Review

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The Status of Knowledge, Attitudes, and Practices Regarding Food Safety Among Food Establishments Across Arab Countries

Dima Faour-Klingbeil [1,*], Tareq M. Osaili [2], Hager Yehia Shalaby [4], Fayeza Hasan [3] and Ewen C. Todd [5]

[1] Michigan State University, College of Law, Klingb10@msu.edu
[2] Department of Nutrition and Food Technology, Faculty of Agriculture, Jordan University of Science and Technology, P.O. Box 3030, Irbid 22110, Jordan
[3] Research Institute for Medical and Health Sciences, University of Sharjah, P. O. Box 27272 Sharjah, United Arab Emirates
[4] Institute of Global Health and Human Ecology, School of Sciences and Engineering, The American University in Cairo
[5] Ewen Todd Consulting, Okemos, MI, USA
* Correspondence: dima@dfkfoodsafety.com

Abstract

A scoping review was conducted to analyze the current state of food safety knowledge, attitudes, and practices of food handlers in the Arab countries. The literature search identified 40 studies that met the inclusion criteria, and their findings were analyzed and discussed; these varied in scope, with some examining all three components and others focusing on knowledge only or knowledge and practices. Their findings revealed a fundamental lack of knowledge in critical food safety areas across food sectors, although hospitals and institutional settings performed relatively better. While studies commonly reported fair to good knowledge of personal hygiene among food handlers, significant gaps remained in the proper application of hygiene practices. Additionally, deficits in food safety knowledge were particularly pronounced among street vendors and those in low-income countries. Despite inconsistent results across studies, widespread misconceptions and deficiencies were evident in food temperature control, sanitation, and cross-contamination prevention. These shortfalls extended to poor practices and, at times, to attitudes that reflected a lack of awareness of their significance, posing a risk of cross-contamination during the preparation, holding, and storage of food, including in healthcare settings. These results underscore the need for targeted interventions that extend beyond conventional training, integrating behaviour-based learning and a strong food safety culture through practical education and robust licensing frameworks to elevate food safety standards across the region.

Keywords: food safety; KAP; food handlers; food safety knowledge; food safety attitudes; food safety practices; food service; Arab region

1. Introduction

Food safety has become a major public health issue worldwide, and it is no longer a new concern in the Arab region. Although significant efforts have been made to improve food safety and implement preventive measures across food businesses, outbreaks of foodborne illnesses continue to pose a major challenge globally. Despite differences in the current political and economic contexts, the Arab region is undergoing transformative changes in its food systems and regulatory frameworks, driven by broader shifts in dietary habits and lifestyles, especially in middle- and high-income countries. Furthermore, the expansion of food trade has allowed some countries to prioritise

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health and consumer protection in their political agendas, often influenced by trade obligations. This trend is reflected in the regulatory reforms and institutional restructuring observed in the Kingdom of Saudi Arabia, Jordan, Egypt, the United Arab Emirates (UAE), Tunisia, Morocco, and others (Faour-Klingbeil, 2022).

The Arab region comprises a diverse group of countries, including the Gulf Cooperation Council (GCC) nations such as Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE, as well as countries like Algeria, Comoros, Djibouti, Egypt, Iraq, Jordan, Lebanon, Libya, Mauritania, Morocco, Palestine, Somalia, Sudan, Syria, Tunisia, and Yemen. Each operates under its own national food control system, with varying levels of progress and development reflecting differences in economic development, regulatory maturity, enforcement capacity, and public health infrastructure.

While many countries align their food safety legislation with Codex Alimentarius principles, the degree to which Hazards Analysis and Critical Control Points (HACCP)-based approaches and Good Hygiene Practices (GHP) are legally mandated and operationally implemented varies considerably. On one hand, the wealthier countries, notably the GCC states, have made significant advances in their food regulation frameworks and efforts to formalise food safety training for workers. For example, in the UAE, the Person in Charge (PIC) programme, led by Dubai Municipality, requires food establishments to appoint certified individuals responsible for ensuring compliance with food safety standards, thus establishing a regional benchmark. Conversely, enforcement of regulations remains insufficient in many countries, particularly in low- and middle-income countries, where food laws are frequently outdated and ill-adapted to current food safety challenges. Several lower-income or conflict-affected countries face institutional constraints that limit effective enforcement and operate under more fragmented or resource-constrained control systems. This regulatory diversity is an important contextual factor influencing food safety knowledge, attitudes, and practices across the region (Faour-Klingbeil, 2022).

Moreover, several Arab countries leverage their geographic proximity to the EU and Africa, along with their competitiveness in agricultural products, to boost agricultural exports. For instance, Morocco, Tunisia, and Egypt are strategically positioned to serve both European and African markets (Morocco World News, 2024). For instance, Egypt's processed food and beverage exports reached US$32.1 billion in 2021, representing a 26% increase from US$25 billion in 2020. In 2022, Saudi Arabia exported nearly US$10.6 million worth of food products to the United States (U.S), including processed dates (Food Export Association of the Midwest USA, n.d.).

In addition to the widespread presence of street vendors in low- and middle-income countries, the food service industry is flourishing, with many businesses operating as international fast-food franchises or offering traditional local cuisine. It is a standard requirement under international food safety regulations and national laws that these businesses take all necessary measures to ensure food handlers do not become a source of microbiological, chemical, or physical contamination, thereby protecting consumers. Food handlers must be trained in food safety and hygiene principles, as well as relevant health policies. The role of food workers in foodborne diseases is well documented, with research linking them to 816 foodborne outbreaks. All these outbreaks involved workers of some kind, and most food workers were infected. According to the CDC, hundreds of foodborne illness outbreaks reported in the U.S. each year can be traced to a single cause: food workers coming to work sick (Todd et al., 2007). Food handlers have been implicated in outbreaks, even when they were not always aware of their infections (Todd et al., 2008), either because they were in the pre-symptomatic phase or asymptomatic carriers. Lengthy post-symptomatic shedding periods and the excretion of many enteric pathogens by asymptomatic individuals are crucial issues for the hygienic management of food workers (Todd et al., 2007). It is reported that 80% of communicable diseases are transmitted through touch (UCI Health, 2018), highlighting the need for well-informed food handlers, practical training, and education on hand hygiene and safe food handling, as well as for food facilities to implement adequate measures to ensure staff adhere to hygiene requirements.

The Eastern Mediterranean Region, which includes countries in the Arab world, has the third-highest estimated burden of foodborne diseases per population after the African and South-East

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Asian regions. Diarrhoeal diseases (caused by *E. coli*, Norovirus, Campylobacter, and non-typhoidal *Salmonella)* account for 70% of the burden of foodborne disease (WHO, 2015).

In 2013, a foodborne outbreak affected over 100 people at a restaurant in Tikrit City (Mehdi Asaad et al., 2014). Investigations revealed that only one of the thirteen staff interviewed held a valid health card, and three had experienced diarrhoea 2-3 days prior to the incident. All were involved in food handling, yet none had participated in food safety education or training sessions organised by the Health Inspection Section. Similarly, Lebanon has experienced numerous cases of food poisoning and food fraud, prompting the government to launch an extensive food safety campaign (Kharroubi et al., 2020), which identified non-compliance with local standards due to *Salmonella* and *E. coli* contamination, often resulting from a lack of knowledge on proper food handling and hygiene, as well as contaminated storage areas.

These cases and others reported globally show that well-informed and compliant food handlers constitute a vital defense for food safety, which starts with acquiring and applying the necessary knowledge in food safety. Food safety knowledge can be defined as the understanding and information that a food handler acquires on foodborne disease transmission and risk factors, and the appropriate handling, manufacturing, holding, and storing of food to prevent and control hazards that could lead to foodborne diseases. However, empirical studies have consistently shown that knowledge alone is insufficient to ensure safe practices (Clayton & Griffith, 2004; Faour-Klingbeil et al., 2015). Proper knowledge combined with a positive attitude toward food safety has been linked to stronger food-handling practices, which are instrumental in preventing foodborne diseases (Angelillo et al., 2000). These findings reflect the core premise of the Knowledge, Attitude, and Practices (KAP) model. The KAP framework is a research model used to explore human behavior toward a matter in question by assessing what respondents know. about it (knowledge), how they feel or agree about it (attitudes), and what they actually do about it (practices). This relationship is grounded in the Theory of Reasoned Action (Ajzen & Madden, 1986), which holds that the intention to perform a behavior, influenced by both attitude and subjective norms, is the strongest predictor of actual behavior. Applied to food safety, this framework predicts that food handlers with adequate knowledge of food safety risks are more likely to hold positive attitudes toward safe practices, and in turn more likely to comply with them

As the food safety landscape and regulatory systems have continued to evolve in the region over the past two decades, ensuring consistent application of food safety standards is essential for protecting public health and supporting the sustainability of the food industry. An up-to-date synthesis of evidence on food handler knowledge, attitudes, and practices across the region is therefore timely and warranted. While Faour-Klingbeil (2022) provided a foundational narrative overview and Begum et al. (2025) synthesised global food safety KAP reviews across consumer and vendor populations, neither offered a scoping review of primary research on food handlers in the Arab countries with a structured cross-sector and cross-country synthesis. To our knowledge, this review is the first in the Arab region that aims to assess and study the current levels of knowledge, attitudes and practices of food handlers across Arab countries and food sectors over the period 2000–2024, identify common gaps or misconceptions, and provide evidence-based findings to inform the development of targeted educational campaigns addressing specific knowledge, attitude, and practice deficiencies.

2. Materials and Methods

A scoping review methodology was adopted based on Arksey and O'Malley's framework (Arksey & O'Malley, 2005) with enhancements from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (Page et al., 2021) to systematically explore and synthesize existing literature on the food handlers' knowledge, attitudes, and practices in the Arab region. A scoping review was selected over a systematic review with meta-analysis because of significant methodological heterogeneity across study designs, data collection instruments, scoring methods, and outcome metrics. This heterogeneity precludes quantitative

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synthesis and meta-analysis. Scoping reviews are recognized as the appropriate methodology for mapping evidence across a topic area where the goal is to characterize the breadth of evidence, identify research gaps, and provide a foundation for future primary research and policy development (Arksey & O'Malley, 2005). Therefore, this review does not aim to rank or compare knowledge scores across studies but to synthesize patterns, identify gaps, and contextualize findings within the Arab region.

The methodology comprised the following five sequential steps:

1) Formulation of research inquiry:

This review was guided by research questions designed to examine the knowledge, attitudes, and practices of food handlers in the Arab region's food service sector sectors (e.g., restaurants, catering, and institutional food services) and to identify variations and gaps across countries and industry sectors. These include:

- What is the status of knowledge, attitudes, and practices among food handlers in the food service sector across the Arab region?
- What patterns of food safety knowledge, attitudes, and practices emerge across different countries in the Arab region?

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- To what extent do food handlers' knowledge, attitudes, and practices vary across different food sectors?
- What are the common gaps or misconceptions identified in food handlers' knowledge, attitudes, and practices regarding food safety in the Arab region?
- What factors (e.g., education, training, experience) are associated with variations in knowledge, attitudes, and practices among food handlers in the Arab food service industry?
- How can the findings from existing studies inform the development of effective interventions to improve food handlers' knowledge, attitudes, and practices in the Arab region?

Given the methodological heterogeneity of the included studies, these research questions are addressed descriptively and thematically rather than through direct quantitative comparisons. Therefore, this review does not aim to test specific hypotheses or draw statistically rigorous cross-group conclusions.

A food handler, food worker, or food employee is defined as a person involved in receiving, unpacking, storing, preparing, cooking, and serving food. They can prepare raw and cooked food, including ready-to-eat (RTE) items, by using or directly touching food-contact and non-food-contact equipment and utensils. They may also handle non-food items such as money, vendors, and customers. Such individuals include chefs, assistant chefs (cooks and cook helpers), and managers working in various food service settings, such as fine dining and fast-food restaurants, hospitals, university cafeterias, schools, and street-vending carts.

2) Identification of relevant studies:

A comprehensive search was conducted to identify relevant studies from databases such as PubMed, ScienceDirect, Scopus, ProQuest, and Google Scholar, as well as regular Google searches and regional platforms like the Egyptian Knowledge Bank. Government and institutional websites were also reviewed to capture any publicly available reports or data. Although KAP studies are not commonly undertaken by government entities, these sources were included in case any relevant findings had been published

Keywords related to food safety, food handlers, knowledge, attitudes, practices, and the Arab region were used to identify relevant literature. Additionally, these terms were combined with each country's name in the region to provide comprehensive coverage of related studies. For example, a literature search was conducted using terms such as "food handlers" OR "food handling" AND "Practices" OR "food safety practices" AND "Attitude" AND "knowledge." Key phrases such as "challenges to food safety practices" AND "Arab region," and "food safety knowledge" OR "food safety" AND "food service establishments" were also included. All keywords were combined with "Arab region" OR "Arab countries," including "GCC countries," in each search. We also incorporated "hand hygiene" terms and "barriers to safe food handling" to account for studies focusing on specific areas and factors influencing the KAPs.

3) Selection of studies:

Criteria for inclusion and exclusion were established to screen and select studies that aligned with the research focus. Studies examining the knowledge, attitudes, and practices of food handlers in the food service sector in Arab countries were included. While the KAP framework provided the conceptual lens for this review, the included studies varied in scope; some assessed all three components in an integrated manner, while others focused on one or two dimensions only.

The considerations of inclusion criteria included:

(a) Geographical consideration: our search was limited to studies conducted in the Arab region, which includes the GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE)), as well as Algeria, Comoros, Djibouti, Egypt, Iraq, Jordan, Lebanon, Libya, Mauritania, Morocco, Palestine, Somalia, Sudan, Syria, Tunisia, and Yemen.

(b) Language: We included publications in English or Arabic to ensure accessibility and comprehensiveness.

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(c) Scope: Studies published from 2000 to 2024 on food handlers employed in various food services settings, such as restaurants, cafes, catering establishments, and street food vendors, were included in the search. It was assumed that most studies on food handlers' knowledge, attitudes and practices in the region had been conducted in the past two decades and that extending the scope to a period that saw advances in food safety standards and regulations would provide comprehensive coverage of existing research.

The search encompassed research articles, dissertations and theses, as well as reviews published in peer-reviewed journals and conference proceedings (where available). We included only studies that examined food safety knowledge, attitudes, and practices among food handlers, or factors affecting these three aspects, as assessed through surveys, interviews, focus groups, or observational methods.

As for the exclusion criteria, studies focusing on farmers' and butchers' KAP, home-based online food businesses, and consumers' food safety behaviours or perceptions were excluded. Scoping and systematic reviews were excluded. Studies and literature reviews lacking validated tools and surveys, or those published with weak English writing, inadequate methodological quality, or insufficient reporting of results, were also excluded.

The article selection process followed the principles outlined in the modified PRISMA statement for scoping reviews. This simplified approach was adopted to accommodate studies with different designs and methodologies, with the goal of mapping existing research on KAPs. After removing duplicate entries, a preliminary selection was made based on a review of titles and abstracts. Then, full-text analyses of the remaining publications were conducted to assess their eligibility against predefined inclusion criteria. All co-authors participated in the literature search and reviewed the final list of selected articles to ensure no references were missed.

4) Data compilation and analysis:

Data were extracted from the selected studies to obtain relevant information. Key findings and trends were synthesised, enabling a comprehensive analysis of the existing literature.

5) Summary and reporting of results:

The extracted data were categorised into three sections: knowledge, attitude, and practices. The findings for each were systematically analysed, summarised, and discussed to highlight key insights into food handlers' understanding and the gaps in practices within the food service sector.

3. Results

Overall, the literature search yielded 120 articles, of which forty-four met the search criteria. All authors reviewed the studies and assessed the data for extraction, resulting in further exclusions due to poor English (which made interpretation difficult) and methodological deficiencies. The selection process for these studies was carried out by all authors. Table 1 provides an overview of the 40 studies included in this review.

Multiple studies have examined KAP across various settings, employing different analytical methods and interpretations. Some focused on the three KAP components, while others investigated knowledge, reported practices, or both. Most studies relied on self-reported practices, except for two conducted in Lebanon (Faour-Klingbeil et al. 2020) and Egypt (Wahdan et al. 2019) that used observational assessments to explore food safety practices (Table 1). Additionally, the analytical methods, the determination of the cutoff point for knowledge adequacy, and the scope of the studies varied. For example, Idris et al.(2024) assessed food handlers' knowledge using a Likert-scale agreement measure, a common method for evaluating attitudes. Such differences limit the scientific accuracy of comparing specific variables across studies. Moreover, the limited number of studies per country restricts the ability to evaluate and explore the influence of external factors, such as regional differences in regulatory frameworks, resources, and environments, on food safety compliance and knowledge.

Furthermore, although many studies examined the KAP framework, the three components were usually reported separately rather than as a single composite KAP score. The measurement of

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attitudes and practices also differed widely across studies, often relying on diverse Likert-type or frequency scales. In contrast, knowledge was typically assessed through sets of factual questions that were subsequently scored. For this reason, Table 1 reports the food safety knowledge score, which represents the most interpretable indicator across the included studies.

As shown in Table 1, the retrieved studies originated primarily from a few countries in the Arab region, predominantly middle-income and GCC countries, highlighting a lack of comprehensive information on Syria, Tunisia, and the Comoros. As expected, the search did not produce results for low-income countries or those affected by prolonged conflict, such as Yemen and Libya, with only a few studies from Sudan, Iraq and Somalia (Table 1).

Table 1. Characteristics of included studies on food safety knowledge, attitudes, and/or practices among food handlers in Arab countries.

	Research setting	Sample size	Components assessed	Food safety knowledge score[†]	Country	References
	Sector: Hospitals					
1	Hospital (N=1) and fast food restaurants (N= 16)	N= 140	KAP towards food poisoning	76.63±19.6	Egypt	(Adel Hakim et al., 2014)
2	Ministry of Health and Population hospitals of Gharbia Governorate (N= 17)	N= 161	Practices (Food safety practices before and after educational intervention)**[Obs]**	N/A	Egypt	(Wahdan et al., 2019)
3	Hospitals (N= 4)	N= 132	KAP (Effect of educational program)	9.2 ± 5.3 (before) 18.5±3.9 (after)[a]	Egypt	(Elsherbiny et al., 2020)
4	Egyptian government hospitals (N= 27)	N= 542	KAP	81.22 ± 8.88	Egypt	(Megahed Ibrahim et al., 2022)
5	Hospitals (N= 3)	N= 50	KAP	No mean score on knowledge	Iraq	(Ali et al., 2022)

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6	Hospitals (N= 37)	N= 532	Food safety knowledge	62.5%	Jordan	(Osaili et al., 2017)
7	Public and private hospitals (N= 6)	N= 245	Food safety knowledge	71.2%	Jordan	(Abdelhakeem et al., 2021)
8	Hospitals (N= 7)	N= 200	KAP	84.82%	Jordan	(Sharif et al., 2013)
9	Hospitals (N= 10)	N= 163	Knowledge and practices	77.9%	KSA	(Alqurashi et al., 2019)
10	Hospitals (N= 5)	N= 315	Food safety awareness and practices	No mean score on knowledge	KSA	(Alsultan et al., 2023)
11	Hospitals (N= 13)	N= 254	KAP	59.2%	Lebanon	(Bou-Mitri et al., 2018)
12	University hospital (N=1)	N= 72	Food safety knowledge and practices	0.54 ±0.15[b],	Morocco	(Guennouni et al., 2022)
13	Hospital (N= 1)	N= 43	KAP‡	91.9 %	Qatar	(Kaabi et al., 2010)
14	Hospital (N= 3)	N=86	KAP	62.27%	Sudan	(Mohammed et al., 2020)
15	Hospital (N = 7)	N = 32	Food safety knowledge and practices	No mean score on knowledge	Sudan	(Mohieldin et al., 2015)
	Sector: Restaurants and catering					
16	Cafeterias, restaurants, food establishments and roadside	N= 994	KAP	39.2%	Egypt	(Hamed & Mohammed, 2020)

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	food seller (N= Not reported)					
17	FSEs (N= 79) on 34 university campuses	N= 520	Food safety knowledge	67.1%	Jordan	(Osaili et al., 2018)
18	Fast food restaurants (N= 297)	N= 1084	Food safety knowledge	69.4%	Jordan	(Osaili et al., 2013)
19	Restaurants (N=2), university canteens (N= 5)	N= 87	KAP	No mean score on knowledge	KSA	(Al-Shabib et al., 2016)
20	Restaurants (e.g., banquet kitchens, fast food, fine dining, and traditional food restaurants) (N= Not reported)	N= 389	KAP	9.3 ± 1.8[c]	KSA	(Alzhrani & Shatwan, 2024)
21	Restaurants (N= Not reported)	N= 402	KAP	70%	Kuwait	(Al-Kandari et al., 2019)
22	Catering establishments in community and healthcare settings (N= Not reported)	N= 405	Food handling and hygiene practices	N/A	Kuwait	(Moghnia et al., 2021)
23	Restaurants (N= 50)	N= 80	KAP	56.6% ± 21.0	Lebanon	(Faour-Klingbeil et al., 2015)

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24	Restaurants (N= 50)	N= 80	Food safety practices [Obs]	N/A	Lebanon	(Faour-Klingbeil et al., 2020)
25	Catering establishments (N= 22)	N= 282	KAP	65.31%	Morocco	(Amaiach et al., 2024)
26	Restaurants (N= 21)	N= 21	Food safety knowledge	No mean score on knowledge	Oman	(Ali et al., 2018)
27	Restaurants (N= 18)	N= 54	Food safety knowledge and hygienic practices	No mean score on knowledge	Oman	(Al-Ghazali et al., 2020)
28	Restaurants (N= 202)	N= 308	Food safety practices [Obs]*	N/A	Palestine	(Al-Khatib & Al-Mitwalli, 2009)
29	FSEs (N= 53)	N= 53	Food safety practices	N/A	Qatar	(Asim et al., 2019)
30	Fast-food restaurants in Qatar university (N= Not reported)	N= 102	KAP	No mean score on knowledge	Qatar	(Elobeid et al., 2019)
31	Restaurants, cafeterias, coffee shops (N= 88)	N= 646	Food safety knowledge	70%	United Arab Emirates	(Taha et al., 2020)
32	Restaurants (N= 30)	N= 30	Food safety Practices	N/A	Somalia	(Hassan et al., 2020)
33	Restaurants (N= 34)	N= 40	Food safety practices	N/A	Sudan	(Abdelrazig et al., 2017)

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34	Food premises (N= 24) in nine university campuses	N= 105	Food safety knowledge and practices	No mean score on knowledge.	Sudan	(Idris et al., 2024)
	Sector: Street food					
35	Street vendors, cafeterias, and popular restaurants,	N=130	KAP	No mean score on knowledge	Iraq	(Kanaan et al., 2023)
36	Mawakibs‡ (N=100)	N= 504	KAP	No mean score on knowledge	Iraq	(Lami et al., 2019)
37	Street food vendors	N= 405	KAP	32%[d]	Jordan	(Elsahoryi et al., 2024)
38	Street food vendors	N= 120	Food safety knowledge and attitudes	54%[e]	Jordan	(Omar, 2020)
39	Street food vendors	N= 50	Food safety knowledge and practices (includingMicrobial quality assessment)	No mean score on knowledge	KSA	(Moutz et al., 2012)
40	Street food vendors	N= 30	Food safety ractices (including microbiological quality of food)	N/A	Lebanon	(Loukieh et al., 2018)

3.1. Food Safety Knowledge

Reported food safety knowledge scores ranged widely across different food service settings, including restaurants, universities, and hospitals. Higher scores (above 70%, a common benchmark in KAP studies) were most frequently reported in hospital settings, except in Lebanon. In restaurants, scores were relatively similar across Jordan and Lebanon, ranging from 56.6% in Lebanon to 69.4% in Jordan. By contrast, higher scores were reported in the UAE and Kuwait, where mean knowledge scores reached approximately 70% (Table 1).

However, studies varied considerably in the breadth of knowledge domains assessed, the number of questions included, and the scoring systems applied (e.g., percentage scores, proportion scales, or raw point scores). Some studies assessed only limited aspects of food safety knowledge. For

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instance, Kaabi et al. (2010) focused primarily on knowledge of foodborne pathogens, whereas Megahed et al. (2022) examined selected closed-ended statements across various themes rather than employing a comprehensive set of questions to cover each domain systematically. Additionally, some authors assigned scores to each food safety knowledge theme (e.g., cross-contamination, personal hygiene), whereas others set cutoff points (e.g., poor, fair, good). Additionally, some studies focused on broader knowledge themes. For example, El Sherbiny et al. (2020), Al-Shabib et al. (2016), Al-Ghazali et al. (2020), and Mohieldin et al. (2015) classified knowledge scores into broad thematic groups such as "personal hygiene" and "cleaning and sanitation," but provided no details on the specific variables measured under each theme.

Given this heterogeneity, values are not directly comparable across studies; therefore, results are presented and discussed thematically, with key findings summarised in Table 2. For studies that used nearly identical questions and scoring methods, their data are also included in Tables 1S, 2S, and 3S (in supplementary materials).

3.1.1. Personal Hygiene

Most studies have shown that food handlers generally understand the role of hygiene in preventing contamination; however, knowledge gaps persist in specific situations, such as handwashing (Table 1S, Supplementary Materials), and these gaps vary both between and within countries. For instance, a high proportion of food handlers in studies conducted in Jordan and Kuwait (over 90%) demonstrated strong knowledge (Abdelhakeem et al., 2021; Al-Kandari & Jukes, 2009; Osaili et al., 2013, 2017, 2018); similarly, in Lebanon, most interviewed food handlers (90%) knew the importance of handwashing after touching raw meat and raw eggs and before handling unwrapped RTE foods (Faour-Klingbeil et al., 2015). In Iraq, 99% of food handlers agreed that handwashing should be practised frequently (Lami et al., 2019). Whereas less than half (50%) in Egyptian restaurants, Saudi Arabian catering services, Jordanian street vendors, and Moroccan food establishments were aware of its importance in preventing cross-contamination (Alqurashi et al., 2019; Elsahoryi et al., 2024; Elsherbiny et al., 2020; Guennouni et al., 2022; Hamed & Mohammed, 2020). In Egypt, the food handlers recognised the need to wash their hands after obvious contamination events, such as using the toilet, handling waste, or sneezing, but were less likely to wash their hands after handling money (Moutz et al., 2012; Osaili et al., 2017, 2018; Taha et al., 2020) or before and after wearing gloves (Taha et al., 2020).

However, in hospital settings, results from Lebanon were no better, with only 62% believing that washing with water alone was sufficient (Bou-Mitri et al., 2018). Also, 63% of food handlers in Jordanian hospitals recognised the importance of handwashing after handling money, compared to 72% of university food service workers (Osaili et al., 2017, 2018). Conversely, in Jordan, hospital food handlers exhibited greater awareness of mask use and the importance of clean work attire than restaurant workers, possibly due to stricter hygiene policies in healthcare settings (Osaili et al., 2017, 2018). Similarly, awareness of personnel illness as a source of food contamination was higher among hospital workers than among restaurant workers, where fewer than 60% knew about the risks associated with handling food while experiencing symptoms of nausea, vomiting, or diarrhoea (Elsherbiny et al., 2020; Moutz et al., 2012).

3.1.2. Sanitation and Cross-Contamination Prevention

Many studies reported gaps in food handlers' knowledge of proper cleaning and sanitation practices for food-contact surfaces, such as knives and cutting boards (Table 2S, Supplementary Materials). Less than 65% of food handlers in Kuwait, Lebanon, Egypt, the UAE, and Jordan recognised the importance of both washing and sanitizing utensils (Abdelhakeem et al., 2021; Al-Kandari et al., 2019; Elsahoryi et al., 2024; Elsherbiny et al., 2020; Faour-Klingbeil et al., 2015; Omar, 2020; Osaili et al., 2013, 2017, 2018; Taha et al., 2020). This limited knowledge is particularly concerning given that improper cleaning and sanitation in food premises may contribute to cross-

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contamination. In Iraq, nearly all food handlers (96%) incorrectly believed that using detergent alone was sufficient for decontamination (Ali et al., 2022).

Regarding the prevention of cross-contamination, only 10–60% of food handlers in restaurants and hospitals in Jordan were aware that separate cutting boards and knives should be used for vegetables and raw meat. Similar proportions were reported in Morocco (40–60%), the UAE (40–50%), and Saudi Arabia (30%) (Alqurashi et al., 2019; Amaiach et al., 2024; Guennouni et al., 2022; Omar, 2020; Osaili et al., 2013, 2017, 2018). In contrast, a higher proportion of food handlers in Iraq (90%) correctly recognised the need to separate utensils (Kanaan et al., 2023). At the Lebanese hospital, only 78% of employees used separate kitchen utensils for preparing raw and cooked food, despite their considerably more positive attitudes toward this task (94%) (Bou-Mitri et al., 2018). More concerning, only 54.6% of food handlers in collective catering facilities in Morocco agreed with the separation of raw and processed food (Amaiach et al., 2024), and this was even lower (8%) at a Mawakib mass gathering in Iraq (Lami et al., 2019). This may be expected since Mawakib food handlers are volunteers with no prior mandatory training requirement.

Proper food refrigeration, such as placing raw meat or poultry on lower shelves to prevent contamination from dripping, was inconsistently understood across various studies. Food handlers in Lebanese restaurants (Faour-Klingbeil et al., 2015) and Jordanian hospital kitchens (Sharif et al., 2013) showed relatively high levels of awareness. In contrast, in Egypt, only 34% were aware of this practice (Hamed & Mohammed, 2020). Similar gaps in knowledge regarding the handling and safe storage of leftovers were observed in several Jordanian studies (Abdelhakeem et al., 2021; Osaili et al., 2013, 2017, 2018). However, a high proportion of correct answers does not necessarily indicate true understanding of the concept. For example, in the Lebanese study, the majority (95%) correctly stated that raw and cooked food should be handled and prepared separately; yet only two-thirds (62%) answered correctly when asked for the rationale for this separation. Furthermore, less than half (49%) identified the most common cause of food contamination (Faour-Klingbeil et al., 2015). Faour-Klingbeil et al. (2015) also found that when food handlers were asked why frozen meat should be thawed on the lowest rack of a refrigerator containing salad, 34% incorrectly believed that the lowest shelf has the least cold air, making it suitable for thawing. Notably, nearly half (47%) had received food safety training. Poor knowledge in this area was reported in Iraq (33.8%) (Kanaan et al., 2023), Egypt (Adel Hakim et al., 2014; Elsherbiny et al., 2020)(10–35%), the UAE (Taha et al., 2020) (60%), Morocco (Guennouni et al., 2022) (38%), and Saudi Arabia (Alqurashi et al., 2019) (30%).

3.1.3. Temperature Control

Knowledge of temperature control during food handling varied across and within countries, as shown in studies from Jordan (30%-84%) (Abdelhakeem et al., 2021; Osaili et al., 2013, 2017, 2018) and Egypt (35%) (Elsherbiny et al., 2020). However, food handlers in hospitals often demonstrated slightly higher awareness than those in restaurants (Abdelhakeem et al., 2021; Osaili et al., 2017, 2018) (Table 4S - Supplementary materials), but this was not consistently observed across studies or in a significant manner. Al Sultan et al. (2023) found an overall lack of knowledge of food and storage temperatures among food service staff at hospitals in Riyadh City. Similarly, knowledge of the cold storage temperature for food was notably low (14%) among food handlers at a Sudanese hospital (Mohammed et al., 2020). In Jordan, fewer than 50% of respondents were aware of the correct refrigeration temperature (Osaili et al., 2013, 2017, 2018), in contrast to the higher proportions (88% and 91-98%) reported in hospitals by Abdel Hakeem et al. (2021) and Sharif et al. (2013), respectively. A similar discrepancy was found in Morocco, where only 40% of catering food handlers knew the correct temperature (Amaiach et al., 2024) compared with 80% in hospitals (Guennouni et al., 2022).

Conversely, in Lebanon, Faour-Klingbeil et al. (2015) found that 77.5% and 55% of food handlers in restaurants knew the correct operating temperatures of the refrigerator and freezer, respectively, and only 11% were aware of the correct hot-holding temperature, of whom half (44%) had received training. The authors found that 57.5% of participants did not recognise the temperature danger zone. Of those who answered correctly, 69% were unable to specify the correct temperature range.

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Additionally, less than half (48%) were aware of the safe temperature for reheating food. Similarly, only 40% of respondents in Egyptian food businesses were aware of the risks of leaving covered food at room temperature for extended periods (Hamed & Mohammed, 2020), and 33% of respondents in Iraqi restaurants knew the appropriate temperatures for storing and refrigerating food (Kanaan et al., 2023). Similarly, most food handlers in Ismailia city hospitals in Egypt (78%) were unaware of the correct refrigerator temperature.

3.1.4. Symptoms of Food Poisoning and Food Pathogens

A majority of food handlers were familiar with food poisoning symptoms (>80%) in Iraq (Ali et al., 2022), Jordan (Abdelhakeem et al., 2021; Osaili et al., 2013, 2017, 2018), Sudan (Abdalla et al., 2009), and the UAE (Taha et al., 2020). However, notably lower proportions were reported in Saudi Arabia (<65%) and Jordan (<30%) (Elsahoryi et al., 2024; Moutz et al., 2012). In Egypt, only 36.2% knew that food poisoning is caused by pathogenic microbes, and only 44.5% were aware that it could lead to hospitalisation or death (Hamed & Mohammed, 2020). In Iraq, 78.7% of respondents knew that leaving perishable food at room temperature for more than 2 hours can lead to food poisoning (Lami et al., 2019).

Among foodborne pathogens, *Salmonella spp.* was the most commonly recognised among food handlers studied in Iraq, Jordan, Kuwait, Morocco, Oman, and Qatar, whereas recognition of *Shigella*, Hepatitis A virus, *Listeria monocytogenes*, *Staphylococcus aureus*, and *E. coli* O157:H7 was comparatively lower (Ali et al., 2022; Ali et al., 2018; Al-Kandari et al., 2019; Elsahoryi et al., 2024; Guennouni et al., 2022; Kaabi et al., 2010).

In this context, Faour-Klingbeil et al. (2015) reported that 77% of food handlers in the studied Lebanese restaurants could not distinguish between food spoilage and contamination, believing that changes in taste, smell, and appearance would indicate a risk of contamination. However, over two-thirds (70%) identified the common symptoms of foodborne diseases. Similarly, Alqurashi et al. (2019) and Guennouni et al. (2022) found that less than 30% correctly knew that changes in taste, smell, or appearance indicate spoilage rather than pathogenic contamination.

Table 2. Key findings on the food safety knowledge of food handlers in the Arab countries.

Theme	Key Findings
Personal Hygiene	Knowledge of handwashing necessity was high but poor to fair for specific occasions when handwashing is important before food handling (e.g., after handling money). Awareness of correct handwashing techniques was not strong overall. There was a high awareness of the contamination risk from touching ready-to-eat food with bare hands. However, gaps in knowledge in relation to correct glove use and PPE were notable. **Hospitals** Generally higher awareness of hygiene and PPE due to institutional policies; misconceptions persist regarding adequacy of washing with water alone. **Restaurants/Catering** Moderate awareness of hygiene necessity but inconsistent application in restaurants; glove-use and correct handwashing occasions often poorly understood. In universities, there is

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	moderate awareness better understanding of hygiene occasions than restaurants. **Street Vendors** Poor knowledge and informal practices predominate.
Sanitation and Cross-Contamination	There is a general good knowledge of the importance of handwashing after handling raw meat, but significant gaps in understanding of the rationale behind it. The limited understanding of contamination transfer principles remains common, with the exception of moderate to high knowledge levels reported in hospitals. **Hospitals** Moderate awareness of utensil separation and cleaning, but gaps between knowledge and actual practice persist; partial understanding of contamination rationale. **Restaurants/Catering** Variable knowledge; weak recognition of sanitization steps and utensil separation importance. **Collective Catering / Mass Gatherings:** Weakest performance; volunteer handlers with no formal training and very limited awareness.
Temperature Control	Marked variability across and within countries. H**igher awareness** observed in select hospital-based studies but **low levels** in restaurants and food businesses. **Hospitals** Some hospitals demonstrated **moderate knowledge**, while others showed **notably poor understanding**, with many staff unaware of safe food temperature and correct refrigerator or holding temperatures. **Restaurants/Catering** **Generally weak awareness** of correct refrigeration, freezing, and holding temperatures. Knowledge of the **temperature danger zone** and **safe reheating** practices was poor across many countries, e.g.. Lebanon, Egypt, Morocco and Kuwait, despite food safety training

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	in some cases.
Knowledge of Foodborne Illnesses	- Recognition of foodborne illness symptoms varied, with higher awareness in Jordan but notable deficits in the UAE, Saudi Arabia, and Lebanon, particularly in understanding that contamination isn't always visible or distinguishable from spoilage. - Institutional and trained handlers show higher symptom recognition, but still hey lack depth in pathogen knowledge. - Generally low knowledge, with significant gaps in awareness of specific pathogens like *Listeria*, E. *coli*, and Hepatitis A, particularly in Jordan, Kuwait, and Lebanon.

3.2. Attitudes

Research on food handlers' attitudes is limited (Table 1) and employed varying approaches. The key findings are summarised in Table 3.

Few studies measured attitudes using a Likert scale (Al-Kandari et al., 2019; Elobeid et al., 2019; Faour-Klingbeil et al., 2015; Sharif et al., 2013), while others represented them as total points based on "correct answers" to a series of statements. The formulation of the statement also differed, potentially leading to different interpretations among respondents. As such, our discussion focuses on specific aspects examined across the studies.

The measurement of attitudes warrants particular methodological attention. Attitudes, by their psychological nature, reflect a continuum of favorability or agreement and are most validly captured using psychometric tools such as Likert scales, which allow respondents to express gradations of agreement (e.g., from 'strongly disagree' to 'strongly agree') (Marklinder et al., 2025). When studies instead classify attitude responses as 'correct' or 'incorrect', treating attitudinal statements as knowledge questions, they reduce graduated attitudinal responses to binary categories. As a result, the attitude data in this review should be interpreted with caution, particularly where studies used non-Likert scoring. This is consistent with concerns raised in a recent study regarding the need for validated, psychometrically sound instruments for attitude measurement (Marklinder et al., 2025)

Overall, most studies reported generally positive attitudes towards food safety, although levels of agreement varied. Regional differences were evident; for example, food handlers in Kuwait had a mean attitude score of 69.12 ± 9.97 (Al-Kandari et al., 2019), with only 65% strongly agreeing on the importance of food safety knowledge, a stark contrast to the 98.9% agreement in Saudi Arabia (Al-Shabib et al., 2016). In Egypt, Hamed and Mohammed (2020) reported that less than half (43.8%) of food handlers working in a hospital considered safe food handling an essential part of their duties, while another 42.9% believed that food safety training was necessary. In Lebanon, the attitude score was higher at 86%, indicating greater agreement with the need for food safety and hygiene training (Faour-Klingbeil et al., 2015). In Jordanian hospitals, a large majority (95.5%) of food handlers agreed that regular food safety training is important (Osaili et al., 2017). Similarly, most food handlers in surveyed Egyptian hospitals demonstrated a positive attitude, recognising that safe food handling was an important part of their responsibilities (Adel Hakim et al., 2014). In contrast, 83.2% of street food vendors in Jordan exhibited overall negative attitudes (Elsahoryi et al., 2024).

Regarding personal hygiene, 72.9% of respondents in Kuwait showed positive attitudes towards personal protective clothing (Al-Kandari et al., 2019) compared with 96.2% in Lebanon and 94.4% in Qatar (Elobeid et al., 2019; Faour-Klingbeil et al., 2015). In Iraq, 98% of participants expressed a positive attitude towards hygiene measures, such as wearing masks and gloves, which they considered important for reducing the risk of food contamination (Tawfeed Ali et al., 2022). When asked about handling food by injured handlers, 70% of handlers in Kuwait and 82.8% in Saudi Arabia

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agreed that injured handlers should be excluded from food handling (Al-Shabib et al., 2016). In contrast, only 57% of Lebanese restaurant food handlers concurred, citing staff shortages as a concern (Faour-Klingbeil et al., 2015). In a study conducted in Egypt, only 10.2% reported that they would refrain from handling food if they had diarrhoea (Hamed & Mohammed, 2020). Moreover, food handlers who reported abstaining from work due to hand lesions or a common cold accounted for 12.1% and 14.6%, respectively. A high proportion of vendors agree that sick food handlers can be a source of foodborne outbreaks and that they should not work when sick (Abdalla et al., 2009). However, this is what they think should happen, not what they actually do, and in practice, two-thirds still work while sick in a Moroccan study (Amaiach et al., 2024). Vendors working while sick can be framed as a public health compliance issue, which is the thrust of this review, but it is also a labor market justice issue for those self-employed, informal work conditions, especially the lack of social protection, unstable income, and the pressures that force workers to continue working even when unwell.

These results indicate generally positive attitudes towards food safety, although some knowledge gaps persist. Almost all food handlers agreed on separating cooked food from raw ingredients to prevent cross-contamination, a practice universally endorsed except among 44% of handlers in Egypt (Hamed & Mohammed, 2020) and 59.3% of street food vendors in Jordan (Elsahoryi et al., 2024). In KSA, 64.4% agreed on proper thawing practices, and 60.9% agreed on proper storage of leftovers (Al-Shabib et al., 2016). In Kuwait, 71.6% acknowledged the importance of temperature control, but only 59.2% believed that cooling appliances should be regularly monitored, compared with a higher proportion (97.6%) in Lebanese hospitals (Al-Kandari et al., 2019; Bou-Mitri et al., 2018). In Iraq, Kannan et al. (2023) found that 54.6% of respondents disagreed that keeping cooked food at room temperature (25°C) for two hours is harmful. While the study interpreted this as a misperception, it clearly reflects limited knowledge of temperature control and its effects on food safety. According to the authors, most participants demonstrated a lack of knowledge, with 57% failing to follow appropriate procedures to prevent food temperature abuse.

In hospital settings, food handlers reported more positive attitudes, with a majority (94%) who believed that excluding food handlers with skin injuries is an important measure to ensure food safety (Bou-Mitri et al., 2018). Similarly, in Morocco, food handlers' attitudes towards food safety were 75.6%. The majority (88.7%) agreed that safe food handling is crucial to their profession, and 78.4% agreed that avoiding work when ill is important. Additionally, 71.3% endorsed storing raw and cooked foods separately, and 75.2% agreed that refrigerator and freezer temperatures should be monitored (Amaiach et al., 2024).

The work environment was found to significantly influence food handlers' attitudes. Those in corporate-managed restaurants were more likely to agree (89.7%) on monitoring food temperatures than their counterparts in sole proprietorships (50%), who often relied on their own experience (Faour-Klingbeil et al., 2015). Additionally, long-term experience in the food sector has been associated with more positive attitudes toward food safety (Bou-Mitri et al., 2018; Sharif et al., 2013).

Table 3. Key findings on food handlers' attitudes towards food safety in the Arab countries.

Theme	Key Findings
General attitude towards food fafety	Most studies report a generally positive attitude among food handlers, with notable regional and sectoral differences. Certain groups, such as street food vendors tend to exhibit less favorable attitudes toward food safety.
Training and professional development	Positive attitudes tend to be stronger among food handlers working in hospitals and corporate-managed establishments, while those in less formal or independently run businesses show lower levels of agreement.
Personal hygiene and protective equipment	Strong positive attitudes toward personal hygiene and the use of personal protective equipment were observed across several countries, particularly

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	in more formal food service environments. In contrast, support was noticeably lower among informal vendors, highlighting gaps in hygiene attitudes among certain groups.
Attitude towards exclusion when ill or injured	Willingness to exclude ill or injured food handlers is generally stronger in institutional settings and Gulf countries, while lower agreement in others, particularly where staffing is limited, suggests operational barriers may undermine food safety attitudes
Attitude towards cross-contamination prevention	Most food handlers express positive attitudes toward separating raw and cooked foods, though this support is less consistent in some regions and among informal vendors. While many recognize its importance, gaps remain, particularly in settings with limited training or oversight.
Temperature control and monitoring	Attitudes toward temperature monitoring are mixed. While some food handlers recognize its importance, others, particularly outside of hospital settings, demonstrate limited awareness of proper temperature control practices. Misperceptions about safe food storage and inadequate attention to cross-contamination indicate significant gaps in both food safety knowledge and attitudes.

3.3. Food Handlers' Practices

The key findings on food handlers' food safety practices are summarised in Table 4.

3.3.1. Personal Hygiene

Personal hygiene and handwashing practices varied markedly across the countries. In Palestine, although most food handlers claimed to wash their hands before work and after toilet use, field observations revealed inconsistent compliance and poor workplace hygiene, corroborated by high bacterial counts in food samples (Al-Khatib & Al-Mitwalli, 2009) Similar findings were reported in Somalia, where most handlers lacked hygiene training or protective clothing, and only a minority used gloves or washed their hands with soap after toilet use (Abdelrazig et al., 2017). Food handlers in restaurants in Somalia also showed a general lack of awareness of the risks of transmitting foodborne diseases (Hassan et al., 2020).

About two-thirds of Moroccan food handlers demonstrated safe hygiene practices, though many continued working while ill or wore jewelry during food preparation (Amaiach et al., 2024). Kuwaiti food handlers demonstrated comparatively better practices (82–96%), including regular handwashing and the use of personal protective equipment (PPE), but some still reused the same gloves for raw and cooked food (Al-Kandari et al., 2019). Similarly, high compliance was observed in Qatar and Saudi Arabia, where most workers reported washing hands before and after glove use and wearing uniforms and masks, though 30% still handled food when sick (Al-Shabib et al., 2016; Elobeid et al., 2019).

In contrast, Omani restaurants exhibited very poor hygiene as most handlers failed to wash their hands before or after touching raw food and frequently ate or smoked at work (Al-Ghazali et al., 2020; Ali et al., 2018). Hospital food handlers generally demonstrated higher compliance, particularly in Qatar and Saudi Arabia, where more than 80% wore gloves, masks, and head coverings during food preparation (Alqurashi et al., 2019; Kaabi et al., 2010). However, Egyptian and Iraqi studies revealed major gaps in hand hygiene and glove use, with fewer than one-third of participants washing their hands before cooking or consistently wearing aprons(Abdelhakeem et al., 2021; Ali et al., 2022; Elsherbiny et al., 2020; Kanaan et al., 2023). Street food plays an important economic role in most developing countries, providing affordable meals and creating jobs. However, as Alimi (2016) noted, its informal nature leaves it unregulated, posing potential health and safety

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risks to participants. Although street vendors are aware of the need for good hygiene, the typical lack of basic facilities at their vending sites suggests they prepare and serve food without the conditions necessary for safe food preparation. Convenience and economic factors were the primary reasons most vendors fail to translate their food safety knowledge into effective practices. This is borne out in the following country examples.

In Sudan, Abdalla et al. (2009) found that most vendors selling cooked meals, drinks, and juice did not wash their food before cooking (66%), and only 62% cooked their meals adequately. In Saudi Arabia, street vendors have limited access to basic hygiene facilities. Moutz et al.(2012) reported that vendors would not work if they were sick with vomiting (84%), diarrhea (68%), sore eyes (66%), or coughs and colds (60%), but were less likely to work if experiencing nausea (56%) or stomach cramps (50%), and would not work at all if another family member was sick. They reported washing their hands after eating meals (90%), handling garbage (86%), and using the toilet (86%), but less often than after touching money (20%) or handling raw foods (42%). Microbial tests indicated elevated levels of food contamination, with *Salmonella* and other pathogens detected, including *E. coli*, *Staphylococcus aureus*, and *Bacillus* spp. The total viable counts for all tested foods were moderate to high, ranging from 3.5 to 5.8 CFU/g. These results indicate that the vendors' adherence to good food safety practices was unsatisfactory, as expected in street settings. They paralleled those reported in Jordan, where only some vendors washed their hands before processing food (37%) and before and after touching unwrapped food (40%). About a quarter (26%) admitted to handling food at work while they have diarrhoea; a similar proportion never wear caps, aprons, or gloves (20-26%) and 36% always smoke (Elsahoryi et al., 2024).

Similarly, in Lebanon, most vendors (87%) prepared and served food without gloves, and only 3% washed their hands before serving. Many handled food and money without washing their hands (60%); 77% cleaned food-contact surfaces with their hands or a dirty apron or cloth, and prepared and served food in unacceptable clothing, such as no hairnets or filthy aprons (Loukieh et al., 2018).

In hospital settings, Wahdan et al. (2019) observed that nearly all food handlers (> 90%) did not wash their hands after touching their hair, nose, or ears, and few wore gloves (15%). Following targeted health education sessions, the mean practice scores increased substantially across hand hygiene, PPE use, cleaning, and utensil sanitation. Also in hospital settings, Kaabi et al. (2010) documented satisfactory food safety practices (90%), and all employees reported washing their hands as instructed. In contrast, Adel Hakim et al. (2014) reported alarming findings among food handlers in the University's tertiary care hospital and workers in fast-food restaurants, who continued to work despite symptoms of illness or hand lesions. Bou-Mitri et al. (2018) documented similar concerning behaviors in Lebanese hospitals, where 38% of food handlers would not suspend their duties to treat existing hand lesions, a serious risk factor for food contamination. Adel Hakim et al. (2014) further reported unsatisfactory hand hygiene and limited glove use (67%) when handling RTE food that had already been prepared. Nail swabs had positive cultures, mainly coagulase-positive and coagulase-negative staphylococci. Dirty nails, combined with the risk of cross-contamination, can result in pathogen growth in RTE food.

Similarly, in Iraq, Kannan et al. (2023) reported that 66% of food handlers working at vending operations, cafeterias, and popular restaurants washed their hands after handling dirty items. However, only 32% did so before cooking. Ali et al. (2022) also found, based on observations, that only 13.3% of participants consistently wore gloves during the distribution of unpackaged foods. Additionally, only 22% of participants washed their hands properly before or after using gloves, and 12% never did.

Although the hygiene assessment score in Kuwait was high (96%), the self-reported questionnaire results showed that 42% would go home with their uniforms, and more importantly, 45% would use the same gloves when handling raw meat and fresh food, with 36% not changing utensils when cooking raw and cooked food. Compliance among community workers was slightly higher than in healthcare settings (Moghnia et al., 2021). Conversely, Alqurashi et al. (2019) demonstrated that food handlers in Saudi hospitals generally exhibited good food safety practices.

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Almost all staff (95%) reported washing their hands before food preparation. Most staff (81%) always wore gloves when handling food during preparation, and the majority used masks (71%) and head caps (82%) when preparing and distributing food. They also stated that they should not prepare food for others if they had symptoms of communicable diseases (86%). Results from Alsultan et al. (2023), obtained from five hospitals in Saudi Arabia during the COVID-19 pandemic, revealed a significant positive correlation between food safety awareness and food safety practices. Older participants (>50 years) reported the highest mean score on food safety practices, although the correlation between food handlers' knowledge and safe food handling was negative. The presence of COVID-19 in the community should have increased food handlers' and other hospital staff's awareness of the need to avoid risky behaviour.

3.3.2. Sanitation and Cross-Contamination Prevention

In Iraq, about two-thirds of food handlers reported washing utensils between uses and separating raw and cooked foods, but fewer than half used separate bowls or cutting boards for raw and ready-to-eat items (Kanaan et al., 2023). In Kuwait, poor hygiene persisted; over half handled ready-to-eat food with bare hands, and fewer than half reheated food adequately or avoided keeping cooked food in the danger zone (Al-Kandari et al., 2019). Lebanese restaurants performed better in separation practices (89.5%), but only half used disinfectants during cleaning (Faour-Klingbeil et al., 2015).

Street vendors demonstrated the lowest level of compliance with hygiene standards. In Sudan, most utensils were washed only once a day, and food samples frequently contained *E. coli*, *S. aureus*, and *Bacillus* spp., indicating high levels of contamination (Abdalla et al., 2009). A more recent study by Elsahoryi et al. (2024) revealed that vendors have shown little improvement over the years; they possess basic hygienic knowledge but do not translate it into positive attitudes and practices towards food safety. Only 20% regularly wash and sanitise knives after cutting chicken or other raw foods, and only 16% wash their hands with soap and water after visiting the toilet.

In Lebanon, food samples also showed unsatisfactory levels of *Staphylococcus aureus* in some fruit, vegetable, meat, and dairy samples (10^3–10^4 CFU/g), as well as contamination with *Salmonella* spp. and *Listeria* spp., which affected over 50% of these same types of vended products. This was largely due to open-air selling, poor access to water (Loukieh et al., 2018) and the lack of separation between raw and cooked food (Hassan et al., 2022).

Institutional settings generally performed better. In Egypt, only 26% of hospital food handlers consistently separated raw and cooked foods, yet some facilities achieved >80% compliance with surface cleaning and fruit washing (Elsherbiny et al., 2020). Adel Hakim et al.(2014) reported that most handlers in the studied hospitals cleaned food-contact surfaces before and after use (>88%) and separated raw food from ready-to-eat food (92%). Utensils were rarely washed with soap and warm water (17%),

In Lebanon, Bou-Mitri et al. (2018) reported that 22% of food handlers did not use separate kitchen utensils to prepare raw and cooked food, and 73% thawed food at room temperature. In Morocco, Guennouni et al. (2022) reported that while hospital kitchen employees generally adhered to key food safety practices, critical knowledge gaps (as discussed in the previous section) remained and required further education and training. The practice was not directly observed, but if it had been, scores for good hygienic behaviour would still have been lower.

In Sudan, although nutrition staff had adequate knowledge of hygiene, gaps remained in HACCP awareness and in understanding temperature control (Mohammed et al., 2020). A similar conclusion was drawn from a study by Elsherbiny et al.(2020) in Egypt, in which the behaviour of food handlers was found to be inconsistent with good hygiene and food safety practices.

In Jordan, Sharif et al. (2013) found that the highest sanitation scores (91%) were in military hospitals, compared with civilian hospitals (84%), reflecting the benefits of structured training and supervision. However, based on the knowledge results of food handlers in Jordanian hospitals reported by Osaili et al. (2017), if practices were directly observed, they would reveal the need for

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improvement. However, a more in-depth examination of food handlers' practices in Jordanian hospitals is required to identify the primary concerns.

3.3.3. Temperature control

Temperature control of food was one of the weakest areas across almost all food establishments, with corporate establishments generally showing better temperature control practices than small businesses. In Morocco, Amaiach et al. (2024) found that cold storage was well maintained, yet nearly half failed to reheat food properly before serving. In Kuwait, 74% of handlers checked temperature settings and 67% stored leftovers appropriately, but fewer than half reheated food until it was steaming hot (Al-Kandari et al., 2019). Similar weaknesses were noted by Allafi et al. (2020), who found that many food handlers, especially among Egyptian and Indian workers, kept cooked food within the temperature danger zone. Similarly, a self-administered questionnaire by Alzhrani and Shatwan (2024) showed that the poorest scores (54-73) were for temperature control.

In Lebanon, temperature monitoring was largely absent in both corporate and small establishments; over two-thirds never measured temperatures during receiving, cooking, or cooling (Faour-Klingbeil et al., 2015, 2020). Studies in Egypt reported inconsistent monitoring of refrigerator temperatures (76%) and poor recording of cooking temperatures (22%) (Adel Hakim et al., 2014). Another study in Egypt found that thawing frozen food was inconsistent, with few recorded temperatures during food preparation (22%), and no temperature was taken during cooking (Elsherbiny et al., 2020)

Regarding street vendors' settings, food temperature was not specifically measured in most studies. In Sudan, Abdalla et al. (2009) found that only 62% of meals were adequately cooked. A few vendors prepared the meals in advance. However, in some cases, these meals were reheated before serving. Most of the food was served done using bare hands. Fewer than half used a cooler box or refrigerator for food storage; 31% stored their food openly in the stalls.

Table 4. Key findings on the food safety practices of food handlers in the Arab countries

4. Discussion

Overall, while basic food safety knowledge and positive attitudes are evident in many settings, clear patterns of deficiencies in key areas, such as temperature control and cross-contamination prevention, have emerged across all sectors, including hospitals. However, food businesses in low-income countries such as Sudan and Somalia, as well as street vendors, show particularly poor food safety knowledge, attitudes, and practices compared with other nations. Economic disparities across the Arab region directly affect food safety outcomes through several mechanisms. In high-income GCC countries, investment in modern infrastructure and regulatory systems has laid the foundation for improved food safety; however, significant implementation gaps remain. Conversely, in middle-income countries such as Jordan, Lebanon, and Egypt, limited resources for enforcement and training restrict the effectiveness of existing regulations. In low-income countries, the fundamental lack of infrastructure compounds knowledge gaps and unsafe practices among street vendors.

Additionally, countries with substantial food export sectors, such as Morocco, Tunisia, and Egypt, face external pressure to meet international food safety standards, as reflected in their regulatory developments and institutional restructuring (Faour-Klingbeil, 2022). However, this emphasis on export compliance may not be equally applied to establishments serving domestic markets, as evidenced by ongoing gaps even in well-resourced settings, resulting in a two-tier food

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safety system. Nonetheless, comparative analyses across countries must be approached with caution. As previously noted, methodologies used across studies vary, and these inconsistencies, combined with the limited number of studies per country, limit the ability to conduct scientifically rigorous cross-country comparisons of specific variables. The mixed results across GCC countries also highlight the complexity of changing behaviour and attitudes and indicate that there is no universal solution to improving food safety knowledge and practices. While modern food control infrastructure and financial resources are available in affluent countries such as Qatar, Kuwait, and Saudi Arabia, significant deficiencies persist in the practical application of food safety measures, including in hospitals. These countries have comprehensive regulations and greater resources than non-GCC countries, but inconsistent enforcement is assumed to undermine their effectiveness (Faour-Klingbeil, 2022). A regulatory approach that relies heavily on inspections may limit the impact of these regulations on actual practice. Moreover, many food businesses in the GCC employ a multicultural workforce with diverse educational backgrounds and language skills, which further complicates tailoring training programmes to meet varying educational levels.

Socio-demographic and institutional factors can significantly influence KAP outcomes, as shown by several studies. Education level, experience, and occupational position were frequently associated with better food safety knowledge and practices, although this association was not consistently observed. Older or more experienced food handlers often demonstrated greater knowledge retention (Abdelwahed et al., 2022; Faour-Klingbeil et al., 2015; Megahed Ibrahim et al., 2022; Osaili et al., 2013; Taha et al., 2020), while others reported negligible effects or even a decline with age (Alsultan et al., 2023; Bou-Mitri et al., 2018; Elsahoryi et al., 2024). Institutional structure and workplace culture also played a defining role, showing that **food safety attitudes are as much a function of organisational climate, leadership style, and supervision as of personal knowledge**. Transformational and participative leadership styles were associated with improved job satisfaction and adherence to hygiene protocols (Taha et al., 2020, 2024), underscoring the importance of management in shaping a positive food safety culture.

The KAP studies have not examined the barriers that may have contributed to deficiencies in knowledge and practices. However, Faour-Klingbeil et al. (2020) reported the results of food handlers' perceptions of these barriers, which were initially explored in the same sample and settings as in their previous work (Faour-Klingbeil et al., 2015). The results indicated a lack of resources, high costs, limited access to food safety information, inadequate management support, and lax enforcement as major obstacles to the implementation of food safety practices. These barriers will likely be perceived by food handlers elsewhere in the region and contribute to a poor food safety culture, resulting in significant knowledge gaps.

Additionally, training frequency and workplace culture were the strongest predictors of positive attitudes. For instance, stronger attitudes in hospital settings and Gulf countries are likely due to formal governance, structured training, and tighter regulatory oversight. In contrast, weaker attitudes were more prevalent where informal employment, staff shortages, and limited enforcement persist, conditions that undermine compliance with hygiene and food safety rules. These variations demonstrate how systemic and cultural factors interact with personal attitudes and ultimately influence practices.

It is important to situate these findings within the socio-economic and cultural diversity of the Arab region. Economic disparities affect access to training and sanitation infrastructure, while cultural norms influence perceptions of hygiene, authority, and risk. For instance, collectivist values may promote obedience to rules in hierarchical institutions, as shown in data obtained from military or hospital settings, whereas informal food markets often prioritise expediency and cost-efficiency. Nevertheless, food safety compliance remains limited by systemic barriers, namely weak enforcement, inadequate supervision, and lack of infrastructure, rather than by ignorance alone. Even in well-resourced institutions, critical practices such as temperature monitoring and cross-contamination prevention were inconsistently applied.

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Questionnaire-based studies examining food handlers' knowledge, attitudes, and self-reported practices may provide general indications of behaviour, but these do not always translate into actual compliance. Food workers tend to overestimate the frequency of safe practices (Clayton & Griffith, 2004), which explains the discrepancy between reported and observed behaviour.

Unfortunately, there are few observational studies in the region, and even fewer from the developing world. In Lebanon, Faour-Klingbeil et al.(2020) observed that many handlers who reported proper glove use or food separation failed to do so during direct observation. The frequency of essential practices for ensuring safe food production was reported by food handlers across 36 to 42 surveyed food service businesses. In contrast, respondents did not show or translate what they reported in practice. Correct practices were visually assessed as "adequate" at only 10 to 20 of the inspected locations. The authors also demonstrated that training alone cannot bridge the knowledge–practice gap; sustainable change depends on creating enabling environments that reinforce hygienic behaviour through policy, leadership, and continuous monitoring.

Globally, observation-based research confirms similar gaps. Lema et al. (2020) found that self-reported practice is usually overestimated, and an observational component might show even less compliance. This is especially important, as previous studies in Ethiopia have shown that food workers carry up to 29% of parasitic ova and enteropathogenic bacteria. Sibisi (2019) investigated the food safety KAP of food handlers in a food retail company in South Africa, using both self-reported responses and observations of actual practices. Despite managers reporting adequate washing stations, observations revealed that they were insufficient, unclean, or inaccessible to food handlers. Additionally, although respondents generally possessed the correct knowledge, operational pressure on employees sometimes led them to overlook recommended practices, as observed in food receiving, where defective goods were occasionally accepted when urgently needed. Also, Freeman et al. (2014) systematically reviewed the literature for observed handwashing prevalence and applied multilevel modelling to estimate handwashing practices worldwide, by region and by country. Unfortunately, no data are available for the Eastern Mediterranean Region. They used direct observation in this study and found that, on average, only 19% of the world population washes their hands with soap after using the toilet. In addition, people with access to designated handwashing facilities are about twice as likely to wash their hands with soap after potential fecal contact as people who lack a facility, and this is important for the food industry because it was noted in the Durban study that handwashing facilities were not available for many of the employees (Sibisi et al. 2019). Although this review of global research encompasses all individuals in various settings, cultural attitudes and practices often carry over into the work environment, a phenomenon that also applies to Middle East countries, even if they were not part of the meta-analysis. In summary, the most effective assessment of actual food safety practices is achieved through observations rather than self-reported surveys.

5. Limitations

This review has several limitations that should be acknowledged. First, despite efforts to expand the scope of the literature search, the availability of relevant studies was limited by the small number of KAP studies in the region. The inclusion of additional databases and grey literature yielded few new records, as government and industry bodies rarely publish KAP research of this type. Second, methodological differences among the studies limited the potential for quantitative analysis. Variations in study design, data collection instruments, analytical approaches, and variable measurements prevented the use of standardized assessment tools and reduced the comparability of results. Consequently, findings were synthesized narratively and thematically rather than statistically.

Third, the presentation of results was affected by the inconsistent reporting formats across studies. Variations in outcome metrics such as percentages, categorical ratings, and Likert-scale responses made visual or quantitative cross-country comparisons unreliable. Attempts to develop graphical summaries demonstrated that data sparsity and unequal sectoral coverage across countries

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could lead to misleading interpretations. Fourth, the number of studies per country varied considerably, and several were based on non-representative samples. These gaps make it scientifically inappropriate to infer causal relationships between KAP levels and the socio-economic or regulatory conditions of a country/ countries.

Finally, the manuscript remains partly constrained by its descriptive nature; As a scoping review, it aimed to map evidence rather than test hypotheses.

6. Conclusion

This scoping review shows that food handlers across the Arab region generally possess fair theoretical knowledge of personal hygiene, yet significant deficiencies persist in key areas, including temperature control, prevention of cross-contamination, and safe food handling. These shortcomings are most pronounced among street vendors and in low-income countries, reflecting socioeconomic disparities in access to training, enforcement, and infrastructure. Even in better-resourced Gulf countries, inconsistent application of food safety practices highlights the gap between knowledge and behavior. Institutional and hospital settings tend to perform better due to structured training and oversight, but gaps remain in areas such as temperature monitoring and consistent compliance.

To address these systemic weaknesses, interventions must extend beyond traditional training to include behaviour-based education and the promotion of a robust food safety culture. Evidence from this review indicates that education level, work experience, and workplace governance significantly influence food safety outcomes. Management commitment, supervision, and regulatory follow-up are as critical to safe practices as individual knowledge and attitudes, whereas inadequate infrastructure and weak enforcement remain key barriers.

Moreover, research and evaluation of the effectiveness of vocational and licensing programs, ensuring alignment with current food sector needs and core food safety principles, should underpin policy development. A paradigm shift is necessary in both vocational education and training programs, one that overhauls existing structures by integrating thematic learning centred on the practical and critical aspects of food safety, rather than relying solely on purely theoretical knowledge. Establishing licensing programs that maintain high learning standards, including for street vendors, can play a pivotal role in improving food safety practices. Inclusive capacity-building initiatives tailored to informal food sectors should prioritise feasible, low-cost hygiene solutions that account for economic and infrastructural constraints.

Ultimately, advancing food safety in the Arab region requires a coordinated, multisectoral approach that integrates education, enforcement grounded in an educational rather than punitive approach, and strong organisational commitment to achieving sustainable behavioural change.

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References

1. Abdalla, M. A., Suliman, S. E., & Bakhiet, A. (2009). Food safety knowledge and practices of street food-vendors in Atbara City (Naher Elneel State Sudan). *African Journal of Biotechnology*. https://www.semanticscholar.org/paper/Food-safety-knowledge-and-practices-of-street-food-Abdalla-Suliman/6d70af59cb8ca7cad486ee95765e261048ee3bca
2. Abdelhakeem, A. A., Feyza, B., & Hekmat, A.-A. (2021). Food Safety Knowledge among Food Handlers in Hospitals of Jordan. *Food Science and Technology*, *9*(2), 17–30. https://doi.org/10.13189/fst.2021.090201
3. Abdelrazig, A., Mustafa, K., & Mohamed, M. (2017). *Hygienic Practices among Food Handlers in Restaurants of Al-Nohod Locality Market-West Kordofan-Sudan-2017*. https://www.semanticscholar.org/paper/Hygienic-Practices-among-Food-Handlers-in-of-Abdelrazig-Mustafa/204dba39658e3e80f36b1de0302dd45e6d4459fa

 doi:10.20944/preprints202504.0146.v2

4. Abdelwahed, A. Y., Metwaly, S. M., Ahmed, A. K., & Alkotb Alagamy, Z. G. (2022). Knowledge, attitudes and practices of food handlers about food safety at Fayoum restaurants. *Tanta Scientific Nursing Journal*, *24*(1), 356–379. https://doi.org/10.21608/tsnj.2022.221609
5. Adel Hakim, S., Mostafa, N., & Abdel-Rahman, S. (2014). ASSESSMENT OF THE KNOWLEDGE, ATTITUDE AND PRACTICE TOWARDS FOOD POISONING OF FOOD HANDLERS IN SOME EGYPTIAN WORKSITES. *Egyptian Journal of Occupational Medicine*, *38*(1), 79–94. https://doi.org/10.21608/ejom.2014.789
6. Ajzen, I., & Madden, T. J. (1986). Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. *Journal of Experimental Social Psychology*, *22*(5), 453–474. https://doi.org/10.1016/0022-1031(86)90045-4
7. Al-Ghazali, M., Al-Bulushi, I., Al-Subhi, L., Rahman, M. S., & Al-Rawahi, A. (2020). Food Safety Knowledge and Hygienic Practices among Different Groups of Restaurants in Muscat, Oman. *International Journal of Food Science*, *2020*, 8872981. https://doi.org/10.1155/2020/8872981
8. Ali, A., Azmi, A., & Shahid, N. (2022). Food Safety Knowledge, Attitude, and Practices Among Food Handlers in Kirkuk City Hospitals, Iraq. *Malaysian Journal of Medicine and Health Sciences*, *18*, 140–145. https://doi.org/10.47836/mjmhs.18.s15.19
9. Ali, M. A., Shuaib, Y. A., Ibrahaem, H. H., Suliman, S. E., & Abdalla, M. A. (2018). Food Safety Knowledge among Food Workers in Restaurants of Salalah Municipality in Sultanate of Oman. *International Journal of Horticulture, Agriculture and Food Science*, *2*(2), 1–6. https://doi.org/10.22161/ijhaf.2.2.1
10. Alimi, B. A. (2016). Risk factors in street food practices in developing countries: A review. *Food Science and Human Wellness*, *5*(3), 141–148. https://doi.org/10.1016/j.fshw.2016.05.001
11. Al-Kandari, D., Al-abdeen, J., & Sidhu, J. (2019). Food safety knowledge, attitudes and practices of food handlers in restaurants in Kuwait. *Food Control*, *103*, 103–110. https://doi.org/10.1016/j.foodcont.2019.03.040
12. Al-Kandari, D., & Jukes, D. J. (2009). A situation analysis of the food control systems in Arab Gulf Cooperation Council (GCC) countries. *Food Control*, *20*(12), 1112–1118. https://doi.org/10.1016/j.foodcont.2009.02.012
13. Al-Khatib, I. A., & Al-Mitwalli, S. M. (2009). Food sanitation practices in restaurants of Ramallah and Al-Bireh district of Palestine. *Eastern Mediterranean Health Journal*, *15*(4). https://www.emro.who.int/emhj-volume-15-2009/volume-15-issue-4/food-sanitation-practices-in-restaurants-of-ramallah-and-al-bireh-district-of-palestine.html
14. Allafi, A. R., Al-Kandari, D., Al-Abdeen, J., & Al-Haifi, A. R. (2020). Cross-cultural differences in food safety knowledge, attitudes and practices of food handlers working at restaurants in Kuwait. *Acta Bio-Medica: Atenei Parmensis*, *91*(4), e2020181. https://doi.org/10.23750/abm.v91i4.8614
15. Alqurashi, N. A., Priyadarshini, A., & Jaiswal, A. K. (2019). Evaluating Food Safety Knowledge and Practices among Foodservice Staff in Al Madinah Hospitals, Saudi Arabia. *Safety*, *5*(1), Article 1. https://doi.org/10.3390/safety5010009
16. Al-Shabib, N. A., Mosilhey, S. H., & Husain, F. M. (2016). Cross-sectional study on food safety knowledge, attitude and practices of male food handlers employed in restaurants of King Saud University, Saudi Arabia. *Food Control*, *59*, 212–217. https://doi.org/10.1016/j.foodcont.2015.05.002
17. Alsultan, S. B., Allowaymi, S. S., Alshammari, G. M., Alrasheed, A., Hassan, A. B., Alzobaa, A. A., Alqahtani, A. B., & Yahya, M. A. (2023). Cross-Sectional Investigation of the Awareness and Practices of Food Safety among Food Service Catering Staff in Riyadh City Hospitals during the Coronavirus Pandemic. *Healthcare (Basel, Switzerland)*, *11*(8), 1134. https://doi.org/10.3390/healthcare11081134
18. Alzhrani, W. F., & Shatwan, I. M. (2024). Food Safety Knowledge, Attitude, and Practices of Restaurant Food Handlers in Jeddah City, Saudi Arabia. *Foods (Basel, Switzerland)*, *13*(14), 2176. https://doi.org/10.3390/foods13142176
19. Amaiach, R., El Ouali Lalami, A., Fadil, M., Bouslamti, R., & Lairini, S. (2024). Food safety knowledge, attitudes, and practices among food handlers in collective catering in central Morocco. *Heliyon*, *10*(23), e40739. https://doi.org/10.1016/j.heliyon.2024.e40739

 doi:10.20944/preprints202504.0146.v2

20. Angelillo, I. F., Viggiani, N. M., Rizzo, L., & Bianco, A. (2000). Food handlers and foodborne diseases: Knowledge, attitudes, and reported behavior in Italy. *Journal of Food Protection*, *63*(3), 381–385. https://doi.org/10.4315/0362-028x-63.3.381
21. Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32. https://doi.org/10.1080/1364557032000119616
22. Begum, M., Alam, M. J., Parikh, P., & De Steur, H. (2025). Understanding food safety knowledge, attitude, and practices of consumers and vendors: An umbrella review. *Food Control*, *171*, 111094. https://doi.org/10.1016/j.foodcont.2024.111094
23. Bou-Mitri, C., Mahmoud, D., El Gerges, N., & Jaoude, M. A. (2018). Food safety knowledge, attitudes and practices of food handlers in lebanese hospitals: A cross-sectional study. *Food Control*, *94*, 78–84. https://doi.org/10.1016/j.foodcont.2018.06.032
24. Clayton, D. A., & Griffith, C. J. (2004). Observation of food safety practices in catering using notational analysis. *British Food Journal*, *106*(3), 211–227. https://doi.org/10.1108/00070700410528790
25. Elobeid, T., Savvaidis, I., & Ganji, V. (2019). Impact of food safety training on the knowledge, practice, and attitudes of food handlers working in fast-food restaurants. *British Food Journal*, *121*(4), 937–949. (world). https://doi.org/10.1108/BFJ-01-2019-0066
26. Elsahoryi, N. A., Olaimat, A., Shaikha, H. A., Tabib, B., & Holley, R. (2024). Food safety knowledge, attitudes and practices (KAP) of street vendors: A cross-sectional study in Jordan. *British Food Journal*, *126*(11), 3870–3887. (world). https://doi.org/10.1108/BFJ-08-2023-0709
27. Elsherbiny, N. M., Sobhy, S. A., Fiala, L., & Kofi, M. A. (2020). Improving food handlers knowledge about food safety in Ismailia city hospitals, Egypt. *International Journal of Advanced Community Medicine*, *3*(1), 172–176. https://doi.org/10.33545/comed.2020.v3.i1c.133
28. Faour-Klingbeil, D. (2022). Chapter 7—Food safety knowledge, attitudes, and practices among food handlers in foodservice establishments in the Arab countries of the Middle East. In I. N. Savvaidis & T. M. Osaili (Eds.), *Food Safety in the Middle East* (pp. 227–273). Academic Press. https://doi.org/10.1016/B978-0-12-822417-5.00002-7
29. Faour-Klingbeil, D., Kuri, V., & Todd, E. (2015). Investigating a link of two different types of food business management to the food safety knowledge, attitudes and practices of food handlers in Beirut, Lebanon. *Food Control*, *55*, 166–175. https://doi.org/10.1016/j.foodcont.2015.02.045
30. Faour-Klingbeil, D., Kuri, V., & Todd, E. (2020). Comparison of hygiene standards and food safety practices between sole-proprietor and corporate-managed restaurants in Lebanon. *British Food Journal*. https://doi.org/10.1108/BFJ-01-2019-0018
31. Food Export Association of the Midwest USA. (n.d.). *Egypt Country Profile: Market Overview*. Food Export Association of the Midwest USA and Food Export USA–Northeast. https://www.foodexport.org/export-insights/market-country-profiles/egypt/
32. Freeman, M. C., Stocks, M. E., Cumming, O., Jeandron, A., Higgins, J. P. T., Wolf, J., Prüss-Ustün, A., Bonjour, S., Hunter, P. R., Fewtrell, L., & Curtis, V. (2014). Hygiene and health: Systematic review of handwashing practices worldwide and update of health effects. *Tropical Medicine & International Health: TM & IH*, *19*(8), 906–916. https://doi.org/10.1111/tmi.12339
33. Guennouni, M., Admou, B., Bourrhouat, A., El Khoudri, N., Zkhiri, W., Talha, I., Hazime, R., & Hilali, A. (2022). Knowledge and Practices of Food Safety among Health Care Professionals and Handlers Working in the Kitchen of a Moroccan University Hospital. *Journal of Food Protection*, *85*(4), 676–685. https://doi.org/10.4315/JFP-21-305
34. Hamed, A., & Mohammed, N. (2020). Food safety knowledge, attitudes and self-reported practices among food handlers in Sohag Governorate, Egypt. *Eastern Mediterranean Health Journal = La Revue De Sante De La Mediterranee Orientale = Al-Majallah Al-Sihhiyah Li-Sharq Al-Mutawassit*, *26*(4), 374–381. https://doi.org/10.26719/emhj.19.047
35. Hassan, G. D., Hirsi, D. A., & Ahmed, H. (2020). Food hygiene practices among food handlers in selected restaurants hawle wadag district in banadir region mogadishu-somalia. *Journal of Health, Medicine and Nursing*, *5*(2), Article 2. https://www.iprjb.org/journals/index.php/JHMN/article/view/1087

 doi:10.20944/preprints202504.0146.v2

36. Hassan, H., Darra, N. E., & Khatib, A. A. (2022). Food safety practices among food carts in North Lebanon. *BAU Journal - Health and Wellbeing*, *4*(2). https://doi.org/10.54729/ZLIC6777
37. Idris, Y. M. A., Mariod, A. A., Mohamedin, K. F., & Alshafi, A. S. (2024). Food safety knowledge and practices of food handlers at a public Sudanese university. *Food Systems*, *7*(2), Article 2. https://doi.org/10.21323/2618-9771-2024-7-2-263-267
38. Kaabi, S. K. A., Lbrahim, A. a. E., & Salama, R. E. (2010). Assessment of Knowledge, Attitude and Practice of Food Safety Among Food Service Staff at Hamad General Hospital in 2006. *Qatar Medical Journal*, *2010*(2), 8. https://doi.org/10.5339/qmj.2010.2.8
39. Kanaan, M. H. G., Salim, I. D., Tarek, A. M., & Abdullah, S. S. (2023). Knowledge, attitude, and hygiene practices of food handlers related to food safety in Al-Suwaira City, Wasit Province in Iraq. *International Journal of One Health*, *9*(2), 150. https://doi.org/10.14202/IJOH.2023.150-158
40. Kharroubi, S., Nasser, N. A., El-Harakeh, M. D., Sulaiman, A. A., & Kassem, I. I. (2020). First Nation-Wide Analysis of Food Safety and Acceptability Data in Lebanon. *Foods*, *9*(11), 1717. https://doi.org/10.3390/foods9111717
41. Lami, F., Radhi, F., Al Dahhan, S., Hashim, R. A., Mahmood, H., Araj, R., & Arbaji, A. (2019). Knowledge, Attitude, and Practices of Food Handlers on Food Safety and Personal Hygiene During Arbaeenia Mass Gathering, Baghdad, Iraq, 2014: Cross-Sectional Study. *JMIR Public Health and Surveillance*, *5*(4), e10922. https://doi.org/10.2196/10922
42. Lema, K., Abuhay, N., Kindie, W., Dagne, H., & Guadu, T. (2020). Food Hygiene Practice and Its Determinants Among Food Handlers at University of Gondar, Northwest Ethiopia. *International Journal of General Medicine*, *13*, 1129–1137. https://doi.org/10.2147/IJGM.S262767
43. Loukieh, M., Mouannes, E., Abou Jaoudeh, C., Hanna Wakim, L., Fancello, F., & Bou Zeidan, M. (2018). Street foods in Beirut city: An assessment of the food safety practices and of the microbiological quality. *Journal of Food Safety*, *38*(3), e12455. https://doi.org/10.1111/jfs.12455
44. Marklinder, I., Wersén, V., & James, K. (2025). Food safety and healthcare professionals: The need for education and research. *Food Control*, *171*, 111118. https://doi.org/10.1016/j.foodcont.2024.111118
45. Megahed Ibrahim, A., Eltabey Sobeh, D., & El-emam Hafez, F. (2022). Food handlers' knowledge, attitude, and practices about safe and hygienic food in Egyptian government hospitals. *Egyptian Journal of Health Care*, *13*(2), 1577–1585. https://doi.org/10.21608/ejhc.2022.246620
46. Mehdi Asaad, A., Al Lami, F., Abdullatif, B., Kareem, A., Mahdi, A., & Mahmood, S. (2014). Food Poisoning Outbreak in Tikrit City, Iraq, 2013: Staphylococcus aureus and Salmonella Typhimurium were the Incriminated Pathogens. *Iraqi Postgraduate Medical Journal*, *13*(2), 169–175. https://ipmj.org/article_93020.html
47. Moghnia, O. H., Rotimi, V. O., & Al-Sweih, N. A. (2021). Evaluating Food Safety Compliance and Hygiene Practices of Food Handlers Working in Community and Healthcare Settings in Kuwait. *International Journal of Environmental Research and Public Health*, *18*(4), 1586. https://doi.org/10.3390/ijerph18041586
48. Mohammed, H. A., Basheir Ahmed, S., & Ahmed, F. A. (2020). Food safety knowledge, attitudes and practices (KAP) of the nutrition staff in three Sudanese hospitals. *Journal of the Saudi Society for Food and Nutrition*, *13*(1), 10–16.
49. Mohieldin, A., Bajin Salam, H. H., Adam, D., & Albassir, K. (2015). Evaluation of food hygiene and safety practices in Bahri hospitals 2015 – Khartoum- Sudan. *International Journal of Healthcare Sciences*, *3*(1), 191–194. Evaluation of food hygiene and safety practices in Bahri hospitals 2015 – Khartoum- SUDAN
50. Morocco World News. (2024). *Morocco Vegetable Export Dominate German Market in Early 2024*. https://www.moroccoworldnews.com/2024/06/363060/morocco-vegetable-export-dominate-german-market-in-early-2024
51. Moutz, E., Suliman, S. E., & Abdalla, M. A. (2012). Surveillance of food safety practices of street food-vendors in Gizan Saudi Arabia. *Agriculture and Forestry*. https://www.semanticscholar.org/paper/Surveillance-of-food-safety-practices-of-street-in-Moutz-Suliman/f7a1ce5673d99935d66aba7daa521d030423df76

 doi:10.20944/preprints202504.0146.v2

52. Omar, S. (2020). Food safety knowledge of street food vendors in downtown Amman-Jordan. *Eurasian Journal of Biosciences*. https://www.semanticscholar.org/paper/Food-safety-knowledge-of-street-food-vendors-in-Omar/1558ed80ec785476d36c52f764bbe6c519c10e4a
53. Osaili, T. M., Abu Jamous, D. O., Obeidat, B. A., Bawadi, H. A., Tayyem, R. F., & Subih, H. S. (2013). Food safety knowledge among food workers in restaurants in Jordan. *Food Control*, *31*(1), 145–150. https://doi.org/10.1016/j.foodcont.2012.09.037
54. Osaili, T. M., Al-Nabulsi, A. A., & Allah Krasneh, H. D. (2018). Food safety knowledge among foodservice staff at the universities in Jordan. *Food Control*, *89*, 167–176. https://doi.org/10.1016/j.foodcont.2018.02.011
55. Osaili, T. M., Obeidat, B. A., Hajeer, W. A., & Al-Nabulsi, A. A. (2017). Food safety knowledge among food service staff in hospitals in Jordan. *Food Control*, *78*, 279–285. https://doi.org/10.1016/j.foodcont.2017.02.057
56. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71
57. Qureshi, A. S. (2020). Challenges and Prospects of Using Treated Wastewater to Manage Water Scarcity Crises in the Gulf Cooperation Council (GCC) Countries. *Water*, *12*(7), Article 7. https://doi.org/10.3390/w12071971
58. Sharif, L., Obaidat, M. M., & Al-Dalalah, M.-R. (2013). Food Hygiene Knowledge, Attitudes and Practices of the Food Handlers in the Military Hospitals. *Food and Nutrition Sciences*, *04*(03), Article 03. https://doi.org/10.4236/fns.2013.43033
59. Sibisi, A. S. (2019). *Food hygiene, safety, handling practices and knowledge of food handlers in a food retail company in Durban, KwaZulu-Natal, South Africa* [Thesis]. https://doi.org/10.51415/10321/3212
60. Taha, S., Osaili, T. M., Saddal, N. K., Al-Nabulsi, A. A., Ayyash, M. M., & Obaid, R. S. (2020). Food safety knowledge among food handlers in food service establishments in United Arab Emirates. *Food Control*, *110*, 106968. https://doi.org/10.1016/j.foodcont.2019.106968
61. Taha, S., Zanin, L. M., & Osaili, T. M. (2024). Studying the perception of leadership styles and food handlers' hygienic practices in food businesses: The role of commitment and job satisfaction as mediators. *Food Control*, *157*, 110148. https://doi.org/10.1016/j.foodcont.2023.110148
62. Tawfeed Ali, A. S., Azmi, A., & Mohd Shahid, N. S. (2022). Food Safety Knowledge, Attitude, and Practices Among Food Handlers in Kirkuk City Hospitals, Iraq. *Malaysian Journal of Medicine and Health Sciences*, *18*(s15), 140–145. https://doi.org/10.47836/mjmhs.18.s15.19
63. Todd, E. C. D., Greig, J. D., Bartleson, C. A., & Michaels, B. S. (2007). Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 3. Factors contributing to outbreaks and description of outbreak categories. *Journal of Food Protection*, *70*(9), 2199–2217. https://doi.org/10.4315/0362-028x-70.9.2199
64. Todd, E. C. D., Greig, J. D., Bartleson, C. A., & Michaels, B. S. (2008). Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 5. Sources of contamination and pathogen excretion from infected persons. *Journal of Food Protection*, *71*(12), 2582–2595. https://doi.org/10.4315/0362-028x-71.12.2582
65. UCI Health. (2018). *Wash your hands, avoid your T-zone to prevent infection*. https://www.ucihealth.org/blog/2018/12/cold-flu-prevention/
66. Wahdan, I. H., Gad, Z. M., Habib, I., & Elshabasy, O. (2019). Effect of an Educational Program on Food Safety Practices in Food Preparation and Handling Procedures in Governmental Hospitals of an Egyptian Governorate. *Journal of High Institute of Public Health*, *49*(2), 90–96. https://jhiphalexu.journals.ekb.eg/article_49261_8c419d260c312af1023b5258f51feeb4.pdf
67. WHO. (2015). *WHO estimates of the global burden of foodborne diseases* (Foodborne Disease Burden Epidemiology Reference Group2007-2015). World Health Organization. https://www.who.int/activities/estimating-the-burden-of-foodborne-diseases

 doi:10.20944/preprints202504.0146.v2