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Review

A systematic review of the knowledge, attitude, and practices (KAP) of food safety among street food handlers

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Abstract

Foodborne diseases are commonly reported from various food establishments; however, little information has been obtained on this topic from the street food industry. Therefore, the present systematic review aimed to provide an overview of the knowledge, attitude, and practices (KAP) of food safety among street food handlers to highlight relevant gaps in the safety and quality of food handling. Articles included in the present systematic review were extracted from several electronic databases based on the PRISMA protocol and CASP checklist. By applying inclusion criteria, twelve peer-reviewed studies from 2010 to 2020 were included in the present systematic review. Results revealed that the food safety KAP level among street food handlers varied across the study settings. It was also found that training plays an essential role in improving food safety practices. KAP assessment is essential as an initial diagnosis to guide and prioritise appropriate strategies based on the food safety aspect that requires the most attention. It also provides a decision-making basis for food safety authorities to develop relevant policies, and organise food safety training.

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Introduction

Food is a necessity in everyone's daily life as it provides energy and maintains human bodily functions. However, the consumption of spoiled food has detrimental effects on human health, known as foodborne disease. Foodborne disease refers to an illness caused by the ingestion of food that is contaminated physically, chemically, or biologically due to poor production, handling, or storage (Al-Mamun *et al.*, 2018). To avoid such disease, food safety practices are crucial. Food safety refers to the safe handling of food and beverage products at any point in the production chain to prevent the risk of foodborne disease (Scallan *et al.*, 2011).

Most reported foodborne disease outbreaks occur when people consume food outside their homes, such as in restaurants, cafeterias, and stalls (Woolhouse and Rocheleau, 2017). However, limited information exists regarding the street food industry despite preliminary findings that observed the consumption of roadside food could increase the risk of foodborne diseases which are caused by a wide variety of pathogens (Lee *et al.*, 2017), as well as by contamination due to inadequate facilities, lack of environmental control at vending sites, and poor food safety practices among street food handlers (Adane *et al.*, 2018).

The location of the street-vending stalls by the side of high-traffic, overcrowded roads, or near waste-dumping sites further contributes to the dispersion of airborne contaminant particles and subsequent contamination (Mohd Nawawee *et al.*, 2019). Wastewater and waste disposed at street vending sites often attract pests and rodents such as rats, cockroaches, and flies. Therefore, food items are not protected from dust and flies, which may be carriers of harmful pathogens (Alimi, 2016). Moreover, street food handlers often escape effective food safety regulations and inspections due to the mobile, itinerant, and temporary nature of their premises (Isoni Auad *et al.*, 2019).

The key person who must ensure strict adherence to food safety principles to reduce food contamination is the food handlers themselves (Asmawi *et al.*, 2018). Food handlers' improper food

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handling techniques lead to food contamination and spoilage, thus risking consumers' health. Food safety malpractices that contribute to food poisoning include the use of contaminated raw materials, cross-contamination during handling, food preparation too far ahead of service (more than four hours before serving time), as well as temperature abuse during storage, preparation, handling, and service (Valero *et al.*, 2016; Salleh *et al.*, 2017; Adane *et al.*, 2018). Therefore, it is essential for food handlers to possess adequate knowledge and understanding of proper food handling, preparation, and storage to promote safe food practices. Knowledge of food safety would regulate their positive attitude towards food safety practices along with their compliance towards food safety principles in handling their daily business (Siau *et al.*, 2015; Ncube *et al.*, 2020).

On the other hand, low level of knowledge and negative attitude towards food safety would directly cause the outbreak of foodborne disease, thus creating economic losses (Hussain and Dawson, 2013) from the changing buying patterns of consumers and the increasing national expenditure for medical treatments. Despite its importance, so far, there has been no comprehensive study assessing the knowledge, attitude, and practices (KAP) of food safety among street food handlers. Determining the status of street food handlers' KAP towards food safety can greatly help policymakers develop better plans to build these individuals' knowledge, create a positive attitude among them, and improve their proper practices. Therefore, the present systematic review aimed to evaluate the KAP of street food handlers towards food safety through the rigorous and systematic screening, selection, analysis, and reporting of extant studies to present strong comprehensive evidence.

Materials and methods

Eligibility criteria

The present systematic review has been registered in the International Prospective Register of Systematic Reviews (PROSPERO; ID: CRD42021227812). It was conducted based on the Cochrane Handbook, and reported using the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) protocol. The present systematic review involved cross-sectional studies on street food handlers published since 2010 in English peer-reviewed journals. Pure qualitative, microbiological laboratory-based, review, and non-English studies were excluded. The outcomes measured in the selected studies were the KAP of street food handlers towards food safety.

Search strategy

The process of identifying, screening, excluding, and including previous research articles in this systematic review employed several electronic databases (ScienceDirect, MEDLINE, CINAHL, PubMed, and Google Scholar). PROSPERO was also searched for ongoing reviews. Additional literature was acquired by assessing the reference lists of all identified studies. Keywords for the searches were first determined with the help of Medical Subject Headings (MESH), and then combined with related words in published articles. The keywords used were: "knowledge" OR "attitude" OR "practice" OR "street food handlers", alternated with "AND" using the Boolean search.

Selection of studies and data extraction

The process of article selection, screening, quality assessment, and data extraction was performed independently by two researchers using the consensus method to resolve any disagreements in the final selection of studies to be reviewed. After searching the databases, the articles were entered into the EndNote software. During the initial screening, duplicated articles were removed, and irrelevant titles were excluded. Then, the abstracts of the remaining articles were reviewed based on the inclusion criteria; items that did not meet the criteria were excluded. Lastly, the full texts of the articles were reviewed before choosing the final items. Extracted items included: author, year, country, study design, number of participants, target population, instrument (type, items, reliability, and validity), study outcome measure, study methodology (sampling, data collection, and data analysis), main outcomes (KAP), and recommendations to improve the KAP of street food handlers towards food safety.

Quality assessment

The studies included in the present systematic review were assessed and critically appraised using the Joanna Briggs Institute's checklist for Analytical Cross-Sectional Studies. This checklist consists of eight items that evaluate the methodological quality of a cross-sectional study to determine the possibility of bias in its design, conduct, and analysis (Table 1).

Table 1. Summary of the JBI Critical Appraisal Checklist for selected studies (n = 12).

Author (Year)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Isoni Auad *et al.* (2019)	Y	Y	Y	Y	Y	UC	Y	Y
Ma *et al.* (2019)	Y	Y	Y	Y	N/A	N/A	Y	Y
Ismail *et al.* (2016)	Y	Y	Y	Y	Y	Y	Y	Y
Samapundo *et al.* (2016)	Y	Y	Y	Y	N/A	N/A	Y	Y
Samapundo *et al.* (2015)	Y	Y	Y	Y	N/A	N/A	Y	Y
Liu *et al.* (2014)	Y	Y	Y	Y	Y	Y	Y	Y
Aluko *et al.* (2014)	Y	Y	Y	Y	Y	UC	Y	Y
Sun *et al.* (2012)	Y	Y	Y	Y	N/A	N/A	Y	Y
Rahman *et al*. (2012	Y	Y	Y	Y	Y	UC	Y	Y
Muyanja *et al.* (2011)	Y	Y	Y	Y	Y	Y	Y	Y
Choudhury *et al.* (2011)	Y	Y	Y	Y	Y	UC	Y	Y
Ackah *et al.* (2011)	Y	Y	Y	Y	N/A	N/A	Y	Y

Q1: Were the criteria for inclusion in the sample clearly defined?; Q2: Were the study subjects and the setting described in detail?; Q3: Was the exposure measured in a valid and reliable way?; Q4: Were objective, standard criteria used for measurement of the condition?; Q5: Were confounding factors identified?; Q6: Were strategies to deal with confounding factors stated?; Q7: Were the outcomes measured in a valid and reliable way?; Q8: Was appropriate statistical analysis used?; Y: yes; N: no; UC: unclear; and N/A: not applicable.

Results

Study selection

Initially, 843 articles were found through the database search, of which 502 articles remained after deleting duplicates. Of these, 368 were excluded for not meeting the inclusion criteria, while another 122 were removed for not being the right type (*i.e.*, reviews, letters to the editor, pure qualitative studies, and microbiology laboratory-based studies). Finally, a feasible amount of 12 articles were identified and examined in the present systematic review (Figure 1).

Characteristics of the selected studies.

The 12 cross-sectional studies included in the present systematic review involved 1,166 street food handlers. The studies were carried out in the years 2011 (n = 3), 2012 (n = 2), 2014 (n = 2), 2015 (n = 1), 2016 (n = 2), and 2019 (n = 2). Most of them were conducted in Asia (n = 7), followed by countries in Africa (n = 3), North America (n = 1), and South America (n = 1). No study was done in Europe and Oceania. The most common type of sampling method used in the studies was random sampling (n = 9). The mean age of the street food handlers who participated in the studies was 45.8 years old. Out of the 1,166 street food vendors researched across all the studies, a large majority were women (n = 985; 84.48%) (Table 2).

Tools

Different measurement tools were used in all the 12 reviewed studies, the most common being researcher-made (n = 8). The tools' contents appeared to have been developed using national, World Health Organization (WHO), and Center for Disease Control and Prevention (CDC) guidelines. The tools included information on the sociodemographic profile of street food handlers and several aspects of food safety, such as personal hygiene, food storage and handling, knowledge of foodborne disease, street-vending environment, and practices of cleaning and sanitation. All studies utilised validated tools that were pre-tested and pilot-tested. The reliability of the various tools was determined via Cronbach's alpha or Kuder Richardson 20 with a score range from 0.71 to 0.81, thus indicating the acceptable reliability of inter-item consistency.

Data collection

The selected studies in the present systematic review employed a cross-sectional quantitative design either via a self-reported questionnaire (n = 3) or a mixed-method approach combining a self-reported questionnaire with a semi-structured interview and/or direct observational checklist (n = 9) to yield data regarding food safety KAP among street food handlers.

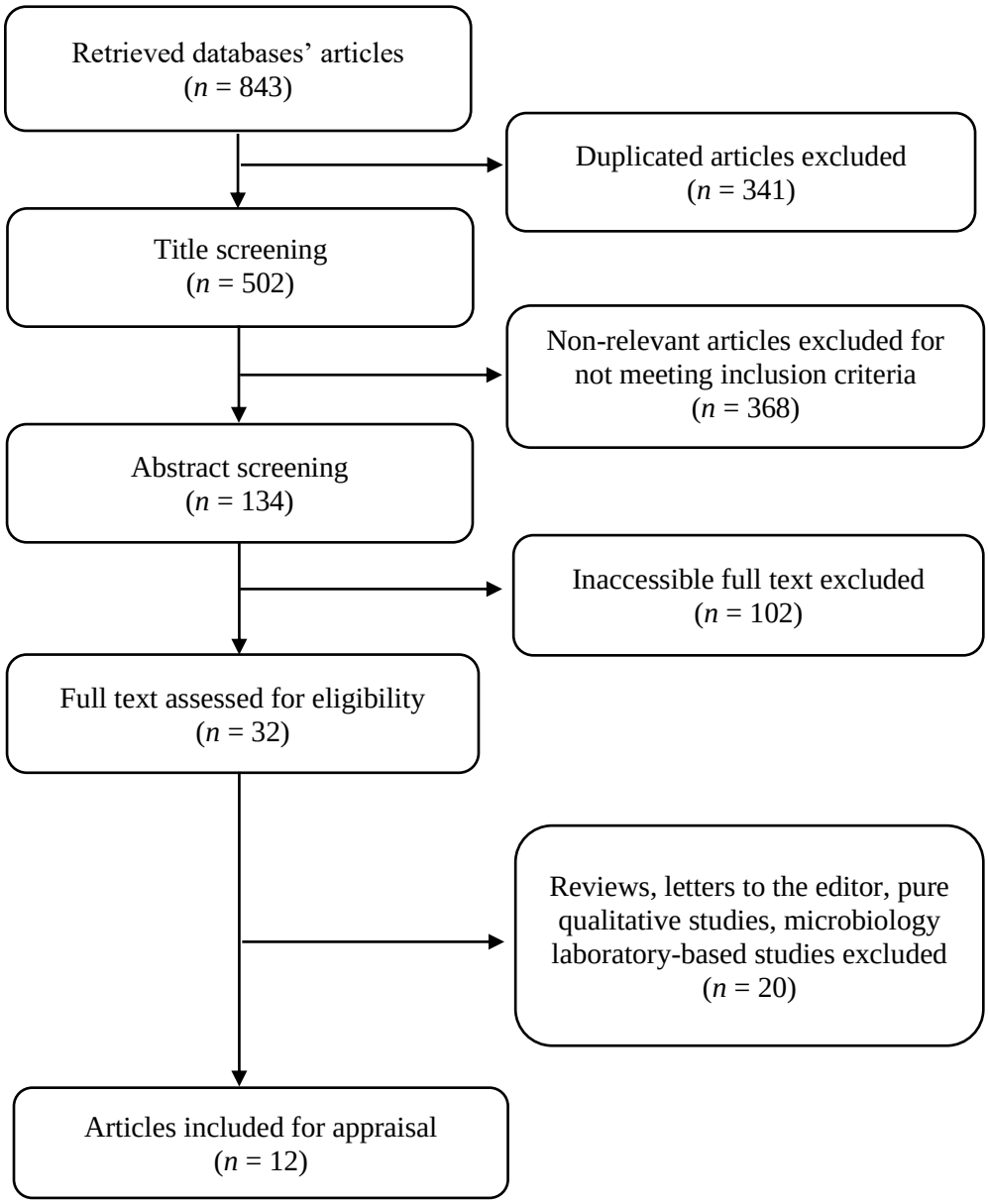

Figure 1. Search strategies according to the PRISMA guideline.

Table 2. Description of the studies on the KAP of food safety among street food handlers.

Author (year)	Country	Study characteristics	Tools	Participants	Knowledge	Attitude	Practice
		(i) Design **(ii) Outcome measure** **(iii) Sampling method** **(iv) Data collection method**	**(i) Type** **(ii) Items** **(iii) Reliability and validity**	**(i) Target population** **(ii) Number of participants** **(iii) Age** **(iv) Gender (Male/Female)**	**Mean** **Level**	**Mean** **Level**	**Mean** **Level**
Isoni Auad *et al.* (2019)	Brazil	(i) Cross-sectional (ii) Knowledge, attitude, practice (iii) Convenience (iv) Interview	(i) Researcher-made (ii) 37 (iii) Approved (0.634)	(i) Food truck vendors (ii) 40 (iii) 32.6 (iv) 32 / 8	7.23 Good	6.85 Good	7.73 Good
Ma *et al.* (2019)	China	(i) Cross-sectional (ii) Knowledge, attitude, practice (iii) Random (iv) Questionnaire, checklist	(i) Researcher-made (ii) Questionnaire/ checklist (40/35) (iii) Approved (NR)	(i) Street food handlers (ii) 100 (iii) 34.4 (iv) 34 / 66	58 Satisfactory	62 Good	NR Inadequate facilities, unhygienic practice
Ismail *et al.* (2016)	Malaysia	(i) Cross-sectional (ii) Knowledge, practice (iii) Cluster (iv) Questionnaire	(i) Adopted from previous research (ii) 35 (iii) NR	(i) Mobile food handlers (ii) 320 (iii) NR (iv) 168 / 150	2.37 - 4.59 Strongest predictor practice ($\beta = 0.624$)		2.71 - 4.29 NR
Samapundo *et al.* (2016)	Vietnam	(i) Cross-sectional (ii) Knowledge, attitude, practice (iii) Random (iv) Questionnaire, checklist	(i) Adopted from previous studies (ii) Questionnaire/ checklist (40/26) (iii) NR	(i) Street food vendors (ii) 40 (iii) 40.7 (iv) 11 / 29	38 Poor	40 Poor	NR Poor personal hygiene, unhygienic stalls
Samapundo *et al.* (2015)	Haiti	(i) Cross-sectional (ii) Knowledge, attitude, practice (iii) Random (iv) Questionnaire, checklist	(i) Adopted from previous studies (ii) Questionnaire/ checklist (40/26) (iii) NR	(i) Street food vendors (ii) 80 (iii) 34.4 (iv) 9 / 71	60 Adequate	73 Adequate	NR Lack of waste disposal facilities
Liu *et al.* (2014)	China	(i) Cross-sectional (ii) Knowledge, practice (iii) Random (iv) Questionnaire, checklist	(i) Adopted from previous study (ii) Questionnaire/ checklist (4/16) (iii) NR	(i) Street food vendors (ii) 50 (iii) 35 - 54 (iv) 28 / 22	NR Lack in knowledge		NR Low
Aluko *et al.* (2014)	Nigeria	(i) Cross-sectional (ii) Knowledge, practice (iii) Systematic (iv) Questionnaire, interview	(i) Researcher-made (ii) 28 (iii) Validated	(i) Street food vendors (ii) 160 (iii) 32.9 (iv) 13 / 147	NR Most aware of the foodborne diseases' symptoms		NR Poor personal hygiene

Sun *et al.* (2012)	Taiwan	(i) Cross-sectional (ii) Knowledge, practice (iii) NR (iv) Questionnaire	(i) Adopted from previous research (ii) 42 (iii) NR	(i) Street food vendors (ii) 120 (iii) > 30 (iv) 69 / 51	NR Low		NR Unsatisfactory hand washing practices
Rahman *et al.* (2012)	Malaysia	(i) Cross-sectional (ii) Knowledge, attitude, practice (iii) Non-probability (iv) Questionnaire, interview	(i) Researcher-made (ii) 44 (iii) Validated	(i) Street food vendors (ii) 361 (iii) 30.9 (iv) 171 / 190	6.7 Poor	38.4 Poor	25.5 Poor
Muyanja *et al.* (2011)	Uganda	(i) Cross-sectional (ii) Knowledge, practice (iii) NR (iv) Questionnaire, interview, focus group discussion	(i) Researcher-made (ii) 32 (iii) NR	(i) Street food vendors (ii) 225 (iii) 21 - 40 (iv) 28 / 197	NR Limited knowledge on foodborne disease		NR Fairly good personal hygienic behaviour
Choudhury *et al.* (2011)	India	(i) Cross-sectional (ii) Knowledge, practice (iii) Selective (iv) Questionnaire	(i) Researcher-made (ii) NR (iii) Pre-tested	(i) Street food vendors (ii) 80 (iii) 21 - 40 (iv) 38 / 5	NR Low		NR Very poor personal hygiene, unhygienic food handling practice and vending site
Ackah *et al.* (2011)	Ghana	(i) Cross-sectional (ii) Knowledge, practice (iii) Random (iv) Questionnaire	(i) Researcher-made (ii) 31 (iii) Pre-tested	(i) Street food vendors (ii) 50 (iii) 25 - 50 (iv) 10 / 40	NR Good		NR Good

Data analysis

All data acquired by the studies in the present systematic review was computed in various versions of the Statistical Package for the Social Sciences (SPSS) software (n = 10) or the Spotfire S+ software (n = 2). The results were presented descriptively and inferentially to identify the relationship between food safety KAP and the sociodemographic characteristics of street food handlers. The Mann-Whitney test, Kruskal-Wallis test, Wilcoxon rank-sum, linear regression, analysis of variance (ANOVA), and chi-square test were among the statistical analyses conducted based on the normality of data in each study.

Food safety knowledge of street food handlers

In the present systematic review, all included studies evaluated the level of street food handlers' knowledge of food safety. The level of knowledge was expressed descriptively as the percentage of participants with adequate food safety knowledge. Among the 12 studies, three studies adopted a similar three-tier scoring system to determine the level of food safety knowledge among street food handlers, *i.e.*, poor (any score below 50%), average (any score from 50 to 75%), and good (any score above 75%). The level of knowledge of street food handlers ranged from 38 to 60% in all the studies (Samapundo *et al.*, 2015; 2016; Ma *et al.*, 2019).

Although the remaining nine studies did not specify their scoring system, they addressed their findings on the food safety knowledge of street food handlers as either adequate or inadequate/poor. Some (n = 5) found that street food handlers are adequately knowledgeable towards food safety, in contrast to the other four studies in India, Uganda, Malaysia, and China.

Moreover, similarities were observed in the domains of food safety knowledge measured in the included studies, such as personal hygiene (n = 12), cross-contamination (n = 9), foodborne disease (n = 9), and sanitation (n = 5). In terms of personal hygiene, eight out of 12 studies reported that most street food handlers possessed adequate knowledge, especially about the importance of handwashing and wearing personal protective equipment such as a head cover, mask, apron, and gloves.

Next, street food handlers' knowledge of food cross-contamination were measured and analysed in nine studies. Results revealed that more than half of street food handlers were not aware of practices that may cause food contamination, for instance, eating or drinking during food preparation (Samapundo *et al.*, 2016; Ma *et al.*, 2019), poor assessment of raw ingredients (Liu *et al.*, 2014), and inadequate food reheating before serving (Samapundo *et al.*, 2015; 2016). In contrast, studies in Malaysia (Rahman *et al.*, 2012; Ismail *et al.*, 2016) reported adequate food hygiene knowledge among most street food handlers, especially regarding the need to separate raw and cooked materials as well as to avoid smoking during food preparation and handling.

Nine of the selected articles assessed street food handlers' knowledge of foodborne disease, such as its symptoms (n = 8), responsible pathogens (n = 3), risk group (n = 3), and management (n = 5). The symptoms of foodborne diseases recognised by most street food handlers in Nigeria are vomiting, abdominal pains, and diarrhoea (Aluko *et al.*, 2014). Conversely, a study in Taiwan found that food handlers were not familiar with all possible foodborne disease symptoms (Sun *et al.*, 2012). Most street food handlers were shown to be unaware of the common pathogens responsible for foodborne diseases, such as hepatitis A, *Salmonella* spp. and *Staphylococcus* spp. (Samapundo *et al.*, 2015; 2016; Ma *et al.*, 2019). Nonetheless, street food handlers knew that they must leave work if they exhibit symptoms of any infectious disease, and must cover skin lesions with a waterproof bandage to reduce the introduction of any pathogen into food (Sun *et al.*, 2012; Aluko *et al.*, 2014; Samapundo *et al.*, 2015; 2016; Ma *et al.*, 2019). However, the primary concern raised in these studies was that some street food handlers continued working despite suffering from foodborne disease, as they wish to avoid income loss during their treatment period (Aluko *et al.*, 2014).

The last component of food safety knowledge evaluated by five out of the 12 selected studies is equipment cleaning and sanitation. Two-thirds of the street food handlers in the studies had good knowledge of proper cleaning techniques, and were well-aware that cleaning and sanitation reduces the risk of food contamination, thus minimising the potential outbreak of foodborne disease (Ismail *et al.*, 2016; Isoni Auad *et al.*, 2019; Ma *et al.*, 2019). However, more than three-quarters of street food handlers in China were found to lack awareness of the

importance of good sanitation practices due to limited sanitation facilities and drainage infrastructure at street food vending sites (Liu *et al.*, 2014).

Generally, the studies suggested that street food handlers had inadequate food safety knowledge (Choudhury *et al.*, 2011; Muyanja *et al.*, 2011; Liu *et al.*, 2014; Samapundo *et al.*, 2016; Ma *et al.*, 2019). Though some had a satisfactory level of knowledge (Ackah *et al.*, 2011; Rahman *et al.*, 2012; Ismail *et al.*, 2016; Isoni Auad *et al.*, 2019), they were lacking in several essential food safety components, which can be improved through continuous training and education.

Food safety attitude of street food handlers

In terms of food safety attitude, street food handlers in Brazil (Isoni Auad *et al.*, 2019), China (Ma *et al.*, 2019), Haiti (Samapundo *et al.*, 2015), and Malaysia (Rahman *et al.*, 2012) demonstrated a positive attitude towards food safety practices in the selected studies. They agreed with several food safety statements regarding the effect of the improper storage of food (Rahman *et al.*, 2012; Samapundo *et al.*, 2015; Isoni Auad *et al.*, 2019), the need for health assessments before commencing work (Ma *et al.*, 2019), and adequate temperatures for food cooling and reheating (Samapundo *et al.*, 2015; Isoni Auad *et al.*, 2019; Ma *et al.*, 2019). However, a poor attitude was found among street food handlers in Vietnam (Samapundo *et al.*, 2016). Most of them were unaware of the importance of regular temperature checking of refrigerators, health assessments, personal hygiene, and separated raw and cooked food storage.

Food safety practices of street food handlers

In the reviewed studies, the researchers utilised different methods to assess the food safety practices of street food handlers. Data collection methods encompassed a self-reported questionnaire (n = 7), an on-site observation checklist (n = 4), and both self-reported and observed food safety practices (n = 1).

The food safety practice scores in each study were expressed descriptively as the percentage of participants who rated the assessed items. Among the 12 studies, only one (Rahman *et al.*, 2012) adopted a scoring system for food safety practices based on Bloom's formula, categorising the practices into three levels: poor, average, and good. Some studies (n = 3) mentioned the mean score of food safety practices along with the possible minimum and maximum scores; however, the categorisation was unclear.

Although the remaining nine studies did not specify their scoring system, they explained their findings on the food safety practices of street food handlers as adequate, good or inadequate, poor, low, or unsanitary. In general, the practices of food safety among street food handlers in these studies were found to be inadequate, with vending sites being far from hygienic. In contrast, some studies (n = 4) discovered that street food handlers in Ghana, Uganda, Malaysia, and Brazil showed a good level of food safety practices. Moreover, some similar domains were seen in the measurement of food safety practices in the included studies, such as personal hygiene (n = 12), food handling and storing (n = 5), cleaning and sanitising (n = 7), and the surrounding environment (n = 6).

It was discovered that most street food handlers in the selected studies (n = 6) had poor personal hygiene practices. Studies conducted in Haiti (Samapundo *et al.*, 2015), Vietnam (Samapundo *et al.*, 2016), China (Liu *et al.*, 2014; Ma *et al.*, 2019), and Nigeria (Aluko *et al.*, 2014) showed that a majority of street food handlers prepared food and handled money using their bare hands, and rarely washed their hands with soapy water. On top of that, street food vendors in Nigeria self-reported that approximately half of them practiced open defecation, but only 17% of them always washed their hands afterward (Aluko *et al.*, 2014). Similarly, in China (Liu *et al.*, 2014), almost half the handlers did not practice handwashing after visiting the toilet or handling raw materials. Other unhygienic practices were prevalent, such as nose-picking, spitting, and sneezing when there were no customers. In addition, more than half the street food handlers in all the selected studies reportedly did not wear any head covers, except the female food handlers in Samapundo *et al.*'s (2015) study, who traditionally cover their head.

Inadequate practices were also demonstrated with regards to food handling and storing. Barely half the street food handlers separated raw materials or ingredients from cooked or ready-to-eat food (Aluko *et al.*, 2014; Liu *et al.*, 2014; Ma *et al.*, 2019), though all handlers appeared to practice this adequately in Haiti (Samapundo *et al.*, 2015). Raw and cooked materials need to be stored and handled separately to reduce the introduction of pathogens and food cross-

contamination (Ohiokpehai, 2003). Additionally, an improper temperature of raw food storage was discovered in several studies (Aluko *et al.*, 2014; Liu *et al.*, 2014; Samapundo *et al.*, 2015).

As for the practice of cleaning and sanitising, street food handlers were aware of the importance of using soapy water to prevent cross-contamination between kitchen tools and cooked foods, as such contamination represents a potential health risk for consumers. These relevant practices were observed in Nigeria (Aluko *et al.*, 2014), Uganda (Muyanja *et al.*, 2011), Vietnam (Samapundo *et al.*, 2016), and Haiti (Samapundo *et al.*, 2015). However, further investigation indicated that most food handlers collected dishwashing water from the nearest public facility using a bucket, and placed it on the floor. This water, used to wash and rinse utensils, was rarely replaced until visibly dirty (Muyanja *et al.*, 2011; Samapundo *et al.*, 2016).

Meanwhile, during their busiest hours, such as lunch and dinner, more than half the street food handlers cleaned their dishes with just cold water, towels, or tissues after each use (Muyanja *et al.*, 2011; Sun *et al.*, 2012). This was practised due to limited access to water at the street-vending site (Choudhury *et al.*, 2011; Sun *et al.*, 2012; Samapundo *et al.*, 2016; Ma *et al.*, 2019) and payment required to collect water (Muyanja *et al.*, 2011). However, the payment system was only implemented in certain countries.

Lastly, studies observed the vending site's surrounding environment to evaluate the external factors that may threaten the food safety practices of street food handlers. Their findings showed that the location and condition of food vending sites were highly unhygienic, with flies and animals evident around the stalls (Choudhury *et al.*, 2011; Muyanja *et al.*, 2011; Samapundo *et al.*, 2015; 2016), as well as limited handwashing, toilet, and waste disposal facilities (Liu *et al.*, 2014; Ma *et al.*, 2019).

Furthermore, almost all stalls were not covered or protected from the sun, wind, and dust (Liu *et al.*, 2014; Samapundo *et al.*, 2015; 2016), which may cause the transmission of pathogenic microorganisms to the prepared foods. Each street food stall was equipped with a trash can; however, it was generally not covered, and the waste was often overflowing, which attracted flies and other insects, and consequently, creates the possibility of food contamination (Muyanja *et al.*, 2011).

Association between street food safety KAP

Several studies in the present systematic review (n = 8) assessed the association between the KAP elements of street food safety. Both studies in Malaysia (Rahman *et al.*, 2012; Ismail *et al.*, 2016) revealed that food safety knowledge was the most influential factor in predicting food hygiene practices. They also established positive correlations between food safety knowledge, personal hygiene, and food hygiene practices.

On the contrary, some studies included in the present systematic review found that attitude was not always translated into practice (Samapundo *et al.*, 2016), knowledge was not always translated into practice (Rahman *et al.*, 2012), and neither knowledge nor attitude were translated into practice (Samapundo *et al.*, 2015). There was also low agreement between self-reported measures of food safety KAP and the observed practices of street food handlers (Isoni Auad *et al.*, 2019).

Sociodemographic factors affecting street food safety KAP

Several studies in the present systematic review analysed the difference in the food safety KAP of street food handlers based on their sociodemographic characteristics. First, studies conducted in Taiwan (Sun *et al.*, 2012) and China (Ma *et al.*, 2019) revealed a significant relationship between gender and food safety knowledge, whereby females possessed better knowledge.

Next, studies in Malaysia (Rahman *et al.*, 2012), Taiwan (Sun *et al.*, 2012), and China (Ma *et al.*, 2019) found a significant relationship between age, food safety knowledge, and practices. Street food handlers' level of education was also revealed to have a positive effect on food safety knowledge (Samapundo *et al.*, 2016; Ma *et al.*, 2019) and attitude (Samapundo *et al.*, 2016).

Interestingly, food handlers' years of experience in the street food industry demonstrated an inverse influence on their food safety knowledge (Sun *et al.*, 2012) and attitude (Rahman *et al.*, 2012). Street food handlers with a shorter work experience appeared to possess better food safety knowledge and attitude than those with long experience in the industry. Additionally, street food handlers' average income played an essential role in food safety knowledge (Choudhury *et al.*, 2011; Samapundo *et al.*, 2016) and attitude (Isoni Auad *et al.*, 2019).

Similarly, street food handlers' marital status indicated a significant relationship with knowledge (Sun *et al.*, 2012) and attitude (Isoni Auad *et al.*, 2019) towards food safety.

Lastly, a significant relationship was established between food safety training and food handlers' level of knowledge (Samapundo *et al.*, 2015; 2016), attitude (Rahman *et al.*, 2012; Samapundo *et al.*, 2015; Isoni Auad *et al.*, 2019), and practices (Rahman *et al.*, 2012). In contrast, Sun *et al.* (2012) discovered that training had no effect on food safety KAP among street food handlers.

Discussion

Based on the KAP model proposed by the WHO (2008), knowledge can directly impact an individual's attitude and practices, while attitude can influence practices. This suggests that an increment in knowledge can improve an individual's attitude, and change his/her behaviours and practices (Schwarz *et al.*, 2009). Essentially, food handlers must possess adequate food safety knowledge to increase their motivation, and eventually, their practices of personal hygiene, disease control measures, food handling, and workplace hygiene.

From the present systematic review, it can be noted that most of the selected studies were predominantly conducted in developing countries. This might be because developed countries have already implemented more mature food safety regulations with the mandatory application of a risk management system; as such, their interests leaned towards evaluating system implementation rather than assessing food handlers' food safety practices (Zanin *et al.*, 2017). In addition, several studies have found that the consumption of street food, particularly in developing countries, is frequently associated with foodborne diseases (Rheinländer *et al.*, 2008; Abdalla *et al.*, 2009; Ackah *et al.*, 2011). Indeed, WHO has reported an immense foodborne disease burden and its health impacts in Africa, closely followed by Asia (Havelaar *et al.*, 2015).

The pattern of published articles on food safety KAP among street food handlers has been constant for the past ten years, thus indicating a persistent interest in this issue. The number of food safety studies is expected to increase, as street fare will continue to be a source of food and income for the growing population, especially in developing countries (Muyanja *et al.*, 2011).

All selected studies employed a cross-sectional design due to its ability to estimate the prevalence of any practice in a large population (Sedgwick, 2014). However, the self-reported data on food safety practices in some studies may pose a limitation, considering that street food handlers may display social desirability bias with regard to their practices (da Cunha *et al.*, 2014). Therefore, it is recommended to utilise multiple methods in data collection on food safety practices, such as: (a) a perception assessment through a self-reported questionnaire; and (b) an observation checklist to assess actual food handling practices (Zanin *et al.*, 2017). Data from both sources can then be compared to obtain more reliable results on street food handlers' food safety practices, and subsequently, assess their compliance (Isoni Auad *et al.*, 2019).

In terms of the sociodemographic characteristics of street food handlers, females seemed to have better food safety KAP than males. This is because female street food handlers are typically perceived as more reliable, safe, clean, and good-natured with consumers (Ma *et al.*, 2019). They also tend to provide higher quality nutrition than males (Kitagwa *et al.*, 2006; Rheinländer *et al.*, 2008). Moreover, food preparation and handling are a gender role assumed by women in African culture (Ackah *et al.*, 2011; Muyanja *et al.*, 2011; Aluko *et al.*, 2014), as well as in Chinese and Asian cultures (Ma *et al.*, 2019). Another reason for women's dominance in this area is that street-vending serves as a strategy for the income generation of poor women (FAO and WHO, 2005). In contrast, some studies suggested a male-dominated street food industry (Choudhury *et al.*, 2011; Sun *et al.*, 2012; Isoni Auad *et al.*, 2019) due to the patriarchal system in their culture, and the high unemployment rate among heads of household.

The street-vending business is famous among those aged 30 to 50 due to difficulties entering the labour market at that age range (Isoni Auad *et al.*, 2019). Therefore, this informal industry represents a source of employment, and provides the opportunity to run their own business (Gadaga *et al.*, 2008; Samapundo *et al.*, 2016). It was also revealed that younger street food handlers had better knowledge of food safety, because they most likely attended the authorities' compulsory food safety training, unlike older food handlers who inherit their family food business.

The studies selected in the present systematic review found that handlers' educational level was related to the level of knowledge towards food safety. This is plausible as less-educated food handlers are less receptive to the updated techniques of food safety knowledge, which makes it difficult for them to practice safe food handling (Liu *et al.*, 2014). Ultimately, this contributes to the higher risk of foodborne disease.

Food handlers, especially those in the street food business, should possess adequate food safety knowledge to prevent and minimise foodborne disease (Jianu and Goleț, 2014). This involves their understanding of safe practices and conditions for food handling, preparation, storage, and personal hygiene (Kwol *et al.*, 2020). Personal hygiene is the most critical factor in this regard, which is commonly addressed in various food safety publications (Ohin *et al.*, 2018; El-Nemr *et al.*, 2019; Yenealem *et al.*, 2020). Some of the studies selected in the present systematic review revealed the shockingly poor personal hygiene of street food handlers. This finding is worrying because street food has been identified as a common source of antimicrobial-resistant pathogen transmission (Guven *et al.*, 2010). In fact, microbial pathogens were found in healthy street food handlers' skin, nose, and mouth (Omemu and Aderoju, 2008). Therefore, maintaining proper personal hygiene is extremely important.

Consistent with the above findings, WHO (2006) has identified several factors associated with foodborne disease outbreak, such as poor personal hygiene, cross-contamination, and inadequate time and temperature of food storage and preparation by street food handlers (Osaili *et al.*, 2013). Therefore, it is evident that these handlers need to acquire more knowledge, and possess a positive attitude to implement food safety practices accordingly.

Limitations

All the studies selected in the present systematic review utilised a descriptive cross-sectional design to determine the level of food safety KAP among street food handlers. When interpreting the results, the specific limitations of these studies should be considered, which may limit the generalisability of this review's results as well. In particular, despite its convenience, this study's design cannot establish a causal relationship and is susceptible to potential incidence bias. Furthermore, the present systematic review only selected published articles in the English language, limiting the selection of potential studies. In some of the 12 included studies, there was incomplete information as well as researcher-made tools, which is another limitation as it impeded the authors from conducting a meta-analysis.

Despite these limitations, there are also several strengths associated with the present systematic review. First, based on the best information available to the researchers, this is the first systematic review in the street food field. Second, in this study, all possible dimensions of food safety KAP among street food handlers have been discussed.

Conclusion

The studies included in the present systematic review evaluated the KAP of food safety among street food handlers, along with their inter-relationships and links to demographic traits. The results varied from satisfactory to unsatisfactory across the studies. In addition, training was recognised as one of the critical aspects that influence safe food handling.

This assessment is important as an initial diagnosis to guide and prioritise appropriate strategies for food safety aspects that demand more focus. It also provides a decision-making basis for the food safety authorities to develop relevant policies and organise trainings to promote food safety and minimise foodborne disease's causative factors.

Furthermore, information derived from the present systematic review can serve as a resource for the healthcare sector, especially nursing. Foodborne disease is always one of the biggest public health concerns that demand significant attention. In public health, nurses play an essential role in advocating health to the community, including food handlers and consumers. They can thus promote food safety and foodborne disease prevention measures by delivering health education and organising campaigns (either offline or online) to attract audiences of all ages to understand the concept of food safety and its importance. Other than that, nurses can directly participate in and actively contribute to food handling training organised by the Ministry of Health. Lastly, the present review benefits future researchers as the literature on food safety issues among street food handlers is still limited despite growing attention to this industry. The information gathered herein can be used as a reference or cross-reference in conducting new research or developing new theories in this area.

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