A Narrative Review of Food Safety Research Studies of Professional Food-Handlers in **Catering and Food Manufacturing Environments.** Ellen W. Evans^{1*}, Rebecca L. Evatt² & David C. Lloyd¹ Arloesi Bwyd Cymru Food Innovation Wales Llywodraeth Cymru International Association for FOOD Protection ¹ZERO2FIVE Food Industry Centre, Cardiff Metropolitan University. ²Cardiff School of Sport and Health Sciences, Cardiff Metropolitan University, Wales, United Kingdom.











Introduction

Foodborne illness outbreaks associated with manufacturing and catering environments remain a public health concern. The food handler is often identified as one of the key causes of foodborne illness¹, and has been frequently cited as a significant contributory factor for foodborne illness in restaurant-associated outbreaks².

Internationally, cross-contamination, insufficient heat treatment of foods, inadequate refrigerated storage of food, inadequate hand decontamination practices and improper cleaning of food contact surfaces are the most common contributory factors associated with the transmission of foodborne infection^{3, 4}.

Consequently, the UK Food Standard Agency have recommendations in place for food businesses to ensure food safety relating to the four key areas of cross-contamination, cleaning, chilling and cooking⁵. Food-handler implementation and adherence of such recommendations are essential.

Subsequently, there is a need to assess the food safety cognition and behaviour of professional food handlers in the food sector. Numerous studies have been conducted involving professional food-handlers, however, to date, a review of the food safety knowledge, attitudes, self-reported practices and observed behaviours of professional food handlers in the food sector has not be conducted.

Purpose

The purpose of the study was to review the methods and measures utilised in research studies to assess the food safety awareness and practices of professional food-handlers in catering and manufacturing environments.

Methods

Data Collection: An inclusion exclusion criteria was devised to identify primary research studies suitable for inclusion. Professional food-handlers were defined as those that are responsible for the preparation, service or sale of food products to/for consumers, are likely to have undergone food safety training and food handling occurs outside of the domestic environment.

Data capture: A database was devised to capture primary research data regarding the food safety knowledge, self-reported practices, attitudes and behaviour of professional food handlers. Identified research studies were reviewed, and findings were summarised and recorded using the database.

Ethical Approval: Approval was obtained from the Health Care and Food,

A total of 20 research studies detailing professional food-handler food safety data were identified and reviewed in this study.

Publication dates of the identified studies ranged from 2004 to present. More than half (65%) of the research studies were published between 2013 – 2017.

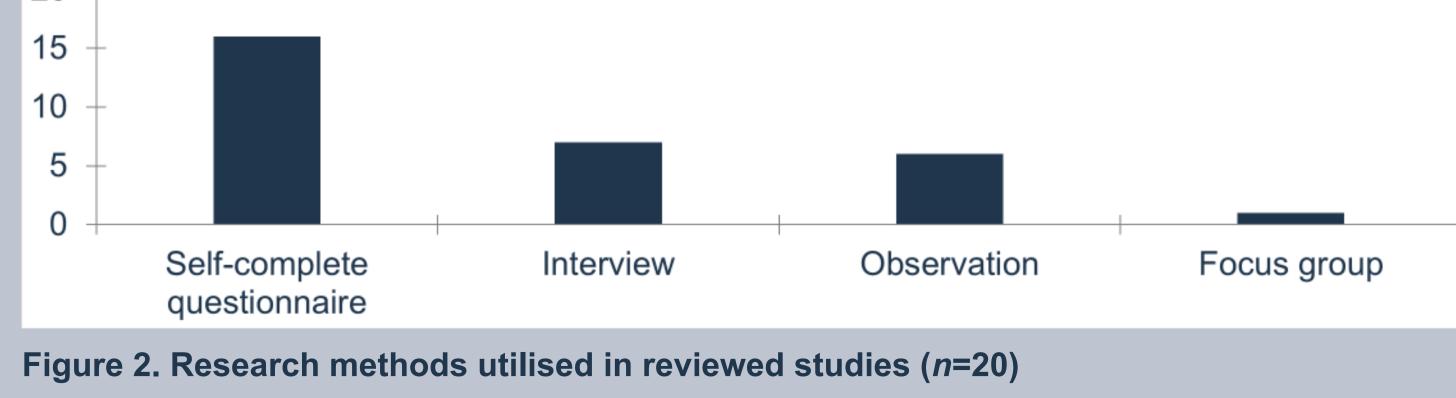
Countries where data collection was conducted included Austria, Brazil, China, Ghana (n=2), Lebanon, Malaysia, Portugal, Saudi Arabia, Serbia, Slovenia (*n*=2), Spain, UK (*n*=2), USA (*n*=4) and Vietnam.

Catering (food service establishment e.g. restaurant/café) e.g. deli/butcher) Institutional food service (school, nursing homes, hospital) ndustry (manufacturing/processing environment e.g. factory) 2 4 6 8 10 12 14 16

Retail (food sales outlet without consumption

This study determined a lack of research detailing food-handler food safety in the food industry sector such as in food manufacturing and processing environments (10%). Given the volume of food produced by the sector data detailing these food-handlers is required.

Figure 2 illustrates that survey methods of data collection were most frequently used in the reviewed studies, which included self-complete questionnaires (80% of studies) and interviews (35%). Observation of behaviour was less frequently used (30%). Only one study utilised focus groups as a method of data collection.



*Corresponding author: elevans@cardiffmet.ac.uk

Results

Reviewed food handler research studies



As indicated in Figure 1 all food handling settings were included in the reviewed studies. The majority of studies (75%) included catering establishments. Fewer studies were conducted in retail and high-risk food service environments (15% of studies).

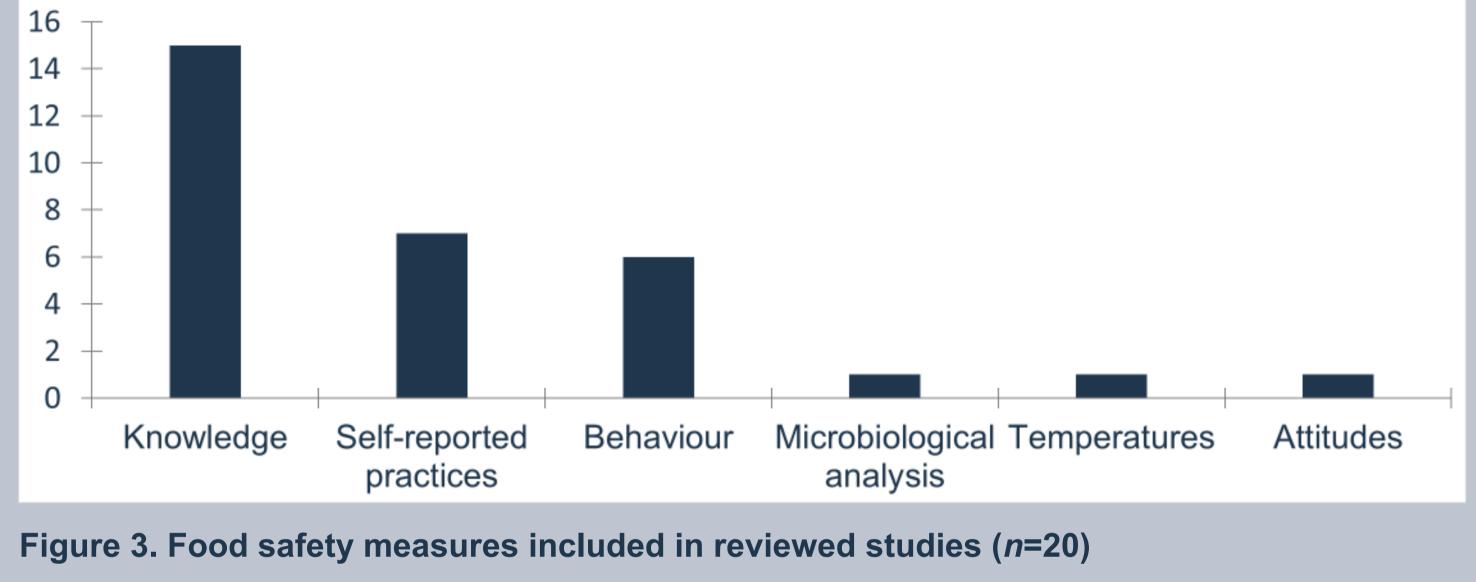
Figure1. Professional food handler setting in food businesses (*n*=20)

Utilised methods

Research measures

Research methods influence the data that can be measured. Given questionnaires were most frequently used, assessment of knowledge and self-reported practices were most frequently determined (Figure 3).

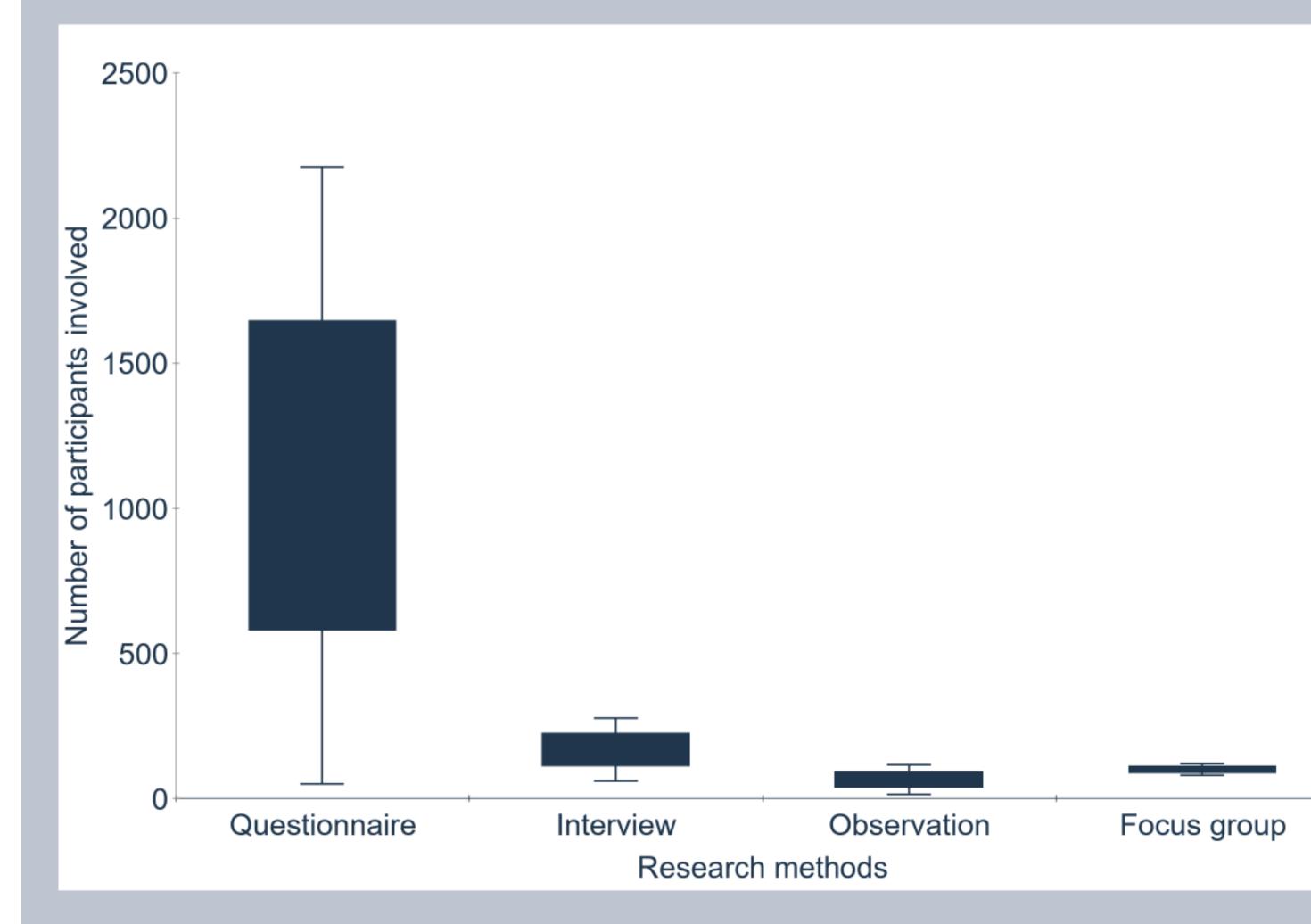
Determination of attitudinal data, actual behaviour along with microbiological and temperature data were less frequent.



Research study sample sizes

The utilised data collection method can also influence the sample size achieved. As illustrated in Figure 4, from the reviewed food-handler food safety studies, survey methods such as questionnaires and interviews obtained the highest sample sizes (< 2,176 food-handlers).

Methods that can be more time consuming and costly to administer such as overt or covert observation of behaviour and focus groups obtained lower sample sizes (<120 food-handlers).



Food safety practices included in studies

The most frequently included food safety topics in the reviewed -handler food safety studies relate to the areas of cleaning, cooking, chilling and separation. Although data detailing 'when' hand hygiene practices were implemented, data the adequate method were less frequently included. Data detailing freezing practices, HACCP principles and personal protective equipment (PPE) were less frequently collated (Figure 5).

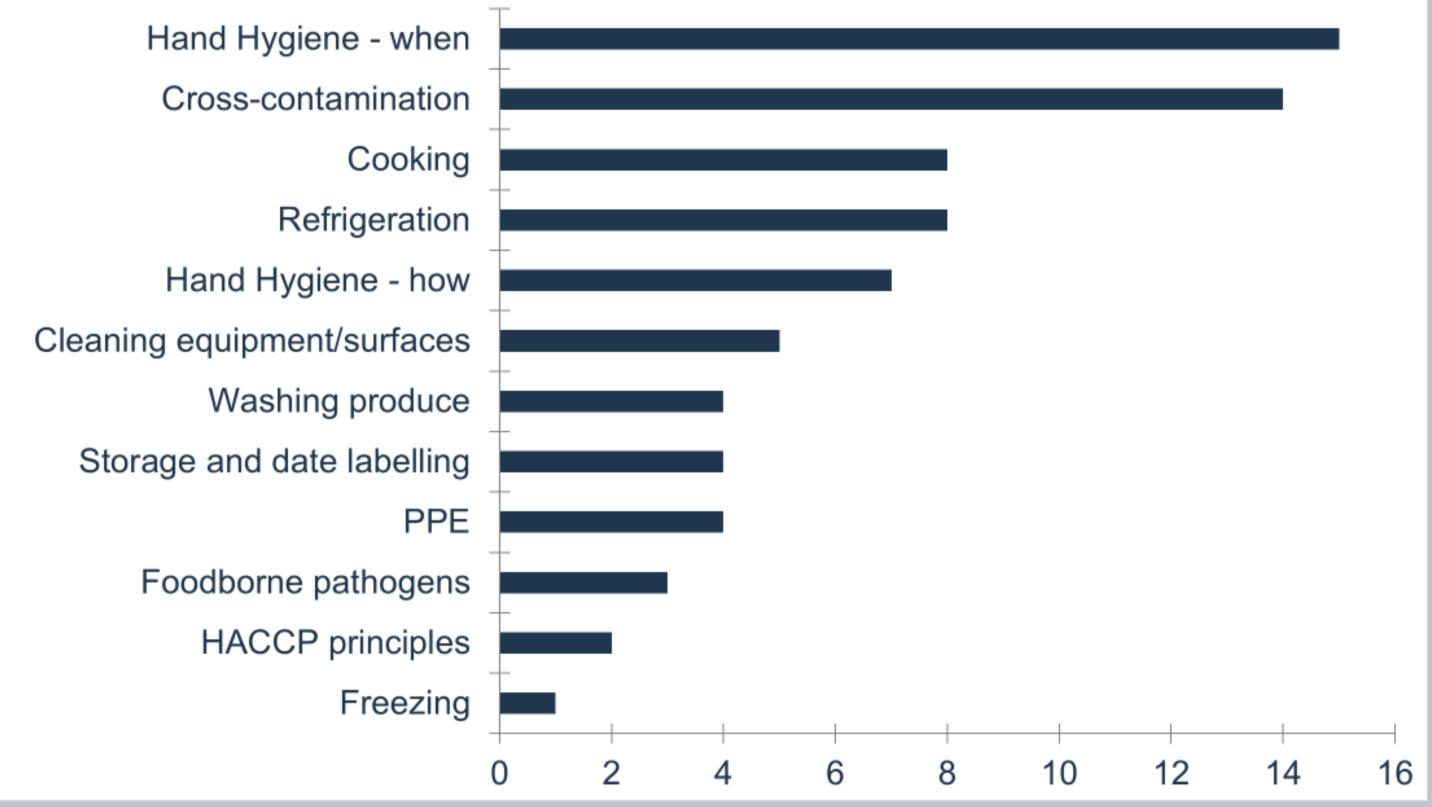


Figure 5. Food safety topics included in reviewed studies (*n*=20)

As indicated in Table 1, food-handlers were most knowledgeable of cleaning and separation practices. However, findings indicate that foodhandlers may implement behavioural malpractices.

Findings suggest discrepancies may exist between knowledge, selfreported practices and observed behaviour, for example >90% were aware of occasions requiring handwashing and reported washing hands at such occasions, however, observational data suggest the majority fail to implement adequate handwashing attempts.

Table 1. Comparison of food safety knowledge, attitudes and observed behavioural data from reviewed studies (*n*=20)

	Knowledge	Self-reported practices	Observe
Cleaning	90 – 99% aware of occasions that required handwashing ^{6, 7}	92 – 95% reported washing hands before/ after specific occasions ^{8, 9, 10}	14% p adequate pra
Cooking	38% aware of the correct temperature to cook raw poultry ¹² 25% not aware of safe holding temperature ¹³	50% reported implementing a corrective action when internal temperature were too low ¹³	Failing cooking was the n viol
Chilling	44 – 87% aware of the safe refrigeration temperature ^{12, 13, 15}	No data available	No data
Separation	89 – 97% aware of the need to separate raw and cooked food ^{6, 9, 13}	36% reported that they use separate utensils to prepare raw and ready-to-eat food ¹⁰	61% us utensils k and coo





ed behaviour

> performed
hand hygiene actice

ng to check temperature most frequent lation

ata available

used different between raw oked foods¹¹

Significance of study

It must be acknowledged that numerous food-handler food safety studies. far exceeding those included in this study have been conducted, however a comprehensive review of the methods and measures utilised in such studies has not been conducted. Completion of this narrative review has identified the need for an in-depth systematic literature review to further explore the topic.

Although vast research exists in relation to food-handler food safety, firstly, there seems to be a lack of research conducted in food manufacturing environments, the majority of research focuses on retail catering and hospitality, secondly, the majority of research incorporates the measures of food safety knowledge and self-reported practices suggesting there is a lack of observational data.

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Handouts

All posters from the ZERO2FIVE Food Industry Centre are available for download from: www.cardiffmet.ac.uk/health/zero2five/research