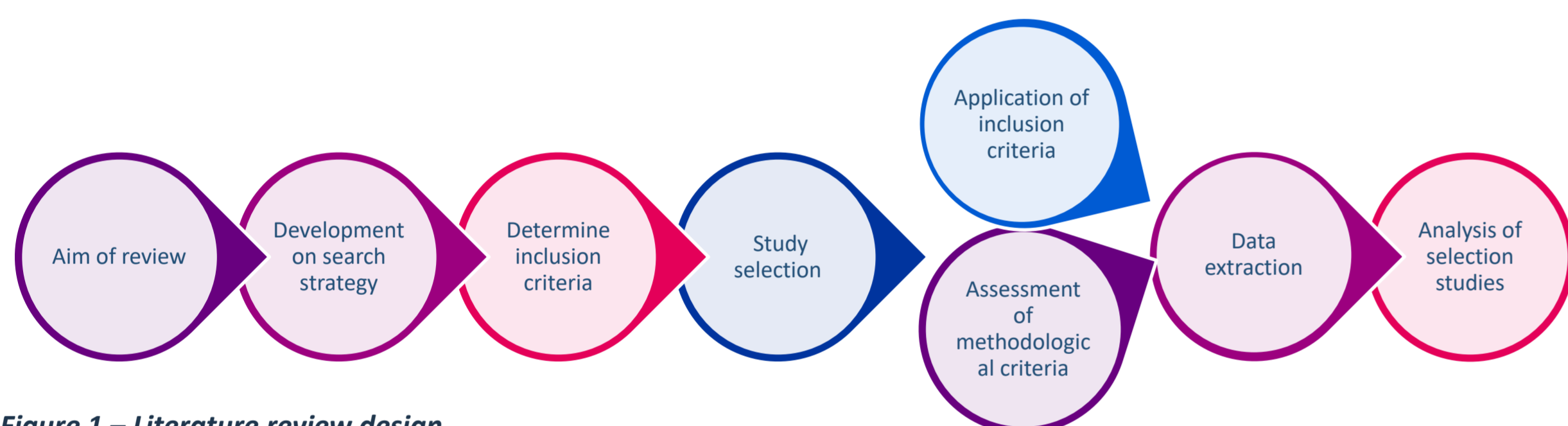
Figure 1 – Literature review design
Adapted from[7,8,9].

The following criteria were used to determine inclusion of studies: primary studies in food safety practice and FSC improvement in FDMP environments, primary studies in food safety practice and FSC improvement in food service environments, primary studies in food safety practice and culture improvement in public health.

It is recognised that processes, procedures and strategies may be varied between manufacturing, food service and public health settings; however, information delivery and application of food safety interventions may have cross sector relevance and therefore both have been included within the scope of this review. A breakdown of study identification using the PRISMA approach can be seen in Table 1.

Review analyses determined:
- Types of interventions utilised for cognitive and behavioural improvement in the sector.
- Intervention effectiveness relating to improved cognitions and behaviours.
- The extent that key FSC parameters have been addressed in relation to food safety.
- Quality improvement interventions in the sector.

Table 1 - PRISMA flow diagram Source: Adapted from[10].

Identification of studies via databases and reference lists	
Identification Records identified from: Databases (n=570) Reference lists (n=16)	Records removed *before screening*: Duplicate records removed (n = 186) Records excluded out of scope (n =303)
Screening Records screened by abstract: (n = 97)	Records excluded (n = 33)
Reports sought for retrieval: (n = 64)	Reports not retrieved (n = 2)
Reports assessed for eligibility: (n = 62)	Reports excluded: Toolkit based on collected study (n = 1) Did not address research questions (n = 14)
Included Studies included in review: (n = 47)	
Sectors Food Manufacturing (n = 6) Food service (n = 18) Public health (n=13) Other (n=11)	

Ethical approval for the review was obtained from the Cardiff Metropolitan School of Health Sciences Ethics Committee (Project Reference Number: PGR-4359).

References

For access to a full reference list, please scan the QR code.

Results and Discussion

Reviewed Paper Characteristics

- Reviewed studies were included from food service (42%), food manufacturing (14%) and public health (30%) sectors. It is recognised that processes, procedures and strategies may vary between such settings; however, information delivery and application of food safety / hygiene interventions may have cross sector relevance and therefore both have been included within the scope of this review.
- Studies from the past 25 years were included in the review, with 38% of studies published between 2018-2022 indicating that there has been increased recognition regarding the importance of food safety, quality and hygiene-related improvement interventions in recent years.
- The majority of studies reviewed were completed in the United States (28%) and studies completed in Brazil and the UK each accounted for 9% of the overall analyses.
- Studies were included from different sized businesses; <10 employees (2%), 11-50 employees (21%), 51-200 employees (35%), 201-500 (33%) and >501 employees (9%).
- The most common aims of the studies that were focussed on food safety improvement (n=41) were behaviour/practice improvement (39%) and knowledge improvement (26%), which are both key elements within food safety culture.

Intervention Types

- Key improvement interventions identified in reviewed studies included various training approaches; posters/signage, notice board, reward and electronic/social media (see Figure 2).
- The most common improvement interventions included one to one training (19%), group training (25%), in-person training (27%) and practical training (12%), suggesting that food safety and quality improvements rely heavily continue to heavily rely on food safety training as part of a food safety management system.
- The majority (95%) of interventions were developed by professional research teams.
- Within the food industry sector, interventions most frequently developed were for food service establishments (17%).
- This highlights that there is a further need for food safety and quality improvement intervention studies to be carried out, particularly within the food manufacturing sector. Furthermore, of the studies identified, there were no studies that aimed to develop a quality improvement intervention in any sector, highlighting an area for further exploration.

Visual Aids: Posters, Signage and Notice Boards
- Cost effective and ability to be targeted.
- Many focussed on hand hygiene compliance.
- May be more effective and sustained when combined with other interventions.

Training
- Practical training can be more effective than theoretical in FDMP environments.
- A training period of no longer than two weeks could be effective.
- Refresher training completed periodically and additional learning opportunities available.

Reward
- Limited studies available for food safety and quality.
- Successful in limited food safety studies – particularly for supervisors.
- Financial rewards have been found to increase motivation (health care settings).

Electronic and Social Media
- Limited studies regarding food safety improvement.
- Used frequently within the food service sector.
- Reported increased efficacy when combined with traditional education techniques.

Figure 2 – Key improvement interventions and findings

Intervention Effectiveness

- Intervention effectiveness was evaluated in 92% of studies, with pre- and post- intervention questionnaire being the most frequently utilised evaluation tool (74%); baseline data was collected in 71% studies. Behavioural change was determined in 25% of studies reviewed.
- Overall, 77% of interventions implemented were successful at improving the targeted area.
- In addition to knowledge and attitude questionnaires, multiple studies used additional food safety indicators to determine intervention effectiveness. Environmental microbiological testing was also utilised to assess effectiveness of food safety improvement training interventions[11,12].
- Furthermore, 30% of reviewed studies used a mixed methods approach to evaluate intervention effectiveness. Triangulation of approaches using such mixed methods to determine aspects of FSC and intervention delivery is reported to strengthen the validity of approaches[19].
- Research has also shown that in order to truly evaluate intervention effectiveness, control groups should be utilised for comparison[13]; however, control groups were only utilised within 21% of studies reviewed.

Mixed Methods

Within this review, it has been identified that 64% of studies used multiple intervention approaches to achieve intended aims.

Research has shown that use of multiple channels and sources of information may increase potential effectiveness of educational initiatives[14].

The most frequently used training types included in-person training (n=17) and group training (n=16). Often training types were combined with other intervention methods e.g. in-person and one to one training was combined with reward interventions to improve food safety related cognitions and attitudes[15] and one to one training was successfully combined with a targeted poster[16].

Using a combination of approaches can provide robustness to an intervention package[17]. Using multiple approaches can reinforce knowledge and desired behaviours and may also ensure that different learning styles are addressed across a population.

Food Safety Culture

Interventions identified from the studies have been coded according to the Culture Excellence FSC categories and dimensions[18].

Findings indicated that interventions were predominantly associated with the "People" category (training: 32%, communication: 30%).

The majority of food safety issues occur due to human intervention; therefore, it can be suggested that intervention strategies focussing on these FSC dimensions may be effective at enabling tangible improvements.

Reviewed studies have not aimed to improve FSC. However, analysis of content has indicated that studies have aimed to improve food safety practices and behaviours and improve food safety attitudes and cognitions which are inextricably linked to the FSC of an organisation.

As there are limited studies developing interventions based on key FSC categories and dimensions, this is an area with a need for further research.

Significance

- Analyses of reviewed studies indicated that successful intervention strategies have included training, noticeboard, reward, poster and electronic/social media interventions. These types of interventions focus on the "People" element of food safety culture.
- As major factors associated with food safety incidence are often attributed to malpractice or behaviours, logic dictates that intervention strategies should be focussed on behaviour improvement. In the studies reviewed, successful interventions related to behavioural change were limited, indicating a need for further research.
- Information dissemination can be successful and cost-effective interventions such as noticeboards, posters and signage can be very effective but should be in a prominent position and changed regularly.
- Individual training interventions were found to be successful in participant groups with limited food safety knowledge; however, this may be less relevant in communities (e.g. food handling manufacturing operatives) who already have experience.
- Questionnaires undertaken pre- and post- intervention are valid evaluation of effectiveness tools; however internally conducted improvement research may be able to utilise other data, therefore strengthening the validity of effectiveness and provides a robust foundation for evaluation.