

Food Safety in Food Service Establishments: A Review of Research Methods, Measures and Triangulation of Findings in Published Research.

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Introduction

With the high prevalence of foodborne illness worldwide there is a concern regarding foodborne outbreaks associated with food-service establishments.³² It is estimated that 2.4 million cases of foodborne illness occur yearly in the UK and that about a half of foodborne outbreaks may be attributed to food service and catering establishments.^{2,17}

Being at the final stage of food production and service, food service employees play a vital role in ensuring food safety. Appropriate implementation of food safety practices such as: preventing cross-contamination, handwashing, cleaning and disinfecting, temperature control, separation of raw and cooked foods, using of safe water and raw materials are of utmost importance.³¹ The complexity of food service operations requires an ongoing cultivation of positive food safety culture to ensure effective management of food safety.^{11,12,20}

In the last 20 years a number of studies have been conducted exploring food safety behaviours of food-service employees with the purpose to ascertain food handler food safety performance. To gain an in-depth understanding cognitive and behavioural factors that influence food handler compliance, and to avoid bias, it is important to rely on findings that are triangulated.^{9,16}

Purpose

This study aimed to identify and analyse primary research studies, focused on food-handler food safety behaviour and cognition in food-service establishments; to explore the utilised methods and measures and to triangulate comparative data to gain deeper understanding of food-handler food safety behaviour and cognition.

Methods

A content analysis of primary research studies ($n=118$), conducted in the last 20 years (2001-2021), detailing food-handler food safety cognition and behaviour in the food-service sector was performed. Findings regarding food safety knowledge, attitude, self-reported practices and observed behaviour were triangulated.

Ethical approval for the study was obtained from the Cardiff School of Sport and Health Sciences Ethics Committee (Project Reference Number: PGR-4434).

Breakdown of the reviewed literature

Quantitative analysis of the food handler food safety studies ($n=118$) has shown that a third (34%) was published in the years 2019-2021, indicating an increased interest in this topic.

The majority of research studies was conducted in the United States (29%), Brazil (17%) and United Kingdom (7%).

Multiple food-service settings were investigated, with the majority of studies conducted in restaurant establishments (70%) and in university (school) food service facilities (31%).

References

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Methods and measures

Different measures and methods were indicated in the food-service food safety studies (Figure 1), as follows:

- Cognitive measures, such as knowledge (58%) and attitude (41%) were most investigated in the reviewed research.
- Behavioural measures were investigated through the self-reports (41%) and observed food safety performance (24%).



Figure 1. Measures investigated in the reviewed research studies ($n=118$).

This review has also determined that:

- Only 11% of reviewed studies investigated a combination of cognitive and behavioural measures.
- Only 28% of studies utilised mixed data collection methods.

Cognitive and behavioural data was captured from food-service food safety studies related to food safety performance (Figure 2):

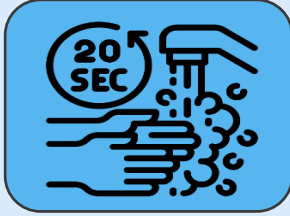
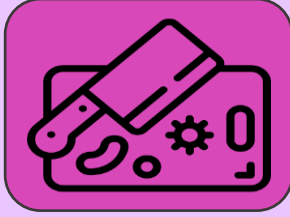
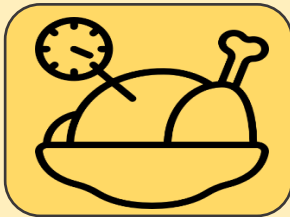
- Food handler food safety was most often investigated through the assessment of food handler knowledge and self-reports.
- There is a particular lack of the observational data detailing the duration of handwashing, occasions when handwashing is performed, freezing/ defrosting and cleaning (Figure 2).



Figure 2. Food safety practices explored in the reviewed studies ($n=118$) through knowledge, self-reports and observation.

Triangulation of findings in the reviewed literature

As previously stated, there is a lack of research investigating a combination of cognitive and behavioural measures. In this literature review the findings of multiple research studies ($n=118$) undertaken in food service establishments were triangulated to create a comprehensive understanding of food handler food safety attitudes, knowledge, self-reported practices and observed behaviour. Hand hygiene, prevention of cross-contamination and temperature control were extensively investigated in the studies, as discussed further.

	Attitudes	Knowledge	Self-Reported Practice	Observed Behaviour
Handwashing 	97-100% of food handlers knew importance of handwashing before handling food, after handling raw food and after using the toilet. ³	97-100% knew to wash hands before handling food and after handling raw foods. ^{7,4,10} 58-87% knew to wash hands after using the toilet. ^{13,19}	18-99% reported washing hands before handling food. ^{1,14,15,27} 64-97% reported handwashing after handling raw products. ^{5,15,21,22,27} 20-95% reported handwashing after using the toilet. ^{1,7,14,19,22}	14-21% were observed washing hands before handling food. ^{6,28} No observational data is available detailing handwashing after handling raw products or using the toilet.
Hand-Food Contact 	95% thought bare hand contact with food was unacceptable. ³⁰	No data is available detailing food handler knowledge regarding hand-food contact.	48-71% reported never using bare hands to probe or touch ready-to-eat food. ^{3,25}	25% did not have direct contact with food during food preparation. ¹⁸
Temperature Control 	73% considered measuring the internal temperature of food important. ¹⁰	31-36% knew the required internal temperature the foods should reach during cooking. ^{23,24}	3-40% reported using a thermometer to check if poultry or meat is fully cooked. ^{5,24,25,27} 27% reported using 'touch'. ⁵ 13% reported using specified period of time. ⁵	43% of cases had food that reached a minimum required internal temperature. ⁸ Cooking controlled by means of preparation time, individual cooking experience and sensory evaluation. ^{26,29}

Handwashing: Many food handlers demonstrated good knowledge of appropriate handwashing practices and self-reported washing hands at appropriate times.⁷ There is a general lack of observational data, but the available studies indicate a possibility of over-reporting and social-desirability bias. Despite having positive attitude and good knowledge, only a small proportion of participants was observed washing hands before food preparation.^{6,28}

Hand-Food Contact: Food handlers were generally aware of the risk of food cross-contamination, and reported that bare hand contact with food was unacceptable.³⁰ However, self-reports and observational data indicates potential malpractice.^{3,25,18} No studies investigated food handler knowledge regarding hand-food contact, but a lack of knowledge about cross-contamination routes and the ways to mitigate the risks may impact appropriate food safety practices.

Temperature Control: Although food handlers reported awareness of the need to measure internal temperature of food when cooking, not many self-reported implementing this practice.^{5,24,25,27} Observational data confirmed the use of sensory and visual clues for temperature control by the food handlers^{26,29}, and the fact that food produced using these methods may not be reaching required cooking temperatures.⁸

Significance of study

- A lack of mixed method studies investigating food handler food safety behaviour was determined.
- Triangulation indicated that knowledge, attitude, and self-reported practices may not reflect the actual behaviour.
- Future studies combining data collection methods and triangulation approach could provide deeper understanding of food-handler cognition and behaviour facilitating the design of food safety education and intervention approaches to reduce the risk of foodborne illness.