# Food Safety Education for Pharmacy Students to Prevent Foodborne Diseases: A Modified Qualitative Systematic Review

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# Abstract

Foodborne diseases remain a critical global public health challenge, disproportionately affecting low-resource settings and vulnerable populations. This dissertation examines the integration of food safety education into pharmacy curricula to prevent foodborne diseases, with a focus on Cambodia. Utilizing a Modified Qualitative Systematic Review (MQSR), the research synthesizes evidence from peer-reviewed articles and grey literature to identify the essential knowledge and skills required by pharmacy students to promote effective food safety practices.

The findings underscore the limitations of current pharmacy curricula in Cambodia, particularly in addressing practical competencies related to food safety education. While foundational topics such as toxicology, bacteriology, and virology are covered, there is a lack of emphasis on household food safety practices and community-focused prevention strategies. Drawing on international best practices, including the World Health Organization's Five Keys to Safer Food, this study highlights the need for targeted training to equip pharmacists with the skills to educate communities on preventing foodborne diseases.

This research proposes incorporating comprehensive food safety modules into pharmacy programs, utilizing interactive, contextually relevant, and evidence-based teaching approaches. The recommendations aim to enhance pharmacists' capacity to serve as frontline educators in mitigating the burden of foodborne diseases. By addressing this critical gap, the study contributes to the development of more effective health education strategies, thereby improving public health outcomes in Cambodia and similar contexts.

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# Attestation of Authorship

I at this moment declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgments), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Sovannaroath Tang

Signature:

Date: 10 December 2024

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# Chapter 1 Introduction

## 1.1 Introduction

This introduction section will describe the statement of the problem, the aims and rationale of the review, and the framework of the research. Finally, the section will end with the structure of the dissertation.

## 1.2 Statement of the Problem

The study answers the following question: what is the most effective curriculum to enhance the skills and knowledge of pharmacy students about food safety to prevent foodborne diseases? This review focuses integrating food safety education into the pharmacy curriculum in Cambodia. No research has been conducted to determine the specific content and competencies required for pharmacy students in this area. By addressing this gap, the study aims to identify the critical components of food safety knowledge and practical skills necessary for pharmacists to educate communities and prevent foodborne diseases effectively.

## 1.3 Aim and Rationale

The research aims to develop a comprehensive guide for incorporating food safety education into pharmacy curricula in Cambodia. The study identifies essential knowledge, competencies, and best practices for pharmacy students to become effective educators and advocates for food safety.

The rationale for this research stems from the growing recognition of pharmacists' role in public health education. By enhancing their capacity to provide evidence-based food safety information, the study seeks to reduce the burden of foodborne diseases, particularly in underserved communities. The findings will provide actionable recommendations for curriculum developers and policymakers to strengthen pharmacists' roles in food safety education.

## 1.4 Framework

The study adopts a Modified Qualitative Systematic Review (MQSR) methodology to analyse existing literature and identify best practices in food

safety education for healthcare professionals. A systematic search of databases, including Scopus, Medline, CINAHL, and Google Scholar, was conducted using key terms related to pharmacy, food safety, education, and public health. Grey literature was also reviewed to capture additional insights. Following Braun and Clarke's guidelines, thematic analysis was used to extract and synthesize data into actionable recommendations (Braun & Clarke, 2006).

The research framework integrates evidence from global and local contexts, including the World Health Organization's Five Keys to Safer Food, to propose a culturally relevant and practical curriculum for pharmacy students in Cambodia, as well as in contexts where pharmacists are the primary healthcare providers, such as in Māori communities.

## 1.5 Structure of the Dissertation

This dissertation comprises six chapters:

Chapter One presents the background, problem statement, aims, framework, and definitions.

Chapter Two presents the literature review, which examines global and Cambodian contexts of food safety, foodborne diseases, and best practices in food safety education.

Chapter Three outlines the methodology. It describes the research design, data collection methods, and analytical approach.

Chapter Four outlines the findings, summarizes the results of the thematic analysis, and provides insights from the reviewed literature.

Chapter Five is the discussion and Recommendations chapter, where it interprets the findings, discusses limitations, and provides recommendations for curriculum development and policy changes.

# Chapter 2 Literature Review

## 2.1 Introduction

This section will focus on the literature on food safety and foodborne diseases at a global level and in Cambodia. It will also review the current global and Cambodian policy, initiatives, programmes, and legislation. Finally, it will look at the best practices in food safety education.

## 2.2 Food Safety and Foodborne Diseases

### 2.2.1 Food Safety

Food is a daily necessity for everyone, making everyone susceptible to illnesses caused by eating contaminated or unsafe food. Food safety is crucial for preventing foodborne diseases. Before looking further into food safety and foodborne diseases, it is important to establish a clear understanding of the terms: ‘food’, ‘food safety’, and ‘foodborne diseases.’

Firstly, what is food? According to the online Longman of Contemporary English (LDOCE) and Oxford Learner's Dictionaries, ‘food’ refers to substances that people or animals eat (LDOCE, n.d.; Oxford Learner's Dictionaries, n.d.). This definition typically excludes beverages or drinks.

However, a broad definition can be found in the Oxford English Dictionary (OED), a comprehensive guide for researchers across disciplines. ‘Food’ is “any nutritious substance that people or animals eat or drink in order to maintain life and growth; nourishment, provisions” (OED, n.d.). This definition concurs with the World Health Organization (WHO) definition, which considers ‘food’ to encompass any substance “whether processed, semi-processed or raw, which is intended for human consumption, and includes drink, chewing gum and any substance which has been used in the manufacture, preparation or treatment of “food” but does not include cosmetics or tobacco or substances used only as drugs” (FAO & WHO, 2023a, p. 20).

In summary, food is described as any edible, drinkable substance, whether in solid, semi-solid, or liquid form, ranging from raw to cooked or processed. Food can be either digestible or indigestible, such as chewing gum, and it can be either

finished products or substances used in food manufacture, preparation, or treatment. Nevertheless, cosmetics, drugs, and tobacco do not fall under the category of food.

Secondly, what is food safety? Published in 2012, the Food Safety Hazard Guidebook defined food safety as “the practice of ensuring that foods cause no harm to the consumer” (Lawley et al., 2012, p. 1). This brief definition covers a wide range of practices, from “basic domestic and personal hygiene to highly complex technical procedures designed to remove contaminants from sophisticated processed foods and ingredients” (Lawley et al., 2012, p. 1).

Instead of rejecting the definition, alternative definitions of food safety showed a wide range of practices to ensure food is safe. The broad coverage of practices in the definition of food safety in the Food Safety Hazard Guidebook aligns with those in the Guide to Food Safety for Consumers in Cambodia, produced by GIZ, Deutsche Gesellschaft für Internationale Zusammenarbeit, or the German Corporation for International Cooperation. (Selmi, 2024). This guidebook defines food safety as “the way we grow, harvest, transport, handle, process, prepare, and store food and beverages in a way that reduces the risk of becoming sick from foodborne diseases.” (Food Roots, n.d., p. 1). The fundamentals of food safety are preventing the contamination of water, beverages, and food and minimising the risk of food poisoning, foodborne diseases, and deaths. (Food Roots, n.d.). The Guide to Food Safety for Consumers in Cambodia uses simple language to explain the concept of food safety to the public, and it conveys that various actions, from production to storage, are aimed at ensuring public understanding and the safe consumption of food.

Further, the WHO describes food safety as the “assurance that food will not cause adverse health effects to the consumer when it is prepared and/or eaten according to its intended use” (FAO & WHO, 2023b, p. 7). Although this definition may seem brief and straightforward, it encompasses a broad range of food safety measures. In the public health context, food safety includes proper food preparation and assurance of food safety. (Grumezescu & Holban, 2018). Hence, food safety refers to a comprehensive set of procedures that span the entire food supply chain, from farm production to consumption at our tables.

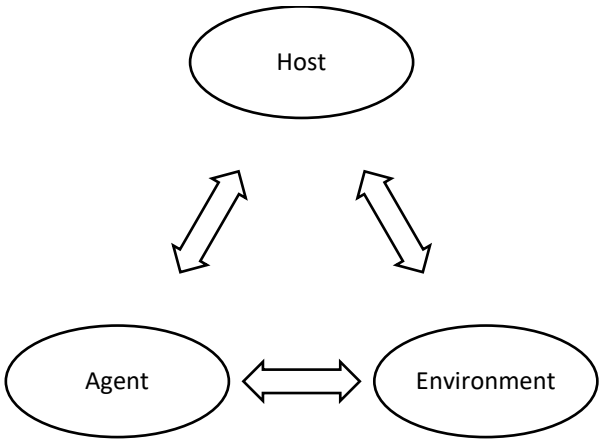
In the Khmer (Cambodian) language, food is ម្ហូបអាហារ [mhoub aeahar], and food safety is សុវត្ថិភាពម្ហូបអាហារ [sovot thephap mhoub aeahar]. Cambodia adopted the WHO definitions to define both food safety and food. They have been translated and incorporated into the Cambodian Law on Food Safety, signed on 8 June 2022 and promulgated as Royal Kram No.NS/RKM/0622/006 (Ministry of Justice, 2022). The definition of food in Khmer is "ម្ហូបអាហារ សំដៅដល់ផលិតផលឬសារធាតុណាមួយ ទោះបីត្រូវកែច្នៃទាំងស្រុង ឬពាក់កណ្តាលកែច្នៃឬមិនទាន់កែច្នៃ សម្រាប់មនុស្សបរិភោគ រួមទាំងភេសជ្ជៈ ស្ករកៅស៊ូ និងសារធាតុទាំងឡាយ ដែលត្រូវបានប្រើប្រាស់នៅក្នុងផលិតកម្ម ការរៀបចំ ឬការធ្វើប្រព្រឹត្តិកម្មនៃម្ហូបអាហារ លើកលែងតែគ្រឿងសម្អាង ផលិតផលថ្នាំជក់ ឬផលិតផលដែលប្រើប្រាស់សម្រាប់ឱសថ។" (Ministry of Justice, 2022, p. ii). English translation: Food refers to any product or substance, whether fully processed, semi-processed, or unprocessed, intended for human consumption. This includes beverages, chewing gum, and substances used in the production, preparation, or treatment of food, except for cosmetics, tobacco products, or products used as medicine. The definition of food safety in Khmer is "សុវត្ថិភាពម្ហូបអាហារ សំដៅដល់ការអនុវត្តដំណើរការធានាថា ម្ហូបអាហារមិនបង្កគ្រោះថ្នាក់ដល់អ្នកប្រើប្រាស់នៅពេលដែលត្រូវបានយកទៅធ្វើការរៀបចំ ឬបរិភោគស្របតាមកម្មវិត្ថុប្រើប្រាស់របស់ម្ហូបអាហារនោះ។" (Ministry of Justice, 2022, p. ii). English translation: Food safety refers to the implementation of processes that ensure food does not cause harm to the consumer when it is prepared and consumed according to its intended use. These Khmer definitions of food and food safety closely align with those outlined in the Inter-Ministerial *Prakas* on the Implementation and Institutional Arrangements of Food Safety Based on the Farm to Table Approach, signed on 22 October 2010 and published as *Prakas* No UATH.BRK 868 (Keat et al., 2010). This *Prakas* was jointly signed by the Deputy Prime Minister from the Ministry of Economy and Finance, the Senior Minister from the Ministry of Commerce, the Ministers of Industry, Mines and Energy, Agriculture, Fisheries and Forestry, Health, and Tourism. The inter-ministerial endorsement indicates that the definition of food and food safety established is widely adopted and applies across key ministries in Cambodia.

### 2.2.2 Foodborne Diseases

Foodborne diseases are "commonly transmitted through ingested food" (WHO, 2014, p. xii). However, not all food consumed causes illness. According Grumezescu and Holban (2018), foodborne diseases occur when three factors –

known as ‘the epidemiologic triad – come together: the host, the agent, and the environment (Figure 2.1). The host is a person who may have weakened immunity or a certain condition, like chronic diseases (HIV, cancer, diabetes mellitus, or tuberculosis), genetic disorders, old or young age, or who is pregnant. The agent includes chemicals, radioactive materials, or microbes such as viruses, bacteria, parasites, and fungi, that cause diseases (WHO, 2022a). The environment includes factors such as contaminated food and how food is produced, prepared, and consumed. For example, diarrhoea occurs when a vulnerable person consumes food contaminated by bacteria carried by flies. In this scenario, the consumption of contaminated food leads to the transmission of disease.

**Figure 2.1 Epidemiologic Triad of Foodborne Diseases**




Note. Relationship between host, agent and environment in the epidemiologic triad of foodborne diseases. *Adapted from Foodborne Diseases* (p. 64), by A. M. Holban and A. M. Grumezescu, 2018, Academic Press. Copyright 2018 by Elsevier.

### 2.2.3 Types and Causes of Foodborne Diseases

Consuming contaminated food can result in more than 200 diseases and symptoms like nausea, vomiting, diarrhoea. Nausea, vomiting, and diarrhoea are the acute, relatively mild gastrointestinal symptoms of foodborne diseases, usually self-limiting (Kuchenmüller et al., 2013). However, severe and chronic foodborne diseases can affect the musculoskeletal, immune, respiratory, and cardiovascular systems and can cause multi-organ failure, neurological disorders, and abortions (Kuchenmüller et al., 2013). Neuro-developmental disorders, cardiovascular disease, cancers, renal diseases, and liver failure can

be consequences of consuming food contaminated with arsenic, lead, mercury, aflatoxins, and dioxins (Kuchenmüller et al., 2013).

Foodborne diseases can be grouped into three categories: those caused by biological agents, chemical agents, and allergens (Grumezescu & Holban, 2018; Lawley et al., 2012). Biological agents include bacterial, viral, fungal, and parasitic (Grumezescu & Holban, 2018). Chemical agents include various contaminants, like agricultural chemicals (i.e., pesticides and chemical fertilizers); environmental contaminants (i.e., heavy metals and dioxins); veterinary drugs (i.e., antibiotics); natural biological toxins (i.e., toxins from fish, plants, and fungus); cleaning and sanitising chemicals; adulterants; and plasticisers (Lawley et al., 2012). Food allergies are also considered foodborne diseases, as some individuals, especially children, may have allergic reactions to particular foods (Lawley et al., 2012). The European Union identifies 14 food allergens, including wheat, milk, egg, sesame, celery, crustaceans, tree nuts, lupin, soya, molluscs, sulphur dioxide and sulphites, peanuts, fish, and mustard (Lawley et al., 2012).

The WHO estimates the global burden of foodborne diseases at 31 hazards causing 32 diseases (WHO, 2015). These hazards include 11 agents causing diarrhoeal diseases, 7 agents causing invasive infectious diseases, 3 chemicals and 10 helminths. Table 2.1 shows the 31 foodborne hazards.

**Table 2.1 The 31 Foodborne Hazards**

| Chemicals and Toxins (3) | Diarrhoeal disease agent (11) | Invasive infectious disease agents (7) | Helminths (10) |
|---|---|---|---|
| 1. Aflatoxin<br>2. Cassava cyanide<br>3. Dioxins | Viruses (1)<br>4. Norovirus<br>Bacteria (7)<br>5. *Campylobacter* spp.<br>6. *Enteropathogenic Escherichia coli*– EPEC<br>7. Enterotoxigenic *Escherichia coli* – ETEC<br>8. Shiga-toxin-producing *Escherichia coli* – STEC<br>9. Non-typhoidal *Salmonella enterica*<br>10. *Shigella* spp.<br>11. *Vibrio cholerae*<br>Protozoa (3)<br>12. *Cryptosporidium* spp.<br>13. *Entamoeba histolytica*<br>14. *Giardia* spp. | Viruses (1)<br>15. Hepatitis A virus<br>Bacteria (5)<br>16. *Brucella* spp.<br>17. *Listeria monocytogenes*<br>18. *Mycobacterium bovis*<br>19. *Salmonella* Paratyphi A<br>20. *Salmonella* Typhi<br>Protozoa (1)<br>21. *Toxoplasma gondii* | Cestodes (3)<br>22. *Echinococcus granulosis*<br>23. *Echinococcus multiloculari s*<br>24. *Taenia solium*<br>Nematodes (2)<br>25. *Ascaris* spp.<br>26. *Trichinella* spp.<br>Trematodes (5)<br>27. *Clonorchis sinensis*<br>28. *Fasciola* spp.<br>29. Intestinal flukes *<br>30. *Opisthorchis* spp.<br>31. *Paragonimus* spp. |

*Note.* * Selected species from families Echinostomatidae, Fasciolidae, Gymnophallidae, Heterophyidae, Nanophyetidae, Neodiplostomidae, and Plagiorchiidae. Adapted from *WHO Estimates of the Global Burden of Foodborne Diseases* (p. 78), by WHO, 2015, WHO Press. Copyright 2015 by World Health Organization.

## 2.3 Global Burden of Foodborne Diseases

### 2.3.1 Morbidity and Mortality

The establishment of the Foodborne Disease Burden Epidemiology Reference Group (FERG) by the World Health Organization (WHO) in 2007 marked a significant step toward systematically estimating the global burden of foodborne diseases on a decadal basis (WHO, 2015). The first global assessment,

published in 2015, estimated that in 2010, there were approximately 600 million cases of foodborne illness and 420,000 deaths worldwide (Havelaar et al., 2015; WHO, 2015). Foodborne diseases also account for more than 5.6 million Years Lived with Disability (YLDs), 27 million Years of Life Lost (YLLs) and 33 million Disability-Adjusted Life Years (DALYs) (WHO, 2015).

These data reflect both the widespread nature of foodborne diseases and their considerable long-term health impacts. Children under the age of five (U-5) accounted for 40% of the total disease burden, indicating their particular vulnerability (Havelaar et al., 2015). This burden calls for urgent, targeted interventions. The economic consequences of unsafe food are also significant, with an estimated annual cost of 110 billion USD in productivity losses and medical expenses in low and middle-income countries (WHO, 2022a). Such evidence highlights the urgent need for stronger food safety education and better cross-sectoral coordination across health, agriculture, and trade sectors, pivotal for reducing disease burden and promoting global health equity.

Most foodborne diseases globally are caused by diarrhoeal diseases, accounting for around 550 million cases annually (WHO (2015). Norovirus and *Campylobacter* spp. are among the leading pathogens. Norovirus alone is responsible for about 120 million cases, and *Campylobacter* spp., for 96 million cases (WHO, 2015). These diseases also place a considerable pressure on healthcare systems. In the United States, norovirus causes about 900 deaths, over 100,000 hospitalisations, 465,000 emergency visits, and millions of clinic visits, costing up to 740 million USD (Burke et al., 2020).

More than half of all foodborne disease-related deaths, or about 230,000, were attributed to diarrheal diseases (WHO, 2015). Non-typhoidal Salmonella enterica was the leading cause, responsible for nearly 60 thousand deaths of diarrhoea and invasive salmonellosis. Other major contributors to foodborne-related deaths include *Salmonella* Typhi, *Taenia solium*, and hepatitis A virus (Havelaar et al., 2015).

*Echinococcus multilocularis*, which causes abdominal and pelvic issues from alveolar echinococcosis, has the highest fatality rate among helminths (fox worms) – nine out of 10 infected persons die (WHO, 2015). On the other hand,

*Ascaris* spp. has the highest incidence rate, with 12 million infections out of 13 million helminth-related infections worldwide (WHO, 2015). As of 2021, 732 million remained people infected with *Ascaris*, globally, particularly in parts of Africa, South America, and Asia (Holland et al., 2022; Wan et al., 2024), despite an overall infection decline since 1990 (Holland et al., 2022).

Concerning chemicals and toxins, dioxin causes most of the foodborne diseases, but no deaths. In contrast, aflatoxin, although responsible for fewer cases than dioxin, caused for most deaths from foodborne diseases caused by chemicals and toxins. Of 22,000 aflatoxin cases, 19,000 resulted in fatalities (>80%), mainly from hepatocellular carcinoma or lung cancer (WHO, 2015). Aflatoxin-related cancers have the highest mortality rate and continue to be a significant public health issue, particularly in developing countries (Xu et al., 2018). Long-term exposure to aflatoxins can be measured using aflatoxin-albumin adducts in blood, which reflect three months of exposure (Xu et al., 2018). Research in Africa found widespread exposure, with biomarker levels ranging from 10 pg./mg in Ugandan children to as high as 578.5 pg./mg in Kenyan adolescents during a 2004 outbreak (Xu et al., 2018). In China, a 2020 study estimated an average daily intake of aflatoxins from foods such as peanuts, peanut oil, corn, and corn-based products was 4.018 ng/kg body weight, contributing to public health (Chen et al., 2022).

### 2.3.2 Social Determinants and Inequality

There are significant links between foodborne diseases and the level of food hygiene knowledge, the level of food safety behaviour of food consumers, and other social determinants of foodborne diseases, including age, education, profession, expenditure on food, and special family members, which were associated with foodborne disease development (Al-Mohaithef et al., 2020; Angelillo et al., 2000; Milovanova et al., 2024; Qu, 2019). Angelillo et al. (2000) found that food hygiene knowledge and food safety behaviour are associated with the risk of foodborne diseases in Italy. Qu et al. (2021) found that interrelated factors, such as price, emotional value, and cultural food preferences, influence people's food choices.

Women, children, and the elderly are particularly vulnerable to foodborne diseases. A study in the US found that children under 5 had the highest incidence

of foodborne illnesses, while those aged 65 and older had the highest rates of hospitalisation and deaths (Centers for Disease Control and Prevention, 2013; Milovanova et al., 2024). In many developing countries, millions of pregnant women and under-5 children are affected by malnutrition (Müller & Krawinkel, 2005). More than half of the deaths are linked to malnutrition, including perinatal conditions (37%), acute respiratory infections (19%), diarrhoea (17%), malaria (8%), and other diseases (19%) (Müller & Krawinkel, 2005).

The causes of deaths among children due to malnutrition in Cambodia are similar, with over $200 million US dollars lost yearly, most of which - 57% - is linked to child malnutrition (Bagriansky et al., 2013).

Milovanova et al. (2024) examined the gendered determinants of food safety in low and middle-income countries. Women, as primary caregivers, play a central role in food preparation, storage, and consumption. However, gender inequality often restricts their access to resources and information on safe food handling. In Ethiopia, cultural practices, education, and income levels influence food safety practices, contributing to disparities among vulnerable populations. Women‘s underrepresentation in leadership roles, lead to food safety policies that lack gender sensitivity and overlook to answer women’s specific needs and concerns. Addressing gender inequality, cultural barriers, and economic disparities is crucial for promoting safer and more equitable food systems (Milovanova et al., 2024).

Newman et al. (2015) reviewed the impact of socioeconomic status on the burden of foodborne diseases in high-income countries, like Australia, New Zealand, Singapore, South Korea, and the United States. They found that the relationship between socioeconomic status, foodborne pathogens, and behaviours. For example, Campylobacter – a common bacterial cause of diarrheal disease - and Salmonella infection – an invasive foodborne pathogen – were more common among higher-income groups, associated with eating out, consuming raw or undercooked food, and international travel. These findings suggest that in developed regions, foodborne disease risk may not necessarily follow traditional patterns of social disadvantage, but rather be influenced by lifestyle, dietary habits, and food sourcing behaviours associated with affluence (Newman et al., 2015).

Newman et al. (2015) also found that *Listeria* infection was more prevalent among individuals with lower socioeconomic status, due to a higher consumption of cold-processed meats, unpasteurized dairy products, and greater vulnerability to immunocompromising conditions.

Concerning *Escherichia coli* infection, no association between income and risk was observed in Denmark and Canada, but a higher risk was observed with higher income in Japan and Finland (Newman et al., 2015). These findings may suggest that beyond individual behaviour, wider structural and environmental factors, such as food safety regulations, cultural behaviours, and systemic factors (Newman et al., 2015).

A study conducted in Pennsylvania, USA, found that socio-economic and geographical factors, such as rural versus urban residency, living in food deserts, and income, influence food choices, food safety, and the risk of foodborne diseases (Smith, 2019). Individuals from lower-income groups were more likely to consume foods commonly associated with Salmonella, such as poultry, eggs, and unpasteurized milk, and fewer foods linked to Campylobacter risk, including restaurant food and fresh produce (Smith, 2019). These patterns show that differences in food access, affordability, and behaviours — influenced by social and economic factors — are critical in determining the type and distribution of foodborne disease risk across population groups (Smith, 2019).

A study in Kenya found climate to be a significant determinant of foodborne disease risk and health inequities (Xu et al., 2018). They found that in 2002, school children from two nearby communities had markedly different levels of aflatoxin albumin in their blood, with higher levels in the more humid, lower-altitude *Matangini* than in the drier, higher-altitude *Yumbuni.* Hence, Yumbuni's elevated and drier climate reduced this risk (Xu et al., 2018).

Similar findings were found in China (Chen et al., 2022). Peanuts and peanut oil are widely consumed in China, but are often contaminated with aflatoxin (Qin et al., 2021). Nationwide surveillance found higher levels of aflatoxin contamination in several regions of East and South China, particularly those with subtropical temperate monsoon climates (Qin et al., 2021). People living in Guangdong, Fujian, and Jiangxi provinces were at a higher risk (Qin et al., 2021). These

findings show how minor climate differences can significantly influence food safety risks and contribute to geographic and environmental health inequalities.

## 2.4 Global Food Safety Policies and Initiatives

Safe food is a pivotal for our health and is a universal human right (WHO, 2022b). This section will outline several global initiatives on food safety, including WHO's Five Keys to Safer Food, WHO Global Strategy for Food Safety 2022-2030: Towards Stronger Food Safety Systems and Global Cooperation, the Codex Alimentarius, and UNICEF Nutrition Strategy 2020-2030.

### 2.4.1 WHO's Five Keys to Safer Food

Proper food handling remains essential for preventing the majority of foodborne illnesses (WHO, 2006). In the early 1990s, the World Health Organization introduced the Ten Golden Rules for Safe Food Preparation, which were later streamlined into the Five Keys to Safer Food in 2001 to enhance public understanding and adoption (WHO, 2006). Since then, no updated or alternative global guidelines have been issued, highlighting the need for renewed efforts to adapt food safety recommendations to current challenges and the evolving food system.

These five keys are: (1) keep clean, (2) separate raw and cooked, (3) cook thoroughly, (4) keep food at safe temperatures, and (5) use safe water and raw materials (WHO, 2006). Further, the WHO also emphasises safe water and raw materials as essentials for ensuring food safety (WHO, 2006). Interventions based on the Five Keys to Safer Food have been proven effective in improving people's knowledge, attitudes, and behaviour regarding food safety (Ghaffari et al., 2020; Susanna et al., 2020).

Suggestions for revisiting the Five Keys to Safer Food were made due to their overuse and evolving challenges (Langsrud et al., 2023). Additionally, the WHO also published manuals to complement and promote food safety practices, like the Five Keys for Safer Traditional Food Markets (WHO, 2023b), Five Keys to Safer Aquaculture Products to Protect Public Health (WHO, 2016), Five Keys to Growing Safer Fruits and Vegetables to promote health by decreasing microbial contamination (WHO, 2012).

### 2.4.2 WHO Global Strategy for Food Safety 2022-2030

The WHO Global Strategy for Food Safety 2022-2030: Towards Stronger Food Safety Systems and Global Cooperation was established in response to member states' requests to tackle current and emerging challenges (WHO, 2022b). These challenges include enhancing regulatory infrastructure, enforcement and surveillance, food inspection, laboratory capacity and capability, coordination mechanisms for prevention and management of events, and education and training. In addition, there is a need to integrate food safety into regional and national health, environment, agriculture, and development policies (WHO, 2022b).

The strategy vision is safe and healthy food for everyone, everywhere, aiming to reduce the burden of foodborne diseases (WHO, 2022b). This strategy was built upon previous strategies, including the Global Strategy for Food Safety (2002) and the Strategic Plan for Food Safety (2013-2022), to ensure continuous improvement in food safety (WHO, 2022b).

These abovementioned strategies reflect WHO's commitment to promoting international and national cooperation in addressing global food safety issues. Such strategies underline the role of food safety in public health and highlight the importance of enhancing global cooperation across the entire food and feed chain to reduce the burden of foodborne diseases (WHO, 2022b).

Following the adoption of the WHO Global Strategy for Food Safety (2022–2030), many countries began working to strengthen their national food safety systems and enhance global cooperation to reduce foodborne diseases. For example, China developed a national roadmap to improve inspection services and expand lab-based surveillance (Wu, 2022). However, developing countries face significant challenges in implementation, such as the prevalence of small-scale food industries, low public awareness, and resistance to regulatory frameworks (Oloo et al., 2018). Cambodia is facing similar barriers and is focusing on strengthening its food safety system by improving its laboratory capacity and standards to detect and monitor outbreaks effectively (NHQC, 2023; So, 2022).

### 2.4.3 Codex Alimentarius

The Codex Alimentarius was established and overseen by the Codex Alimentarius Commission, comprising members and associate members of the Food and Agriculture Organization (FAO) and WHO (FAO & WHO, 2023a). Public health has been the foundation for the Codex Alimentarius (WHO, 2022b). The primary aim of the Codex Alimentarius is to protect consumers and ensure fair food trade practices (FAO & WHO, 2023a).

The scope of the Codex covers a wide range of foods, including raw, semi-processed, and processed food for consumer distribution (FAO & WHO, 2023a). Codex also provides guidelines for food additives, food hygiene, veterinary drugs, pesticide residues, contaminants, labelling and presentation, analysis and sampling methods, food inspection, and certification for food import and export (FAO & WHO, 2023a). However, it is essential to note that the Codex Alimentarius neither replaces nor serves as an alternative to national legislation. Compliance with the country's laws and administrative procedures regarding food safety is essential (FAO & WHO, 2023a).

### 2.4.4 UNICEF Nutrition Strategy 2020-2023

UNICEF commits to consistently supporting governments and partners in tackling childhood malnutrition and advocating for every child's right to adequate nutrition (UNICEF, 2021). Positive progress has been observed globally, with a one-third reduction of U-5 undernutrition and 55 million fewer undernourished children (UNICEF, 2021). However, one in three children still face malnutrition, risking stunting. Two in three children do not receive the minimum diet adequate for optimal growth, development, and learning (UNICEF, 2021). In Africa, 82% infants aged 6 to 12 months do not achieve the minimum dietary diversity (MDD), which is one of the indicators assessing nutrient intake for children (Vollmer et al., 2025). Among 49 low- and middle-income countries that share infants and young children aged 6 to 23 months making minimum adequate diet is 9% in Sub-Saharan Arica; 18% in Central Asia; 23% in South and Southeast Asia, 24% in North Africa, Wester Asian, and Europe; 40% in Latin America and Caribbean (Baye & Kennedy, 2020).

The UNICEF Nutrition Strategy 2020-2030 envisioned a world where all children, adolescents, and women realise their right to nutrition by promoting diets,

services, and practices that support optimal nutrition, growth, and development (UNICEF, 2021). One key priority of the strategy is to establish a system that engages the five fundamental systems: food, health, water and sanitation, education, and social protection, to improve nutrition outcomes (UNICEF, 2021). The food system is pivotal and must work together with the other four systems (UNICEF, 2021).

Additionally, the food system comprises policies, actors, and services necessary to ensure children's access to safe, nutritious, affordable, and sustainable diets (UNICEF, 2021). Therefore, food safety is a key component of the food system and a priority in the UNICEF Nutrition Strategy 2020-2030.

## 2.5 Food Safety and Foodborne Diseases in Cambodia

Foodborne diseases are still a significant public health problem in Cambodia, with diarrheal diseases being a major contributor to the burden (Havelaar et al., 2015; Kirk et al., 2015). A systematic review of animal products from 2000 to 2022 showed gaps in food safety research and surveillance in Cambodia, particularly outside the capital (San et al., 2024). Outbreaks, such as the one linked to Khmer noodles in 2014, highlight the need for better food safety measures (Kimsean et al., 2017). Climate change and extreme weather worsen the risk of waterborne diseases, especially for vulnerable groups, like women and children (Davies et al., 2015). Cambodia is working to strengthen its regulatory structures, improve monitoring and surveillance, and focus on targeted intervention research (Thompson et al., 2021). However, data on specific pathogens like Campylobacter are limited, suggesting the need for increased laboratory capacity and awareness among healthcare professionals (Nguyen et al., 2017).

The Cambodian National Infectious Disease Surveillance collects case and death data related to 10 infectious diseases from all 25 provinces of Cambodia through the reports of health centres and from the general public (Lan et al., 2022). These ten diseases are fever with rash, severe respiratory infection, acute jaundice, acute flaccid paralysis, suspected dengue fever, neonatal tetanus, meningitis or encephalitis, acute diarrhoea, rabies, and diphtheria (Communicable Disease Control Department, 2023).

According to the annual report of International Health Regulations (IHR) core capacities for surveillance and response to any potential public health events of international concern, the surveillance capacities of Cambodia scored 4.5 (90%) in 2022, and level 5 is the highest level (WHO, 2023a). Level 5 indicates that, in terms of early warning surveillance function, national guidelines and/or SOPs for surveillance have been developed and implemented at national, intermediate, and local levels. Additionally, the system is regularly exercised, reviewed, evaluated, and updated, with improvements at all levels throughout the country. Event management, a process or mechanism for managing detected events, is being implemented at national, intermediate, and local levels and exercised, reviewed, evaluated, and updated regularly (WHO, 2021).

Cambodia scored 3 out of 5 for its good safety capacity in 2022. This score indicates that a multisectoral collaboration mechanism and communication channels between the International Food Safety Authorities Network (INFOSAN) Emergency Contact Point and the National IHR Focal Point and all relevant sectors for food safety events, such as emergencies at the national and international level have not been established and exercised, regularly reviewed, evaluated, and updated (WHO, 2021, 2023a).

Currently, Cambodia is strengthening its capacity in food inspection, monitoring, and laboratory testing at the provincial level. All food poisoning samples are now analysed at the National Health Products Quality Control Centre (NHQC), located in the Capital city of Phnom Penh, Cambodia (National Institute of Statistics, 2023).

The Cambodian NHQC obtained accreditation for ISO 17025 in 2023. ISO 17025 is an international standard specifying requirements for quality and competence in testing and calibration laboratories (NHQC, 2023).

In addition, another ISO 17025 accredited laboratory is the Laboratory of Environment and Food Safety (LEFS) at Institute Pasteur du Cambodge (IPC), which has been able to analyse samples for contaminants such as *Salmonella*, Coliform's bacteria, *Escherichia coli*, Enterobacteriaceae, and other microorganism in food products and animal feed since 2022 (So, 2022). These show the improvement of the foodborne disease surveillance system and the

capacity for food safety, even though the current surveillance system seems to primarily focus on reportable diseases, which neglects the self-limiting foodborne illnesses or diseases (Chea, 2023).

Nearly 30 foodborne disease outbreaks occur annually in Cambodia (Srey, 2021). Foodborne diseases and outbreaks pose significant public health burdens to Cambodia. While 16.6% live below 2.7 USD per day per person, the cost of foodborne disease hospitalisation is around 63 USD per case (Srey, 2021).

Between 2010 and 2015, more than half of the 288 disease outbreaks in Cambodia (51%, 144 outbreaks) were linked to diarrheal diseases (Lawpoolsri et al., 2018), which has been a significant health burden in the country for decades. A cohort study (2012–2018) in rural and peri-urban Cambodian villages found that nearly one-third of participants (29%, 5,027 people) reported at least one diarrheal episode – an annual incidence of 281.5 per 1,000 persons (Kelly et al., 2023). Common causes included *Escherichia coli*, *Shigella* spp., norovirus, and parasites, with mixed infections in more than a third of cases (36%) (Kelly et al., 2023). The risk of diarrhoea was higher among the unemployed, those without access to protected water, and those with poor sanitation (Kelly et al., 2023). Findings highlight the need for targeted, community-based public health interventions in Cambodia.

Between 2014 and 2019, Cambodia reported 134 foodborne disease outbreaks, resulting in 6,000 illnesses, 5,600 hospitalisations, and 81 deaths (Mekong Institute, 2019). From 2018 to 2022, there were 1,534 cases of food poisoning, with 818 hospitalisations and 82 deaths (Ministry of Health, 2023). While some outbreaks were traced to chemical contaminants such as methanol, pesticides, parasites, and microbes, many incidents remained unidentified (Chea, 2023; Thompson et al., 2021). These figures highlight serious public health risks and gaps in food safety surveillance, outbreak investigation, and regulatory enforcement. Improving food monitoring systems, laboratory testing, and intersectoral coordination is critical to detecting and preventing outbreaks.

## 2.6 Policies and Programmes in Cambodia

This section discusses food safety regulations in Cambodia, including relevant laws related to food safety and ministries responsible for overseeing food safety regulations and standards in Cambodia.

### 2.6.1 Ministries Responsible for Ensuring Food Safety

Six ministries in Cambodia are responsible for ensuring food safety, each with distinct duties and responsibilities related to different stages of the food supply chain, as illustrated in Table 2. These six ministries are the Ministry of Health, the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Industry, Science, Technology and Innovation, the Ministry of Commerce, the Ministry of Tourism, and the Ministry of Economy and Finance (GIZ, 2013; Thompson et al., 2021). With their distinct duties and responsibilities, for instance, the Ministry of Health monitors hygiene, storage conditions, and biological contamination at the consumer stage across various settings, including homes, formal establishments such as restaurants, and informal settings like street food vendors.

Collaboration amongst ministries is essential at certain stages of the supply chain. For example, the Ministry of Health collaborates with the Ministry of Trade during the food services stage to enforce adherence to HACCP, ensuring hygiene and preventing food contamination (physical, chemical, and biological) in formal establishments and street markets. Table 2.2 provides a comprehensive overview of the roles and duties of each ministry at different stages of the supply chain.

**Table 2.2 Key Ministries Responsible for Ensuring Food Safety in Cambodia**

| Stage of the food supply chain | Food safety hazards | Responsible ministries | Key responsibilities |
|---|---|---|---|
| Import | | Ministry of Agriculture, Forestry and Fisheries | Raw produce, stock feed, genetic material, live animals, plants, or seeds |
| Primary Production | Ag/Vet chemical residues; physical, chemical, and biological contaminants; environmental contaminant | Ministry of Agriculture, Forestry and Fisheries | Farm production, aquaculture, intensive production, wild harvest |
| Primary Processing | Hygiene issues: physical, chemical, and biological contaminants; | Ministry of Agriculture, Forestry and Fisheries | Sorting, cleaning, slaughtering, drying, etc |
| Manufacturing | HACCP; Hygiene issues; physical, chemical, and biological contaminants; | Ministry of Industry, Science, Technology, and Innovation | Production of processed foods |
| Import | Certification and compliance checks, safety checks, and testing of high-risk food imports | Ministry of Commerce | Ingredients, processed, and manufactured foods |
| Wholesale and Retail | Storage, spoilage, and physical, chemical, and biological contamination | Ministry of Commerce | Both formal establishments and street markets |
| Food Services | HACCP, hygiene issues, physical, chemical, and biological contaminants | Ministry of Health<br>Ministry of Tourism | Formal establishments and street food |
| Consumer | Poor hygiene, storage, and biological contaminants | Ministry of Health | At home, in formal establishments, and in street food |
| Storage and Transportation | Physical, chemical, or biological contamination, or spoilage | Ministry of Commerce | |

*Note.* Adapted from “Food Safety in Cambodia” [Presentation slides] by I. Neth, 2019, p. 14. Copyright 2019 by Inrasothythep Neth

### 2.6.2 Food Safety Regulations in Cambodia

This section outlines key food safety regulations in Cambodia from the 1980s to the 2020s, including major laws and regulatory documents. Important laws include the Law on the Management of Quality and Safety Products and Services, the Law on Fisheries, the Law on Standards of Cambodia (products, services, and management), the Law on the Management of Pesticides and Fertilisers, and the Law on Food Safety. These were signed by the King and published by the Ministry of Justice (Ministry of Justice, 2022; WHO, 2017). Additionally, regulatory documents also include sub-decrees signed by the Prime Minister, *prakas* (notices), and instruction circulars signed by the ministers. Table 2.3 summarises these laws and regulations.

Two of the thirteen documents focused directly on food safety, while two of them focused on food hygiene. The Law in Food Safety was established to safeguard the public health and protect consumers' rights by defining what is legal and what is prohibited in food handling, production, and distribution (Ministry of Justice, 2022). The Inter-Ministerial *Prakas* on the Implementation and Institutional Arrangement of Food Safety Based on the *Farm-to-Table Approach* identified responsible ministries to ensure food safety in Cambodia. Sub-decree on Food Hygiene for Human defines a general rule about the hygiene of products that are intended to serve as food for humans (Royal Government of Cambodia, 2003), while the Instruction Circular on Requirements for Hygiene of Food Shops and Restaurants defines the rules that food shops and restaurants must adhere to during food processing and storage (Ministry of Health, 2005).

Law on the Management of Quality and Safety Products and Services and Law on Standards of Cambodia (products, services, and management) set the general quality and standards for products and services relevant to food (Ministry of Justice, 2000, 2007). However, for specific types of food products, there are six legal documents. Sub-decree on the Transportation of Fishery Product and Law on Fishery focus on products made of fish. Sub-Decree on Marketing of Products for Infant and Young Child Feeding focuses on food for infants and young children. Notice on Procedure of Animal Sanitation Control and Animal Origin Products focuses on products made from animals, and *Prakas* on the List of Maximum Residue Limits of Pesticide in Agricultural Products of Plant Origin

and Law on the Management of Pesticides and Fertilisers focus on plant-based products. Finally, *Prakas* on Procedures for Inspection of Imported Food focuses on ensuring the safety of imported food from other countries.

**Table 2.3 Laws and Regulatory Documents to Ensure Food Safety in Cambodia**

| No. | Laws and regulatory documents | Year of publication | Publisher |
|---|---|---|---|
| 1 | Sub-decree on the Transportation of Fishery Products | 1988 | (Royal Government of Cambodia, 1988) |
| 2 | Law on the Management of Quality and Safety Products and Services | 2000 | (Ministry of Justice, 2000) |
| 3 | Sub-decree on Food Hygiene for Human | 2003 | (Royal Government of Cambodia, 2003) |
| 4 | Instruction Circular on Requirements for Hygiene of Food Shops and Restaurants | 2005 | (Ministry of Health, 2005) |
| 5 | Sub-Decree on Marketing of Products for Infant and Young Child Feeding | 2005 | (Royal Government of Cambodia, 2005) |
| 6 | Law on Fishery | 2007 | (Ministry of Agriculture Forestry and Fisheries, 2007a) |
| 7 | Law on Standards of Cambodia (products, services, and management) | 2007 | (Ministry of Justice, 2007) |
| 8 | *Prakas* on the List of Maximum Residue Limits of Pesticides in Agricultural Products of Plant Origin | 2007 | (Ministry of Agriculture Forestry and Fisheries, 2007b) |
| 9 | Notice on the Procedure of Animal Sanitation Control and Animal Origin Products | 2009 | (Ministry of Agriculture Forestry and Fisheries, 2009) |
| 10 | Inter-Ministerial *Prakas* on the Implementation and Institutional Arrangement of Food Safety Based on the Farm to Table Approach | 2010 | (Ministry of Economy and Finance et al., 2010) |
| 11 | Law on the Management of Pesticides and Fertilisers | 2012 | (Ministry of Justice, 2012) |
| 12 | *Prakas* on Procedures for Inspection of Imported Food | 2019 | (Ministry of Commerce, 2019) |
| 13 | Law on Food Safety | 2022 | (Ministry of Justice, 2022) |

*Note.* Data collected by the author in 2024

## 2.7 Current and Best Practices in Food Safety Education

This section will synthesize and articulate current understanding and best practices in food safety training or education.

Food safety training or education programs have primarily targeted food handlers in the food industries, rather than consumers. This emphasis highlights the fact that most foodborne disease outbreaks are associated with food-processing facilities or restaurants (Holst et al., 2024; Lee et al., 2021; Sivaramalingam et al., 2015; Young et al., 2020). For example, in New Zealand, the food safety course at Manukau Institute of Technology is designed for people who are employed or looking for employment in the food industry (Manukau Institute of Technology, 2024). Export standards also drive the need for food safety training for competent food handlers who are committed to safe food practices.

However, there has been a growing need for food safety education for consumers, particularly home cooks and food handlers not employed in the food industry, educators, and healthcare professionals. Research shows that unsafe food handling at the household level significantly contributes to foodborne illness (Dong et al., 2024; Sivaramalingam et al., 2015; Suominen et al., 2023). Healthcare professionals and teachers with strong knowledge and commitment to food safety also play a critical role, as they are generally trusted sources of knowledge within the community (Ovca et al., 2018).

Food safety education is often lacking in low-income countries and households, where food handling practices are passed down through generations and learned through observations and traditions rather than formal training. Limited access to food safety education, inadequate kitchen tools and risky cultural practices increase the community's vulnerability to foodborne diseases (Chen et al., 2023). There is a clear need to expand food safety education, both at the elementary school (Peng et al., 2021) and household levels to ensure that communities have the skills, resources to support safe food handling practices (Tanyitiku et al., 2022).

Several delivery methods for food safety training and education can include in-person sessions – (groups or one-to-one); printed and digital materials (e.g., brochures, online information/training, online newspaper); media campaigns

(e.g., home visits, radio, television, social media), interactive activities (demonstrations, skits, mascots, experiential learning, web-based video games, kitchen self-audit) and community based announcement (loudspeaker announcements; mass emails, medical alerts) (Sivaramalingam et al., 2015).

Key contents of food safety education include general food safety principles, personal hygiene, proper washing of fruit and vegetables, food preservation and spoilage, time and temperature control, adequate cooking, avoiding unsafe or high-risk foods, preventing cross-contamination, food-recall procedures, and Hazard Analysis Critical Control Points (Sivaramalingam et al., 2015).

The effectiveness of food safety education and methods of delivery depends on the target audience. For direct consumers, effective methods include community-based training; school and university courses and curricula; social-marketing campaigns; and easily accessible educational materials (e.g., brochures, videos) (Sivaramalingam et al., 2015).

For students, web-based tutorials have been shown to improve students' learning (Fajardo-Lira & Heiss, 2006), suggesting the incorporation of digital tools in teaching strategies (Fajardo-Lira & Heiss, 2006). The Facebook food safety video intervention has improved students' knowledge, and students found it more engaging than conventional lectures (Mayer & Harrison, 2012). When combined with lectures, Facebook use led to higher knowledge gained (Mayer & Harrison, 2012).

However, Facebook interventions had only moderate to low effectiveness across various groups (Berglund et al., 2024), including students, consumers, and food workers. Many may struggle to stay focused, including social isolation, time constraints and difficulties in understanding the materials. Future online food safety training should use clear, simple language, time time-efficient, and incorporate social or interactive elements, such as game-based training that is practical and engaging (Berglund et al., 2024)

Building on these insights into effective food safety education, the following discusses how food safety content is currently integrated into the pharmacy curriculum in Cambodia.

## 2.8 Food Safety Contents in University Pharmacy Curricula in Cambodia

The Bachelor of Pharmacy (B. Pharmacy) in Cambodia is a 5-year program regulated by the Ministry of Health (Ministry of Health, 2007). Students study theoretical subjects in classrooms, practice in laboratories (practical work/PW), and complete the clinical placement (clerkship).

In the foundation year, students take general health science subjects, like Mathematics, Chemistry, Psychology, Physics, History, Philosophy, Medical Terminology, Demography, Biochemistry, Embryology, Biology, and Anatomy. Before progressing to Year 2, all students must pass a National Entrance Exam administered by the MOH's Human Resource Department.

From Years 2 to 5, the curriculum shifts to professional pharmacy subjects (summarised in Table 2.7.1). This national curriculum is used across all universities offering B.Pharmacy, including the University of Health Sciences (UHS), the University of Puthisastra (UP), International University (IU), Norton University (NU), and the Health Science Institute of the Royal Cambodian Armed Forces (RCAF).

Upon graduation, students must register with the Pharmacy Council of Cambodia (PCC) to be licensed pharmacists. Licensure must be renewed every two years through completion of 20 professional development credit points annually (PCC, n.d.).

Career pathways for registered pharmacists in Cambodia are diverse – they. may work in community, clinical pharmacies, hospitals, pharmaceutical companies, import-export businesses, distribution firms, or in biomedical laboratories (UP, n.d.). Pharmacists also find employment in NGOs, the Ministry of Health, and both private and public sectors. Others may decide to pursue academic careers or research, or run their pharmacies, labs, or pharmaceutical industries.

While data on pharmacy graduate career choices is limited, international research provides insights. In the US, top career paths for pharmacist graduates in 2021 were community (23%), hospital (21%), clinical specialty (19%) (Cameron et al., 2024). In Korea and Canada (Park & Kang, 2021; Patel et al., 2023), 64%

found work in community pharmacy and 28% hospital pharmacy. Such a trend suggests that many pharmacy graduates are engaged in patient-servicing roles.

Pharmacists are often the first point of contact for health advice, and they play an important role in public health during disease outbreaks (Vicary et al., 2020). For example, during the Campylobacter outbreak, pharmacists provided advice on hand washing, food safety handling practices, such as proper boiling water (Vicary et al., 2020). However, knowledge gaps can limit pharmacists' ability to provide effective advice. For example, in developing countries, only a few pharmacy staff could provide correct advice on safe medication use (Brata et al., 2015). Abualhasan et al. (2023) found that only 21% of experienced pharmacists could provide proper counselling on food-drug interaction, which could significantly impact treatment efficacy and safety.

Patients may also ask food and nutrition-related questions during pharmacy visits, highlighting the importance of nutrition content in pharmacy training (Tommelein et al., 2021). However, the current Cambodian curriculum of B.Pharmacy lacks a dedicated course on foodborne diseases and food safety.

**Table 2.4 Subjects, Number of Credits, and Number of Hours taught from Year 2 to Year 5 in the program of Bachelor of Pharmacy in Cambodia**

| Theory in Classrooms | | | |
|---|---|---|---|
| Subjects | Year | No. of Credits | No. of Hours |
| Foreign Language | 2, 3 | 12 | 300 |
| Hydrology | 4 | 3 | 45 |
| Toxicology | 4 | 3 | 45 |
| Bromatology and Nutrition | 4 | 3 | 45 |
| Statistics | 3 | 3 | 45 |
| Plant Biology | 2 | 3 | 45 |
| Analytical Chemistry | 2 | 3 | 45 |
| General Chemistry | 2 | 3 | 45 |
| Inorganic Chemistry | 2 | 3 | 45 |
| Organic Chemistry | 2 | 3 | 45 |
| Botany | 2 | 3 | 45 |
| Cryptogamy and Toxic Plants | 3 | 3 | 45 |
| Instrumental Analytical Chemistry | 3 | 2 | 30 |
| Physic and Biophysics | 2 | 3 | 45 |
| Parasitology | 3 | 3 | 45 |
| Molecular Biology | 2 | 3 | 45 |
| Microbiology | 3 | 3 | 45 |
| Applied Bacteriology | 3 | 3 | 45 |
| Immunology | 3 | 3 | 45 |
| Haematology | 3 | 3 | 45 |
| Clinical Biochemistry | 4 | 3 | 45 |
| Integrated Course | 5 | 3 | 45 |
| Physiology | 2 | 3 | 45 |
| Clinical Pharmacy | 4, 5 | 6 | 90 |
| Clinical Biology | 5 | 3 | 45 |
| Semiology and Pathology | 4 | 3 | 45 |
| Applied Pharmacology | 4, 5 | 6 | 90 |
| Pharmacy Practice | 5 | 3 | 45 |
| Pharmacognosy | 4 | 3 | 45 |
| Notion of Galenic Pharmacy | 2 | 3 | 45 |
| Pharmacokinetics | 4 | 3 | 45 |
| Molecular Pharmacology | 4 | 3 | 45 |
| Galenic Pharmacy | 3 | 3 | 45 |
| Pharmaceutical Technology | 4, 5 | 6 | 90 |
| Pharmaceutical Legislation and Management | 5 | 3 | 45 |
| Therapeutic Chemistry | 4, 5 | 6 | 90 |
| Metabolic Biochemistry | 3 | 6 | 90 |
| Practical Work in Laboratories | | | |
| Subjects | Year | No. of Credits | No. of Hours |
| Toxicology PW | 4 | 1 | 30 |
| Plant Biology PW | 2 | 1 | 30 |
| Analytical Chemistry PW | 2 | 1 | 30 |
| Inorganic Chemistry PW | 2 | 1 | 30 |
| Organic Chemistry PW | 2 | 1 | 30 |
| Instrumental Analytical Chemistry PW | 3 | 1 | 30 |
| Physic and Biophysics PW | 2 | 1 | 30 |
| Parasitology PW | 3 | 1 | 30 |
| Applied Bacteriology PW | 2 | 1 | 30 |
| Haematology PW | 3 | 1 | 30 |
| Physiology PW | 2 | 1 | 30 |
| Pharmacognosy PW | 4 | 1 | 30 |

| | | | |
|---|---|---|---|
| Pharmaceutical Technology PW | 4, 5 | 2 | 60 |
| Therapeutic Chemistry | 4 | 1 | 30 |
| Applied Pharmacology PW | 4 | 1 | 30 |
| Metabolic Biochemistry PW | 3 | 1 | 30 |
| Clerkship | | | |
| Location and Objectives | Year | No. of Credits | No. of Hours |
| Hospital Pharmacy<br>• Supply of drug, medical equipment and materials in hospital<br>• Drug management: Storage and partition of drug, entry slip, issue slip, stock card<br>• Study on medical prescription: Rational drug use | 3 | 2 | 90 |
| Laboratory of Medical Biology<br>• Practice analysis tests in parasitology, bacteriology, haematology, hemogram, biochemistry, serology and immunology | 4 | 6 | 270 |
| Pharmaceutical Enterprise<br>• In-process control in production<br>• Batch document<br>• Calibration of balances<br>• Validation of assay procedure<br>• Analysis of raw materials<br>• Analysis of finished products<br>• Establish Free Sale Certificate (FSC=AMM) document | 5 | 10 | 450 |
| Department of Drug and Food<br>• Procedure of drug registration<br>• Procedure of drug order | | | |
| Central Medical Store (CMS)<br>• Storage management: Storage and partition of drug, medical equipment and materials, entry slip, issue slip, and stock card | | | |
| National Laboratory of Drug Quality Control<br>• Drug analysis technique | | | |
| National Centre of Traditional Medical Research<br>• Usage of medicinal plants: Herbier<br>• Empiric formulas of traditional medicine | | | |
| *Camcontrol*<br>• Food analysis technique | | | |

*Note.* Adapted from *Minimum Standard of Bachelor of Pharmacy Curriculum* (p 13) by the Ministry of Health, 2007. Copyright 2007 by the Ministry of Health.

The pharmacy curriculum in Cambodia includes subjects such as toxicology, parasitology, virology, bacteriology, and immunology, which may touch on most foodborne hazards listed in Table 2.1 (Ministry of Health, 2007). However, these subjects cover a broad range of topics, and none specifically focus on foodborne disease transmission. At present, there is no dedicated courses on foodborne diseases in the curriculum.

The B.Pharmacy programme also includes a nutrition course, *Bromatology and Nutrition*, which covers international food safety standards such as the Codex Alimentarius and Hazard Analysis Critical Control Points (HACCP) – (Ministry of Health, 2007). These standards are important for regulating food hygiene and quality in large-scale food production and imports, and exports. Pharmacists involved in food production must adhere to these standards and should be able to advise customers to check for the HACCP logos on packaged or processed food to ensure food safety. However, the curriculum does not cover the WHO's Five Keys to Safer Food, which offer practical guidance at the household level, highlighting gaps in everyday food safety knowledge.

In their final year, students receive training on food analysis techniques at the labs of *Camcontrol* – now known as the Consumer Protection Competition and Fraud Repression Directorate-General (CCF) since its renaming in 2020 (CCF, n.d.; Ministry of Health, 2007). CCF's primary mission is to ensure the quality and safety of products and services for the protection of consumer health and safety (CCF, n.d.). These laboratory techniques practised are pivotal in food safety control in import and export procedures, but they are complex and not applicable for practical use in patient consultations.

## 2.9 Summary

This literature review section discusses key aspects of food safety and foodborne diseases, including their types, causes, and public health burden, with links to morbidity, mortality, social determinants, and inequalities. This review also explores relevant global and national (Cambodia) initiatives, programmes, and regulations, and discusses good practices in food safety education, effective intervention, delivery methods, and current food safety content within the Cambodia B.Pharmacy curriculum.

# Chapter 3 Methodology

## 3.1 Introduction

In this section, the review focuses on the research methodology undertaken to conduct this review. There are six main sections in this chapter. This chapter begins with section 3.1, which is an introduction, and it finishes with section 3.6, which is the summary. The reasons for choosing Modified Qualitative Systematic Review (MQSR) and thematic analysis are discussed in section 3.2 and section 3.3. Section 3.4 looks at the search strategy, followed by the descriptions of the selected studies in section 3.5. Lastly, section 3.6 discusses the research ethics and the assessment of quality.

## 3.2 Modified Qualitative Systematic Review

This research investigates the skills and knowledge of food safety that undergraduate pharmacy students should learn so as to contribute to food safety education and prevent foodborne diseases in community pharmacies. MQSR will be used to review relevant published literature to identify and tackle the research objectives that advance relevant food safety education to pharmacy students. MQSR is the view that focuses on the experiences, perspectives, and needs of the participants, which is most appropriately answered through qualitative research (Butler et al., 2016).

A research paradigm reflects the researcher's beliefs about reality, how knowledge can be acquired or understood, and what is valued in the research process (Pretorius, 2024; Shrestha & Sharma, 2024). In pragmatism, knowledge is acquired when addressing real-world problem, with knowledge developed through the process of finding practical solutions. This process could be experimental rather than following a single process of inquiry (Dube et al., 2024; Kaushik & Walsh, 2019). The pragmatism paradigm is a suitable approach for the research question, given the limited published scholarship on the topic. Pragmatism allows flexibility and a practical approach rather than rigid rules and methodologies (Kaushik & Walsh, 2019). In public health, pragmatism helps researchers deal with complicated public health issues effectively. Overall, embracing pragmatism helps the researcher contribute to public health and

related fields in a meaningful way (Creswell, 2013; Tashakkori & Teddlie, 1998) – finding best practices in food safety education relevant to pharmacy students.

Systematic reviews have been used for their benefits in providing robust and high-quality evidence available at the time for evidence-based practice and recommendations for patient care (Butler et al., 2016; Stern et al., 2014). Systematic reviews have also been used to address healthcare professionals' and policy makers' diverse information needs (Munn et al., 2018). While several types of systematic reviews exist, the MQSR investigates qualitative evidence of human experiences or contexts and meanings of a particular phenomenon (Munn et al., 2018). The information gained from MQSR, for example, on best practices in food safety curriculum for pharmacy students, is crucial to inform effective and relevant food safety education.

The MQSR is suitable for this proposed research as there has been little study on this topic in Cambodia. Findings from this research are expected to inform future research development in this topic area. The MQSR incorporates a modification of the conventional qualitative systematic review to include relevant literature including peer-reviewed mix-method articles or grey literature to anticipate the research challenge that there might be insufficient peer-reviewed qualitative articles on the topic for a robust analysis (Butler et al., 2016). The MQSR is suitable for the short time frame of a 60-point dissertation and a novice researcher.

## 3.3 Thematic Analysis

Thematic analysis was used to analyse data in consideration of its wide usage and its flexibility in analysing qualitative data (Braun & Clarke, 2006). In accordance with Braun and Clarke's guidelines, the data analysis process involves six steps. Firstly, the included articles, which are the data, were read and reread to allow the researcher to be familiar with the data and to be able to search for meanings and patterns. At this first stage, initial ideas were noted down for coding. The second step is initial coding. It is when the researcher codes appealing features of the data in a systematic way across the whole data set and collates data pertinent to each code.

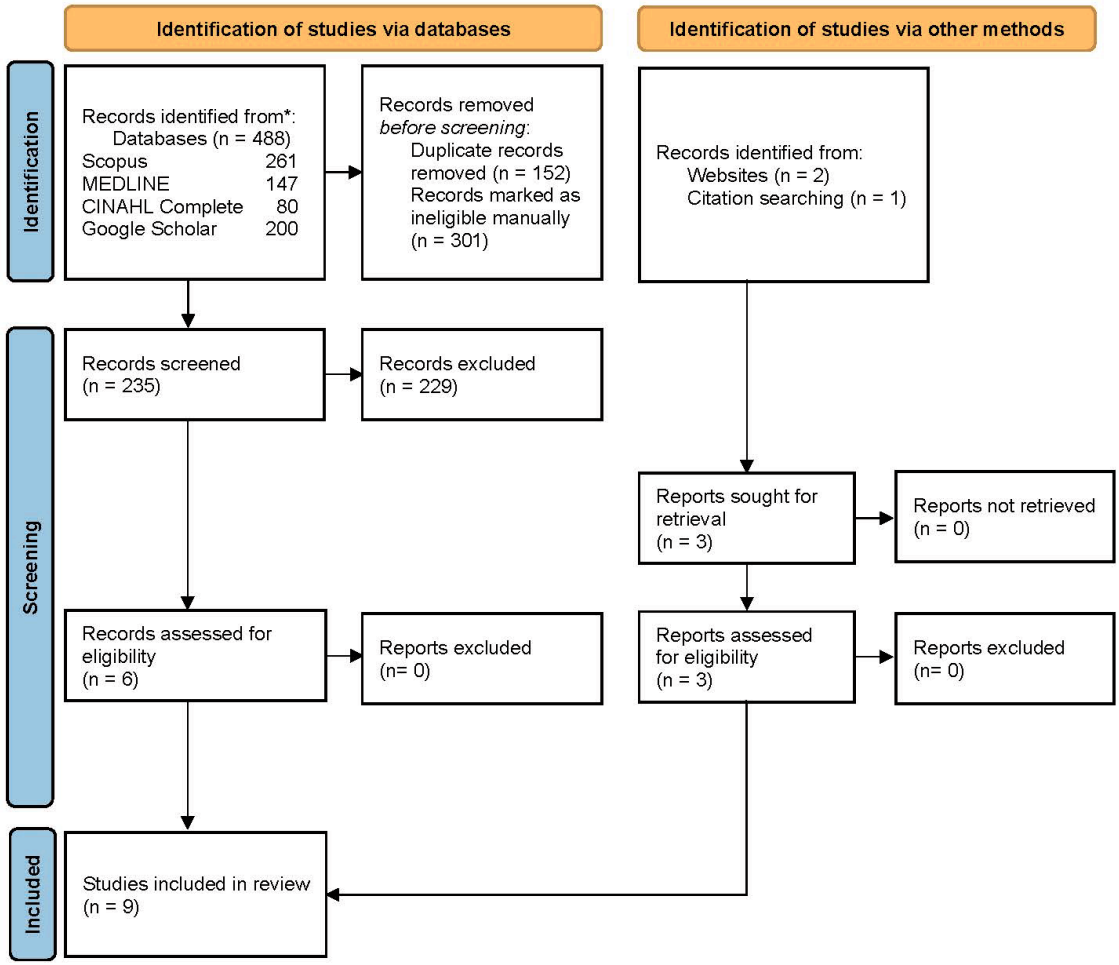
Themes were then generated by examining the patterns of codes for coherence. In the fourth step, the researcher revised the themes by checking their coherence with the coded extracts and the whole data set; then producing a thematic analysis map. Themes were categorised, organised, and defined in the fifth step, which included the development of a set of fully worked-out themes. The final step includes the report writing of the findings (Braun & Clarke, 2006).

The data gathered in the MQSR is managed and organised using NVivo software, which is relevant for qualitative data analysis and management (Dhakal, 2022).

## 3.4 Search Strategy

This MQSR is guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) approach to ensure a structured flow of information (Butler et al., 2016). The search strategy is documented using the PRISMA flow chart in PRISMA ensures that this MQSR is reported in a transparent and accurate manner, making readers in easily assessing the reliability and validity of the study (Butler et al., 2016).

**Figure 3.1 PRISMA Flow Chart for the MQSR**



Relevant literature are identified by searching four health databases: Scopus, EBSCO Health Medline, ESCO Health CINAHL, and Google Scholar by using the key terms in Figure 3.2 illustrates the three-step process in the literature search. The first step, the exploratory search, examines available literature on the skills and knowledge related to food safety. The second step, the purposeful search, narrows the focus to skills and knowledge about food for pharmacists or other healthcare professionals. The final step, the target search, especially seeks for literature on skills and knowledge about food safety for pharmacists or healthcare professionals to prevent foodborne diseases.

This three-step search generates initial phrases for the preliminary search, from which keywords were determined in the database searches. Initially, the purposeful search focused on skills and knowledge about food safety for pharmacists. However, due to a lack of research on pharmacists, the scope was expanded to include studies on other healthcare professionals and health science students. This expansion allowed for applying insights from healthcare professionals' contexts to the field of community pharmacy.

Table 3.1. outlines the search terms applied to articles, titles, abstracts, and keywords. Filters included publication years 1990-2024. Data were drawn from qualitative studies that meet the inclusion criteria (Table 3.2) and exclusion criteria (Table 3.3).

This review includes literature written in English from 1990 until now on the grounds that the first WHO food safety intervention was produced in the 1990s (WHO, 2006) and examination of any follow-up literature on food safety education for health professional students, therefore, is important. Due to limited qualitative studies available on the topic of interest, mixed-methods studies were included for review. Additionally, two articles were identified by website searches, and one article was identified by citation searching. A total of nine articles were included in the final review.

The databases, search strategy, and search terms are formulated after discussions with the supervisor, a tutor, and an AUT liaison librarian, who is an expert in systematic literature search mechanism in relevant databases in public health. These databases and search terms are undergone refinement and

adjustment through repeated meetings with the supervisor, the librarian, and a teaching assistant.

**Figure 3.2** illustrates the three-step process in the literature search. The first step, the exploratory search, examines available literature on the skills and knowledge related to food safety. The second step, the purposeful search, narrows the focus to skills and knowledge about food for pharmacists or other healthcare professionals. The final step, the target search, especially seeks literature on skills and knowledge about food safety for pharmacists or healthcare professionals to prevent foodborne diseases.

This three-step search generates initial phrases for the preliminary search, from which keywords were determined in the database searches. Initially, the purposeful search focused on skills and knowledge about food safety for pharmacists. However, due to a lack of research on pharmacists, the scope was expanded to include studies on other healthcare professionals and health science students. This expansion integrated insights from healthcare professionals into community pharmacy practice.

**Table 3.1 Search Terms Used in the Databases**

| Scopus | EBSCO HEALTH Medline and CINAHL | Google Scholar |
|---|---|---|
| (learn* OR train* OR educat* OR competen* OR skill* OR knowledge) W/5 ("foodborne disease*" OR "foodborne illness*" OR (food W/5 (safety OR poison* OR stor* OR prepar* OR handl* OR hygiene))) AND (pharmac* OR physician* OR doctor* OR nurse* OR nutritionist* OR dentist* OR "health* professional*" OR "university student*" OR "college student*" OR "tertiary student*") | (learn* OR train* OR educat* OR competen* OR skill* OR knowledge) N5 (“foodborne disease*” OR foodborne illness* OR food N5 (safety OR poison* OR stor* OR prepar* OR process* OR handl* OR hygiene)) AND (pharmac* OR physician* OR doctor* OR nurse* OR nutritionist* OR dentist* OR "health* professional*" OR "university student*" OR "college student*" OR "tertiary student*") | (learning OR training OR education OR competency OR skill OR knowledge) AND (foodborne disease OR foodborne illness) AND (food safety OR food poisoning OR food storage OR food preparation OR food handling OR food hygiene) AND (pharmacist OR physician OR doctor OR Nurse OR nutritionist OR dentist OR health professional OR university student OR college student OR tertiary student) |

*Note.* In Scopus, the search terms were searched within article title, abstract, and keyword; and the filters applied include: year range: 1990-2024, document type: limited to article and review, publication stage: limited to final, source type: limited to journal, language: limited to English; In EBSCO HEALTH Medline and CINAHL, the search terms were search within abstract, and the filters applied include refine results: find all my

search terms, limiters: full text, publication date: 1990-2024, source type: academic journals, language: English

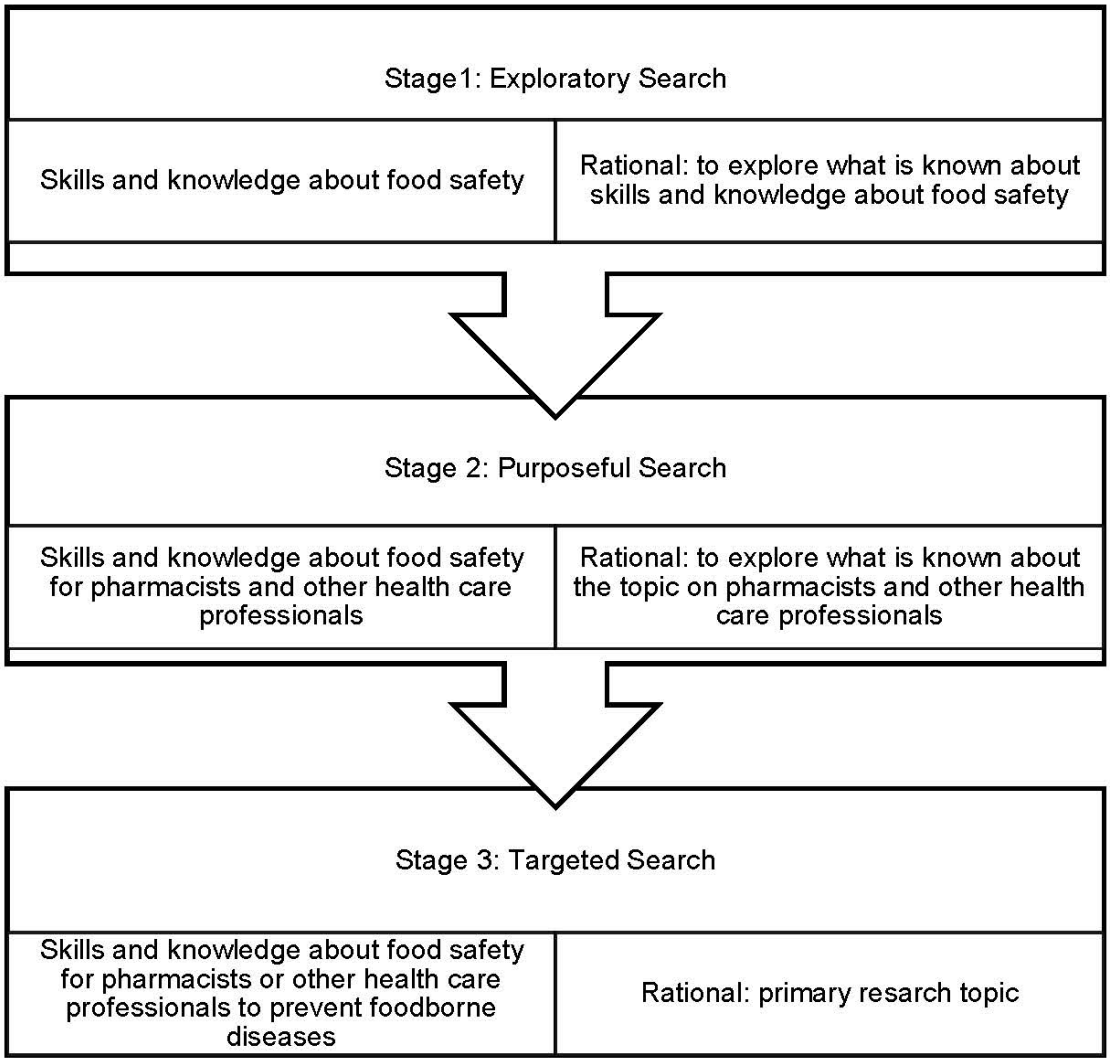
**Table 3.2 Inclusion Criteria**

| No | Questions |
|---|---|
| 1 | Is the study targeting skills or knowledge about food safety? |
| 2 | Is this study targeting pharmacy students or pharmacists? |
| 3 | Is this study targeting health care providers or health science students? |
| 4 | Is this study targeting improving pharmacy curriculum? |
| 5 | Is this study targeting foodborne disease? |

**Table 3.3 Exclusion Criteria**

| No | Questions |
|---|---|
| 1 | Is this study not a qualitative study? |
| 2 | Does this study only focus on university, college student, or tertiary students? |
| 3 | Is this study duplicated? |

**Figure 3.2 The MQSR Process**




## 3.5 Description of Selected Studies

In total, nine research articles were selected and included for the MQSR, which are summarised in Table 3.4. It is noticed that the oldest article was published in 1999, and the most recent article was published in 2024. Two articles were published by the same authors (Medeiros et al., 2008; Medeiros et al., 2004). The former article was published in 2004; the latter was published four years later.

**Table 3.4 Bibliographical Details of the Nine Studies Reviewed**

| No. | Authors & Year of publication | Types of resource | Titles | DOI/Link |
|---|---|---|---|---|
| 1 | Alamneh, Abate, Assaye, Demlie, Guma, & Belachew (2024) | Research article | Experience of caregivers on the continuum of care and prevention of malnutrition among children with cholera in Ethiopia: a phenomenology study | https://doi.org/10.1186/s12889-024-18080-1 |
| 2 | Bondarianzadeh, Yeatman, & Condon-Paoloni (2011) | Research article | A qualitative study of the Australian midwives' approaches to *Listeria* education as a food-related risk during pregnancy | https://doi.org/10.1016/j.midw.2009.06.002 |
| 3 | Chen, Shyu, Ko, Kung, & Shao (2016) | Research article | Perceptions about eating experiences of low-literate older adults with heart disease: a qualitative study | https://doi.org/10.1111/jan.12876 |
| 4 | Douglas, McCarthy, McCotter, Gallen, McClean, Gallagher, & Ray (2019) | Research article | Nutrition education and community pharmacy: a first exploration of current attitudes and practices in Northern Ireland | https://doi.org/10.3390/pharmacy7010027 |
| 5 | Goldberg, Rudd, & Dietz (1999) | Research article | Using 3 data sources and methods to shape a nutrition campaign | https://doi.org/10.1016/S0002-8223(99)00171-6 |
| 6 | Lin, Huang, & Wahlqvist (2009) | Research article | Waste management to improve food safety and security for health advancement | https://search.informit.org/doi/full/10.3316/informit.713276807568051 |
| 7 | Medeiros, Chen, Hiller, & Kendall (2008) | Research article | Discovery and development of educational strategies to encourage safe food handling behaviours in cancer patients | Printed materials https://pubmed.ncbi.nlm.nih.gov/18724762/ |
| 8 | Medeiros, Chen, Kendall, & Hillers (2004) | Research article | Food safety issues for cancer and organ transplant patients | Printed materials https://pubmed.ncbi.nlm.nih.gov/15636391 |
| 9 | Tommelein, De Boevre, Vanhie, Tongelen, Boussery, & Saeger (2021) | Research article | Revisiting the food- and nutrition-related curriculum in healthcare education: an example for pharmacy education | https://doi.org/10.3390/pharmacy9020104 |

## 3.6 Ethics and assessment of quality

Ethical approval was not required for this review, as it did not involve any animal or human participation in data collection. Nevertheless, the review adhered to the ethical guidelines of the Auckland University of Technology Ethics Committee (AUTEC) and the New Zealand National Ethical Standards. The researcher followed the guiding principles outlined by Suri (2020) to ensure ethical decision-making in mixed-methods MQSR and to maintain the quality of the research.

This review employed a pragmatist epistemology, which is aligned with the review's purpose and scope (Kaushik & Walsh, 2019). Pragmatism offered the flexibility in choosing an MQSR approach, given the limited number of published qualitative studies on food safety education for pharmacists and other healthcare professionals (Kaushik & Walsh, 2019).

This review aimed to fill a knowledge gap and benefit the relevant stakeholders, including patients, caregivers, health care professionals who educate patients, and policy makers who require evidence-based solutions to improve food safety education and prevent foodborne diseases.

There was no conflict of interest, despite the researcher being a recipient of the Manaaki New Zealand Scholarships sponsored by the New Zealand Government and the study being funded by the Faculty of Health and Environmental Science, AUT. The researcher consistently reflected to minimise the influences of personal, professional, or financial interests on the review findings (Suri, 2020).

The review process followed the PRISMA guidelines to ensure transparency and maintain quality and rigour (Suri, 2020). All reviewed articles were peer-reviewed from reputable sources to avoid publication bias (Suri, 2020). The search strategy was carefully designed to access relevant primary research in reputable health databases, incorporating diverse viewpoints from patients, caregivers, and healthcare professionals (Suri, 2020).

Thematic analysis was used to analyse the data, allowing the researcher to stay close to the results of primary studies and provide reliable answers to the research question (James & Angela, 2008).

## 3.7 Summary

This chapter outlines the research methodology, explaining the choice of using modified qualitative systematic review and thematic analysis. It also includes search strategy, ethics, and quality assessment.

# Chapter 4 Findings

## 4.1 Introduction

This chapter presents the findings from the selected nine literatures. It includes two main sections: a summary of the nine articles and the result of the thematic analysis. Six main themes emerged, categorised under two main headings: knowledge required to deliver food safety information and education and skills needed for effectively delivering it.

## 4.2 Summary of the Nine Articles

Section 4.2 provides a summary of the nine articles, mainly discussing the research participants, research design, and methods in the reviewed studies.

### 4.2.1 Research Participants

Table 4.1 provides a summary of the authors, the countries where the studies were conducted, the number of participants involved in each of those selected articles, and the participants' backgrounds.

Approximately 500 respondents participated in these nine articles, except for one study by Lin et al. (2009) It was a literature review. Of nine articles, eight had between 10 and 170 participants. Two studies included 10 participants (Alamneh et al., 2024; Bondarianzadeh et al., 2011). Chen et al. (2016) included 13 participants in their research. Between 59 to 70 participants were included in three articles by Goldberg et al. (1999), Medeiros et al. (2008), and Medeiros et al. (2004). Two studies involved more than 130 participants: 135 participants in Tommelein et al. (2021) and 170 participants in Douglas et al. (2019).

Participants in those respected studies included healthcare professionals, food safety experts, educators, and patients or community members. Healthcare professionals included midwives (Bondarianzadeh et al., 2011), community nutritionists (Goldberg et al., 1999), physicians, registered nurses, registered dietitians, social workers (Medeiros et al., 2008), food regulatory experts, food safety educators, epidemiologists, microbiologists, healthcare providers working with cancer and transplant patients (Medeiros et al., 2004), registered community

pharmacists, pre-registered pharmacists (Douglas et al., 2019), and pharmacy interns (Tommelein et al., 2021).

The community members and patients included in the studies were mothers or caregivers of malnourished children under the age of 15 with a history of cholera (Alamneh et al., 2024), low-literate older adults with heart disease (Bondarianzadeh et al., 2011), African American women, people of colour or those of marginalised groups (Goldberg et al., 1999), cancer patients undergo chemotherapy (Medeiros et al., 2008), cancer, bone marrow or organ transplant patients (Medeiros et al., 2004).

The selected articles represent diverse regions, including Africa, Asia, Australia, North America, and Europe, covering a range of development levels. Notably, only one study was from a low-income country, Ethiopia (Horn of Africa) (Alamneh et al., 2024), which may offer some contextual relevance to Cambodia. Chen et al. (2016) conducted a study in Taiwan (Western Pacific region), an upper-middle income country. However, no studies were conducted in Southeast Asia, where Cambodia is located. The remaining of seven studies were conducted in high-income countries: Australia (Bondarianzadeh et al., 2011), the USA (Goldberg et al., 1999; Medeiros et al., 2008; Medeiros et al., 2004), Belgium (Tommelein et al., 2021), and Ireland (Douglas et al., 2019).

**Table 4.1 Author, Country of Study and Participants' Background**

| No. | Author & Date | No. and types of participants | Country of study |
|---|---|---|---|
| 1 | Alamneh, Abate, Assaye, Demlie, Guma, & Belachew (2024) | 10 mothers or caregivers of malnourished children under the age of 15 with a history of cholera | Ethiopia |
| 2 | Bondarianzadeh, Yeatman, & Condon-Paoloni (2011) | 10 midwives who provide antenatal care in the hospital | Australia |
| 3 | Chen, Shyu, Ko, Kung, & Shao (2016) | 13 low-literate older adults with heart disease | Taiwan |
| 4 | Douglas, McCarthy, McCotter, Gallen, McClean, Gallagher, & Ray (2019) | 160 registered community pharmacists, 10 pre-registered pharmacists | Ireland |
| 5 | Goldberg, Rudd, & Dietz (1999) | 57 community nutritionists and African American women | USA |
| 6 | Lin, Huang, & Wahlqvist (2009) | None | Not specified |
| 7 | Medeiros, Chen, Hiller, & Kendall (2008) | 31 cancer patients undergo chemotherapy, 5 physicians, 6 registered nurses, 4 registered dietitians, & 3 social workers | USA |
| 8 | Medeiros, Chen, Kendall, & Hillers (2004) | 28 microbiologists, epidemiologists, food safety educators, and food regulatory experts; 6 focus groups with cancer patients; 11 interviews with bone marrow transplant patients; 2 focus groups and 5 interviews with organ transplant patients; 18 health care providers whose practices include cancer or transplant patients | USA |
| 9 | Tommelein, De Boevre, Vanhie, Tongelen, Boussery, & Saeger (2021) | 135 pharmacy interns | Belgium |

### 4.2.2 Research Design and Methods in the Reviewed Studies

Section 4.3 provides a summary of the research design used in the selected studies. The research objectives, methodology, findings, and recommendations of each study are summarised in

Table 4.2 presents a summary of the research design used in the selected studies, including the research objectives, methodology, and findings.

Of the nine selected studies, five were qualitative studies, and four were mixed-methods studies. In-depth interviews and focus group discussions (FGDs) were the most common data collection methods.

A study by Lin et al. (2009) reviewed the effects of food production systems on the environment, pollution from food waste, and related health consequences and benefits of effective waste management. The authors aimed to identify future opportunities for enhancing food safety, food security, and public health through food waste management (Lin et al., 2009).

Three qualitative studies used a semi-structured interview schedule. Alamneh et al. (2024) explored the experiences of mothers or caregivers of malnourished children under 15 years of age with a medical history of cholera; Bondarianzadeh et al. (2011) investigated the experiences of midwives in providing food-related risk information during *Listeria* education to pregnant women. Chen et al. (2016) examined the eating experiences of older adults with low literacy and heart disease.

A study by Goldberg et al. (1999) employed a qualitative methodology and 3 data collection methods, including telephone interviews, observations, and FGDs. Telephone interviews were held with nutritionists working with African American women (Goldberg et al., 1999), followed by a series of FGDs with African American women using a discussion guideline developed from the interview results (Goldberg et al., 1999). Observations were carried out at food suppliers, like supermarkets, neighbourhood stores, and local restaurants (Goldberg et al., 1999). The observation results were used to triangulate findings from the telephone interviews and FGDs (Goldberg et al., 1999).

Douglas et al. (2019) conducted a two-phase mixed-method study to explore nutrition education among community pharmacists. In phase 1, community pharmacists completed an online questionnaire that included open and closed questions, gathering qualitative and quantitative data (Douglas et al., 2019). In phase 2, a nutrition training programme intervention was developed based on the results of phase 1 and delivered to pre-registered pharmacy students (Douglas et al., 2019). The intervention was evaluated using a before-and-after

questionnaire assessing the students' knowledge, attitudes, and practice (Douglas et al., 2019).

Medeiros et al. (2008) conducted a three-part study to develop strategies for promoting safe food handling among cancer patients. Two parts were involved: one with FGDs among cancer patients and another with in-depth interviews with healthcare providers (Medeiros et al., 2008). Before the FGDs and interviews, a survey was conducted with cancer patients to assess their food preferences and food safety attitude, and healthcare providers completed a background questionnaire. The third part used these findings to create and evaluate three prototypes of educational resources for cancer patients.

The 2004 study by Medeiros et al. laid the groundwork for their 2008 study (Medeiros et al., 2008; Medeiros et al., 2004). The 2004 study explored why cancer and transplant patients are at a higher risk of foodborne diseases, identifying food handling and key pathogens through expert panels, FGDs, and interviews. Patients completed two surveys: one on risky food consumption and another on their acceptance of the expert panel's food safety recommendations, which were then discussed in FGDs and interviews. The researchers also interviewed healthcare providers to understand the food safety information they provide to patients and their opinions on the recommendations (Medeiros et al., 2004).

Tommelein et al. (2021) conducted an observation study in community pharmacies. Pharmacy interns reported food- and nutrition-related cases by answering seven questions via an online platform. The data gathered were qualitatively analysed by categorising and counting the number of cases in each category expressed in percentages.

To summarise, the section reviewed the research designs and methods of the selected studies. Both qualitative and mixed-methods studies were included, and the most commonly used qualitative data collection methods were in-depth interviews and focus group discussions.

**Table 4.2 Research Methods Used in the Studies**

| No. | Authors & year of publication | Research Objectives | Methodology | Findings |
|---|---|---|---|---|
| 1 | Alamneh, Abate, Assaye, Demlie, Guma, & Belachew (2024) | To explore the experiences of caregivers or mothers of children with a history of cholera on the continuum of care to prevent malnutrition in Ethiopia | Qualitative, a phenomenology study | • Causes of malnutrition: poverty, high cost of living, and poor utilization of diversified food<br>• Health facilities did not provide any service to the mothers of admitted malnourished children<br>• 5-year-old children and above were excluded from the food and malnutrition program<br>• Barriers: interruption of supplies, low attention given to child feeding, inadequate knowledge, and lack of time to prepare diversified food |
| 2 | Bondarianzadeh, Yeatman, & Condon-Paoloni (2011) | To explore midwives' perceptions of food-related risks and their approaches to *Listeria* education during pregnancy | Qualitative, an exploratory design | • Approaches: midwives took both active and passive approaches<br>• Focus of education: some of the high *Listeria*-risk foods<br>• Little focus on safe food-handling practices education<br>• Midwives have limited scientific knowledge; they rely on experiential knowledge and their common sense in education<br>• Factors Influencing midwives' practice: temporal pressure, limited availability of educational materials, and low adherence to *Listeria* recommendations within the health system |

| | | | | |
|---|---|---|---|---|
| 3 | Chen, Shyu, Ko, Kung, & Shao (2016) | To explore perceptions of low-literate older adults with heart disease about their eating experiences | Qualitative, a qualitative descriptive study | • These older adults had inappropriate or inadequate eating information<br>• They held a passive, fatalistic perspective about eating with heart disease |
| 4 | Douglas, McCarthy, McCotter, Gallen, McClean, Gallagher, & Ray (2019) | To explore nutrition education among community pharmacists in Northern Ireland | Qualitative and Quantitative | • Assessment of the attitude and practice of community pharmacists confirmed the limited nutrition education<br>• Pharmacists considered health promotion and disease prevention activities to be within their professional role<br>• Pharmacists considered that they had an insufficient level of nutritional education<br>• Knowledge, attitudes, and practices of pre-registered pharmacists were improved after attending the education intervention |
| 5 | Goldberg, Rudd, & Dietz (1999) | To define a target population of African American women more clearly and to provide specific information about the needs and preferences of that population in order to design an effective, culturally relevant, community-based communications campaign to promote more healthful lifestyles | Qualitative | • Target population: young African American women<br>• African American women accepted a higher weight for height as normal, compared with white women<br>• Information and skills related to food preparation were needed and desired by African American women<br>• Consistently high-quality products, especially fresh and frozen food, were needed in food markets |

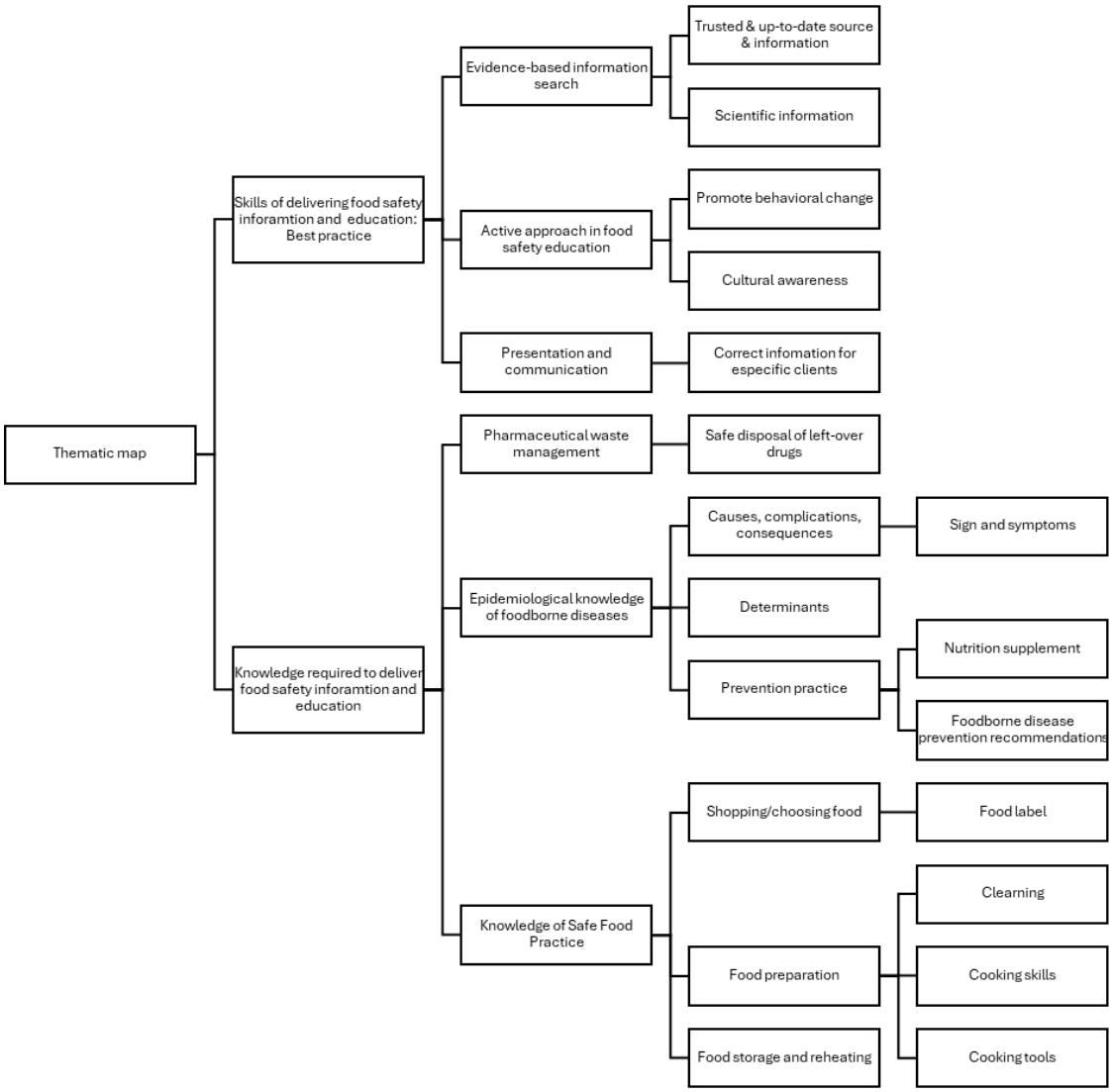
| | | | | |
|---|---|---|---|---|
| 6 | Lin, Huang, & Wahlqvist (2009) | To review the impacts of food production systems on the environment, pollution resulting from food waste, costs, and economic advantages in food waste management, and health consequences of waste | Qualitative, a review | • The effects of food production on the environment include water resources, greenhouse gas emissions, and land degradation<br>• The effects of food waste on the environment include waste generation and greenhouse gas emissions<br>• Water contamination, soil contamination, and food contamination are the main focuses on food safety and health<br>• One obvious ethical and equity issue was that food was excessive in developed countries, while a billion people faced food insecurity |
| 7 | Medeiros, Chen, Hillers, & Kendall (2008) | To assess the food safety informational needs of cancer patients and to determine factors that may influence prospective educational interventions that foster risk-reducing behaviours. | Quantitative and Qualitative | • Disbelief of high-risk food, personal preferences for high-risk food, and lack of information were the barriers to practicing the food safety recommendations expressed by these patients<br>• Scientific and credible information, fear of illness, and statistics on foodborne illness incidence and deaths were motivators to practicing the food safety recommendations expressed by the patients<br>• The majority of health care providers thought that dietitians, physicians, and nurses should provide the food safety education, but physicians complained about having little time to do so |

| | | | | |
|---|---|---|---|---|
| 8 | Medeiros, Chen, Kendall, & Hillers (2004) | To explore the reasons why cancer and transplant patients are at greater risk for food-borne illnesses, and which pathogens and food-handling behaviors are of particular concern | Qualitative, a review | • the experts identified 9 different pathogens of particular concern for these patients<br>• the experts identified 12 recommendations on food-handling behavior of special importance to these patients<br>• These patients were more likely to accept the recommendation if they were familiar with it and it did not interfere with their lifestyle<br>• A lack of information or misinformation was the barrier for these patients practicing safe food-handling recommendations<br>• These patients desired to receive food safety information at their doctor's offices or in clinics<br>• Health care providers thought the recommendations were good, and they were willing to recommend them to their patients |
| 9 | Tommelein, De Boevre, Vanhie, Tongelen, Boussery, & Saeger (2021) | To obtain an overview of nutritional topics discussed in community pharmacies, to adapt the nutrition-related course content in pharmacy education | Quantitative and Qualitative, an observational study | • The most discussed food and nutrition topics in pharmacy were food supplements, baby food, health food, and nutritional recommendations<br>• After seeking extra information from different sources, pharmacy interns could answer nearly all cases. |

## 4.3 Main Findings

Thematic analysis identified six main themes under two main headings: knowledge needed for delivering food safety information and education and skills required for delivering food safety information and education. Figure 4.1 simplifies these themes and related codes.

**Figure 4.1 Thematic Map**




### 4.3.1 Knowledge Required to Deliver Food Safety Information and Education

The review indemnified that the knowledge required to deliver food safety information and education includes understanding the epidemiology of foodborne disease, implementing safe food practices, and managing pharmaceutical waste,

## Theme 1 Epidemiological Knowledge of Foodborne diseases

The epidemiology of foodborne diseases involves understanding of the distribution of diseases, their determinants, methods of prevention and control. This theme included three subthemes: causes, complications, and consequences; determinants; and prevention practices of foodborne diseases.

### *Causes, Complications, and Consequences of Foodborne Diseases*

This review revealed that often caregivers, parents, health providers, and patients lacked knowledge of symptoms, causes and signs of complications, such as parents of malnourished children (Alamneh et al., 2024) or midwives working with pregnant women (Bondarianzadeh et al., 2011) or cancer and transplant patients (Medeiros et al., 2004).

For example, Alamneh et al. (2024) found that some parents or caregivers lacked knowledge about the signs and symptoms of acute malnutrition in children, while some could describe in-depth interviews with mothers or caregivers of children under the age of 15 with a history of cholera, revealed diversity in knowledge. Three male participants, at the age of 32, 34, and 38, of those with sufficient knowledge explained:

> A malnourished person shows these symptoms: shrinking body, swollen stomach, thin leg when were pinch the skin not returned back, there will be mental retardation, and as experts told us that children who are malnourished their stomachs are not proportional to their bodies and their necks are thin. (Alamneh et al., 2024, pp. 4–5)

Others were lacking in their understanding of causes and the consequences of the malnutrition and poor feeding practice. Many parents were not worried about the types of food their children ate as long as they were fully fed, regardless of whether the food was diverse:

> Poverty is the root cause of malnutrition, but lack of food and knowledge on consequences are the immediate causes. People are often told in our society what will happen to a child if his stomach is full. We heard food type should be from different kinds of grains or animal products and from fruits. (35-year-old male participant) (Alamneh et al., 2024, p. 5)

In-depth interviews with 10 midwives revealed that one-third of the midwives interviewed did not include details about complications of *Listeria*-related

infection, including premature labour, in pregnant women in their education. Nancy, a midwife, said, “We don’t talk specifically about implications on there. In some ways that could have more of an effect but I guess it could also be distressing too” (Bondarianzadeh et al., 2011, p. 224).

However, midwives with experience with complications of listeriosis in pregnant patients expressed the importance of including complications of diseases in *Listeria* education. Judy, a midwife, shared, “I looked after a couple of women being very sick that have gone into premature labour because of it and have had a sick baby because of it. So I’m very concerned about listeriosis” (Bondarianzadeh et al., 2011, p. 224).

On the other hand, some midwives lacked understanding regarding the causes, complications, and consequences of *Listeria* infection. This led to an underestimation of risk:

> I’ve heard of women having still birth after eating mussels and scallops and I‘ve heard of a Greek woman too with the feta as well, because they eat quite a lot of feta… but with miscarriage it’s difficult to know and I suppose they want to identify something to just blame it on. (Midwife, Margaret) (Bondarianzadeh et al., 2011, p. 224)

A need assessment study with cancer patients suggested that knowledge and awareness of foodborne disease outbreaks and associated mortality motivates cancer patients to follow the recommendations to reduce food safety risk (Medeiros et al., 2008).

An expert panel discussion identified the nine pathogens of unique concern for cancer and transplant patients, including Norovirus, *Shigella* spp., *Escherichia coli*, *Salmonella* spp., *Campylobacter jejuni*, *Yersinia enterocolitica*, *Toxoplasma gondii*, *Vibrio* spp., and *Listeria monocytogenes* (Medeiros et al., 2004).

Medeiros et al. (2008) found that cancer patients appreciated statistics on foodborne diseases, related pathogens, and symptoms, which generated their fear of illnesses and improved their awareness of risk and severity.

***Determinants***

Determinants of foodborne diseases include poverty, poor living conditions, high market cost, low-quality market food, education level and income.

Caregivers or mothers of children in a study by Alamneh et al. (2024) were able to identify determinants of malnutrition, including poverty, poor living standard, high food cost, poor dietary habits, and eating limited varieties of food. One 35-year-old male participant explained:

> There are causes of malnutrition, like poor standard of living has its own effect, our eating behaviour itself is a factor, and most people do not want to eat a different type of food from the usual type; their need is only to eat the same types of food. (Alamneh et al., 2024, p. 5)

In FGDs with African American women, Goldberg et al. (1999) found that employed or university-enrolled women were more likely to eat healthily and motivate their family members and friends to do the same. Participants also discussed the limited time spent cooking and the difficulty of cooking diversified food, as well as the limited availability of fresh fruits and vegetables and substandard frozen products, which were confirmed by the community observations in the same study. A community nutritionist interviewed remarked:

> Time, convenience, and availability of markets providing quality foods at reasonable prices…The quality of the produce, in particular, tends to be poor, its availability is limited, and prices are high. Economics are a major factor; people are always 'juggling' to cope with their difficult lives. (Goldberg et al., 1999, p. 719)

Bondarianzadeh et al. (2011) revealed that there was a belief among midwives that pregnant women or patients from high socioeconomic and educational backgrounds did not need food safety education. Consequently, nine of 10 midwives did not provide education on food hygiene and handling practices to the pregnant women who appeared to have higher education and socioeconomic status. Mary, a midwife, said:

> You know, I look at the person and I think 'ok, she looks good, she is clean' you know, like their appearance and it seems they are well educated, then I see no reason to educate them on that [food hygiene]. I just don't. (Bondarianzadeh et al., 2011, p. 224)

### *Foodborne Diseases Prevention Recommendations*

Foodborne disease prevention recommendations include practices to help individuals prevent and avoid foodborne illnesses.

A study by Douglas et al. (2019) with community pharmacists in Ireland found that the participants believed that nutrition was important in reducing the global burden of diseases. The most common food and nutrition topics discussed with a pharmacist include food supplements, baby food, health food, and nutritional recommendations. The older persons, pregnant women, and children were the client groups most likely to seek advice about vitamin supplements. Community pharmacists provided tailored recommendations regarding nutritional supplements to different client groups (Douglas et al., 2019), as detailed in Table 4.3.

**Table 4.3 Types of Clients and Their Suggested Nutritional Supplements from Community Pharmacists**

| Types of Client Groups | Vitamins/Supplements |
|---|---|
| Elder persons | Vitamin D |
| Pregnant women | Calcium |
| Children | Multivitamins/tonics |
| Teenagers/young females/childbearing age | Omega/fish oil |
| Illness/post-illness | Glucosamine |
| Housebound/little sunlight | Vitamin C |

*Note.* Adapted from "Nutrition Education and Community Pharmacy: A First Exploration of Current Attitudes and Practices in Northern Ireland," by P. L. Douglas, H. McCarthy, L. E. McCotter, S. Gallen, S. McClean, A. M. Gallagher, and S. Ray, 2019, *Pharmacy*, 7(1), Article 27, p. 11. Copyright 2019 by Pauline L. Douglas, Helen McCarthy, Lynn E. McCotter, Siobhan Gallen, Stephen McClean, Alison M. Gallagher, and Sumantra Ray.

Table 4.3 shows that community pharmacists have engaged with diverse community groups, including children, teenagers, pregnant women, and household individuals.

Similarly, Medeiros et al. (2004) study provided recommendations for food handling for cancer and transplant patients to prevent foodborne diseases, detailed in Table 4.4.

**Table 4.4 12 Recommendations for Cancer and Transplant Patients to Prevent Foodborne Diseases Produced by Expert Panel**

| Recommendations |
|---|
| Obtain shellfish from approved sources |
| Avoid eating raw or undercooked seafood |
| Cook shellfish until the shell opens and the flesh Is fully cooked; cook fish until the flesh is opaque and flakes easily with a fork |
| Drink only pasteurised milk. |
| Avoid eating foods containing raw eggs. |
| Store eggs and poultry in the refrigerator |
| Wash knives, cutting boards, and food preparation surfaces with hot water and soap after contact with raw poultry, meat and seafood |
| Drink only pasteurised fruit juices. |
| Avoid eating raw sprouts. |
| Thoroughly rinse fresh fruits and vegetables under running water before eating. |
| Avoid fresh soft cheeses, cold-smoked fish, and cold deli salads. |
| Reheat hot dogs and lunch meats to steaming hot or 165°F or 74 °C |

*Note.* Adapted from “Food Safety Issues for Cancer and Organ Transplant Patients,” by L. C. Medeiros, G. Chen, P. Kendall, and V. N. Hillers, 2019, *Nutrition in Clinical Care, 7*(4), p. 143. Copyright 2004 by Nutrition in Clinical Care.

### Theme 2 Knowledge of Safe Food Practice

The review highlights that knowledge of safe food practices includes how to choose food while shopping, proper food preparation, including cleaning, cooking skills, and correct use of kitchen utensils and appliances, and food storage and reheating processes.

Medeiros et al. (2004) assessed the acceptability of cancer and transplant patients toward food safety recommendations from the expert panel. Mixed responses in reheating hotdogs were reported by the patients, while most patients did not accept recommendations for reheating cold lunch meats. Healthcare professionals agreed with the expert panel on the importance of reheating hotdogs and lunch meats (Medeiros et al., 2004).

Additionally, Medeiros et al. (2008) reported mixed acceptance of the recommended use of a food thermometer for cooking meat and poultry. Some cancer patients either did not own or did not use a food thermometer when cooking ground meat and chicken breasts (Medeiros et al., 2008).

A study with low-literate senior adults (Chen et al., 2016) found that many seniors did not know how to use various cooking appliances such as microwaves, gas cookers, or electric pots. Some responses include:

> I'm old and don't know how to use the microwave or gas. I feel they aren't safe for me. I don't know how to set the microwave; moreover, it might explode, so I always use the electric pot. Well, yes, food cooked in an electric pot is not delicious. I don't care; I want to live in peace. (low-literate older adult, No.12) (Chen et al., 2016, p. 807)

> My daughter-in-law has a lot of cooking tools and she uses them to cook very good meals for my family. But even if I want to drink a cup of juice, I must use my hands to squeeze the fruit, because it is safe for me. (low-literate older adult, No.9) (Chen et al., 2016, p. 807)

Chen and colleagues also found that illiterate older persons or those with low education levels found it difficult to purchase food effectively (Chen et al., 2016). One participant explained:

> I can't buy any food from the store, because I can't read the food labels. One day, I tried to buy beef for my son. I couldn't find it and I couldn't even explain to the shop assistant what I wanted to buy; Therefore, I have no confidence in preparing food for my family, because I am illiterate. (low-literate older adult, No.9) (Chen et al., 2016, pp. 806–807)

A research by Alamneh et al. (2024) found that caregivers or mothers of children under the age of 15 lacked knowledge about creating diversified meals, which is important for preventing malnutrition. One 30-year-old female participant explained:

> Even if it [food items] exists in the zone, it will not reach the area where we are. Therefore, it is very difficult because poverty is hard. Even if grain is available, lack of knowledge on how to make it [prepare diversified food], also other problems (Alamneh et al., 2024, p. 5)

A study by Goldberg et al. (1999) revealed that African American women struggled with selecting low-fat foods or planning low-fat diets. Some believed that preparing healthy food was too complicated and time-consuming, while others felt that healthy food did not taste as good as less healthy food (Goldberg et al., 1999). Participants agreed that they needed more information, especially

recipes, shopping tips, and a chart identifying healthy options from unhealthy choices of food (Goldberg et al., 1999).

Evaluation of educational materials for cancer patients found that helpful information includes guides on dining out and picnics, safe temperature guides, cold storage guides and alternatives to risky foods. (Medeiros et al., 2008).

**Theme 3 Pharmaceutical Waste Management**

Pharmaceutical waste management involves handling expired, leftover, contaminated, or unsuitable drugs, vaccines, and medicines. Only one reviewed article discussed the impact of pharmaceutical waste on water pollution, causing unsafe water consumption, food safety concerns, and public health risks. (Lin et al., 2009). Medicines are not only prescribed to humans but also in in veterinary medicine, agriculture, and aquaculture (Lin et al., 2009). In Taiwan, pharmaceutical waste from households, industries, and farms was found in streams (Lin et al., 2009). Compounds such as antibiotics and hormones are common in surface water and are typically not targeted for removal during waste or sewage water treatment (Lin et al., 2009). Water is essential for drinking, food processing, and farming, so contaminated water poses a serious health risk to the public, potentially causing pathophysiological complications (Lin et al., 2009). To safeguard public health, it is crucial to address these pharmaceutical contaminants in waste or wastewater management at the household, public, and industrial levels (Lin et al., 2009). Educating patients and communities on the safe disposal of expired or leftover drugs is equally important in managing household waste and maintaining food safety practices.

### 4.3.2 Skills of Delivering Food Safety Information and Education: Best Practices

Three themes emerged regarding the skills needed for delivering food safety information and education in this review. These skills include the ability to take an active approach to deliver food safety information and education, the capability to search for evidence-based information, and effective presentation and communication skills.

### Theme 4 Active Approach to Food Safety Education

In this theme, taking an active approach to food safety education means that healthcare professionals, including pharmacists, play a crucial role in actively engaging in education. They must be aware of the cultural norms, beliefs, practices, traditions and religious practices that influence patients' or clients' adherence to food safety recommendations.

#### *The Role of Healthcare Professionals in Food Safety Education*

Recognising the role of food safety education motivates pharmacists and healthcare professionals to proactively engage in preventing foodborne diseases.

This review found that, in addition to consulting with mothers, family members, friends, role models, or other patients, individuals rely upon nurses, nutritionists, general practitioners, doctors, health workers in the community, and other healthcare professionals for sources of food safety information and education (Bondarianzadeh et al., 2011; Chen et al., 2016).

On the one hand, some healthcare professionals recognised their crucial role in providing food safety education. Douglas et al. (2019) found that pharmacists considered health promotion and disease prevention as part of their role, although some felt inadequately educated on nutrition and food safety due to limited training. Medeiros et al. (2008) found that only dietitians were trained in food safety education among other health professionals working with cancer patients. Even so, the findings found that nurses and dietitians working with cancer patients also recognised their roles in providing foodborne illness prevention information, at the same time, the physicians also played the same role they introduced the cancer patients to the topic of food safety, and the details would be discussed by the nurses (Medeiros et al., 2008).

On the other hand, some health professionals felt that providing food safety information and education was outside their role and duties. Social workers working with cancer patients said that food safety education was not a focus of their daily routine (Medeiros et al., 2008). Similarly, midwives varied in their approaches to providing *Listeria* education and information on food-related risks (Bondarianzadeh et al., 2011). Seven out of 10 midwives did not see it as their responsibility to educate pregnant women on safe food-handling practices to

prevent *Listeria* infection. Amanda, a midwife, said, “I don’t feel that it’s my job to tell them how to cook and prepare their food … I think that people need to take a little bit of responsibility on themselves for those types of things…” (Bondarianzadeh et al., 2011, p. 224). Most midwives believed that general practitioners should take a more active role in providing *Listeria*-related food safety education. Margaret, a midwife, commented:

> They don’t come to the antenatal clinic until sometimes between I don’t know 14 and 20 [weeks] and then they could eat whatever they want earlier so it’s a bit late. They should really have been informed about these things earlier on. So I don’t know whether their GP should be covering like *Listeria* or not. (Bondarianzadeh et al., 2011, p. 225)

A general challenge in providing food safety education is the limited consultation time available for healthcare professionals. This constraint can lead to the oversight of the importance of food safety education and result in missed opportunities to provide it. Belinda, a midwife, explained her reluctance to teaching *Listeria* risk, stating: “I’m big on alcohol and cigarette smoking … but not taking about *Listeria* and stuff. … as I’ve never come across somebody who’s had *Listeria* poisoning or whatever or been even sick because of food” (Bondarianzadeh et al., 2011, p. 224). Bondarianzadeh et al. (2011) reported that one-third of 10 midwives felt that temporal pressure negatively affected their ability to provide comprehensive health education, including *Listeria* advice:

> We only get half hour sessions … and we have to do introductions, hello, how are you, … we have to do an examination and history and all that sort of stuff. The half hour goes pretty quickly … and then: ‘this is some advice we can give you’ and we follow it up with a pamphlet that they can take away and digest at home. (Midwife, Belinda) (Bondarianzadeh et al., 2011, p. 225)

### *Cultural Awareness*

When providing food safety education and information, it is crucial to consider the influence of patients’ cultural upbringings, traditions, norms, religious practices, and habitual practices, as these factors may affect their adoption and adherence to food safety recommendations.

Alamneh et al. (2024) found that the traditional food and feeding practices contributed to unfavourable attitudes toward addressing acute malnutrition in the

community. Many community members preferred eating their usual food rather than diversifying their diets, even if it would improve nutritional outcomes. A 35-year-old male participant shared, "…most people do not want to eat a kind of food different from usual type, their need is only to eat the same types of food." (Alamneh et al., 2024, p. 5)

The cultural influences may lead to poor child feeding practices, where children were not given options to eat according to their developmental needs and were instead forced to eat the same food as adults in the family. A 35-year-old male participant explained:

> Most of the time people or children use the same types of food instead of eating different types of food, which means preference of food is not allowed. For example, you cannot say that I do not like such kind of food. They are forced to eat only what is given to them. Therefore, due to these attitudinal problems, it is difficult to eat different types of foods. (Alamneh et al., 2024, p. 6)

The influences of culture on food preferences and choices were also evident in interviews with nutritionists, who revealed that African American women accepted a higher weight for height as normal, compared to the white communities in the US (Goldberg et al., 1999). Additionally, the African American women strongly believed that reducing dietary fat would diminish the taste of food and preferred fried food over healthier options (Goldberg et al., 1999). Some women reviewed that baking was a less active cooking method compared to frying (Goldberg et al., 1999).

Habits and food preferences are significant factors influencing food safety practices. Cancer patients rejected the recommendation to heat lunch meats because it contradicts the convenience of having cold lunch meats (Medeiros et al., 2004).

Religious practices and customs play a critical role in food safety education. Some senior adults with heart diseases relied on their religious beliefs to manage their conditions. For example, a low-literature adult No. 3, stated, "I really don't know why I have heart disease. All I know is it depends on Buddha. What happens is your destiny" (Medeiros et al., 2004, p. 808). Another low-literature adult No. 7, said, "We have an old saying that to keep our health, the first priority is God and the second is the doctor [laughs]" (Medeiros et al., 2004, p. 808).

Considering cultural influences, traditions, norms, religious teachings, and eating habits while providing food safety education can lead to positive food safety practices and behavioural changes in individuals. This is evident in the interviews with mothers or caregivers of malnourished children who highlighted two effective prevention methods: changing dietary habits by diversifying diet with locally available ingredients and feeding times to include traditional foods available at home (Alamneh et al., 2024).

Likewise, cancer and transplant patients would be more likely to accept food safety recommendations when they aligned with their lifestyles and easily incorporated into their daily routines (Medeiros et al., 2004).

***Inclusiveness***

Providing inclusive food safety education is crucial regardless of age, disease severity, and socioeconomical status. Alamneh et al. (2024) found that in the African American community, children under 15 years old, who are at high risk of malnutrition were often excluded from any food and malnutrition programmes. The exclusion could contribute to the high rates of malnutrition in this group. Additionally, while these children were admitted to health facilities, their mothers or caregivers often did not receive food safety education, potentially missing out on information on foodborne disease prevention.

Cancer patients are at higher risk of foodborne diseases and often do not receive food safety advice from health professionals unless they experience neutropenia (Medeiros et al., 2008). Neutropenia is a condition in which white blood cells are depleted due to chemotherapy (Medeiros et al., 2004).

Additionally, this review reveals that pregnant women from a higher socio-economic background or those with higher education levels were at times excluded from *Listeria*-risk food education. This exclusion was based on stereotypes that these pregnant women are educated, more knowledgeable, and capable of seeking relevant information on their own (Bondarianzadeh et al., 2011).

***Right Timing***

This review highlights the significance of providing food safety education at the earliest possible opportunity for the effective prevention of diseases. One midwife

suggested offering *Listeria*-risk food safety education in antenatal classes to ensure timely advice, as pregnant women typically see their midwives between 14 and 20 weeks of their pregnancy (Bondarianzadeh et al., 2011). Cancer patients also indicated the need for food safety education early in their treatment. Two of the six focus groups expressed that they should have received food safety education and information at their first oncology appointment or as soon as they received the diagnosis (Medeiros et al., 2008).

**Theme 5 Evidence-Based Information Search (Trusted and Up-to-Date Source and Information, Scientific Information)**

This theme focuses on the importance of evidence-based information search as a crucial skill for pharmacists in providing accurate, reliable, and up-to-date food safety information. The information must be derived from reliable sources.

The review highlights that evidence-based information supports pharmacist interns in effectively answering questions from the clients in the community. Research Tommelein et al. (2021) suggested that nearly 95% of client queries were answered by seeking additional evidence-based information. Subsequently, Tommelein et al. (2021) recommended integrating training on evidence-based information search and evaluation into pharmacy education programmes.

Midwives also faced challenges in accessing up-to-date food safety information for their clients. Margaret, a midwife, expressed concerns about the lack of updated information and evidence-based education on *Listeria*: “There’s not a lot of education even with midwives about *Listeria* … you know we don’t have updated information on it that is current and evidence based and I’m not sure of the risks involved.” (Bondarianzadeh et al., 2011, p. 225). Another midwife, Mary, shared, “Basically, we have a lot of well-educated people. They do a lot of reading and come and challenge us. I have to go back and read my books!” (Bondarianzadeh et al., 2011, p. 225)

The information provided to patients and clients must be accurate, and scientifically based, specific to their needs, and up to date. Interviews with cancer patients revealed that they preferred food safety information that was specific, up-to-date, tailored to their conditions, scientifically based, and accurate (Medeiros et al., 2008). The acceptance of recommended food safety handling

was higher when patients trusted the source of the information (Medeiros et al., 2008).

### Theme 6 Presentation and Communication (Correct Information for Specific Clients)

Effective presentation and communication skills are crucial in providing food safety information and education. Methods and materials must be suitable and tailored to meet the diverse needs of patients and their specific circumstances.

The review highlights the need for visual and practical materials, such as videos, images, or hands-on practice for older persons with low literacy. Older persons often struggle with abstract or text-heavy information, relying instead on visual symbols and practical demonstrations to help them adopt healthy food habits:

> The most difficult thing in my life is being illiterate. Even when just a food advertisement comes in the mail, I need to wait for my family and ask them to read it to me. How can I know the names of different foods, their prices and the nutrients inside? (Low-literature adult, No. 6) (Chen et al., 2016, p. 806)

> I can't buy any food from the store, because I can't read the food labels. One day, I tried to buy beef for my son. I couldn't find it and I couldn't even explain to the shop assistant what I wanted to buy … (Low-literate adult, No. 9) (Chen et al., 2016, p. 806)

Visual materials are particularly suitable for senior adults or people who cannot read. Symbols, signs, and the use of colourful materials as food labels – such as colour, appearance, cost, and taste – are helpful. This is supported by the responses from four adults with low literacy: adult No. 13 said, "I don't know the food name, but I know I drink from the yellow bottle every day" (Chen et al., 2016, p. 807); adult No. 10 said, "I don't know how much to each, but my daughter says I need to eat three fingers of meat and one handful of tofu every day" (Chen et al., 2016, p. 807); adult No. 3 said, "The doctor told me to eat a low-salt diet. I know that a high-salt diet is when food tastes salty, like fermented bean curd …" (Chen et al., 2016, p. 807); and adult No. 7 said, "Because I can't read food labels, the only thing I can catch is the price. That's why I always buy high price food because you get what you pay for" (Chen et al., 2016, p. 807).

Written materials are suitable for people who can read, while videos are effective for most populations. Cancer and transplant patients were less interested in

media, but preferred written or video materials from professionals or authors with scientific backgrounds (Medeiros et al., 2004).

In contrast, the African American community was more inclined to listen to local radio stations and read community newspapers. (Goldberg et al., 1999).

The cancer patients in the research by Medeiros et al. (2008) reported that although they could read, they had difficulties with technical terms such as *Cryptosporidium parvum* and campylobacteriosis. Thus, it is suggested that materials be developed to meet the patients' specific needs. (Medeiros et al., 2008).

From the perspectives of midwives working with pregnant women and health care providers providing care for cancer patients, written materials were considered the most effective method for providing education. They recommended that healthcare professionals verbally review the written information with clients before giving them the written materials. (Bondarianzadeh et al., 2011; Medeiros et al., 2008). Other effective methods included posters, videos, audio tapes, websites, newsletter articles, refrigerator magnets, and lectures by professionals or patients who have experienced foodborne illnesses (Medeiros et al., 2008).

# Chapter 5 Discussion and Recommendation

## 5.1 Introduction

This systematic review employs MQSR to explore the literature on the food safety knowledge and skills that pharmacy students should have to prevent foodborne diseases. However, due to the limited qualitative studies specific to pharmacy students and practitioners, this review also includes best practices in food safety education from diverse perspectives, including those from non-pharmaceutical healthcare professionals, patients, caregivers, and experts, to enhance the educational framework of pharmacy education.

Of the nine reviewed articles detailed in Chapter 4, findings are categorised into two main themes: knowledge encompassing the epidemiology of foodborne diseases, knowledge of safe food practices, and pharmaceutical waste management; and skills including active approaches in food safety education, evidence-based information gathering, and skills in presentation and communication.

This discussion chapter is organised into seven sections. The first two sections outline the study's aim and summarise the findings. The following sections discuss key topics on food safety knowledge in foodborne disease prevention and skills essentials in food safety education. This is followed by a discussion on study's limitations, recommendations, and conclusions. Reflections are made on how insights from this review can enhance food safety education for pharmacy students, focusing on the Cambodian context.

## 5.2 Summary of Findings

This review identified key areas of essential food safety knowledge for preventing foodborne diseases, as shared by healthcare professionals, patients, caregivers, and food safety experts, including:

- Epidemiological knowledge of foodborne diseases
  - Causes, complications, and consequences of foodborne diseases
  - Determinants of foodborne diseases
  - Recommended prevention for foodborne diseases

- Safe food practices
  - Selecting reasonably good quality and healthy food and ingredients
  - Proper food preparation techniques (cleaning, cooking, and using kitchen utensils and appliances)
  - Food storage and reheating methods
- Pharmaceutical waste management
  - Safe disposal of expired, unsuitable, or leftover household medications
- Skill for engaging in food safety education for patients
  - Proactive attitudes in providing food safety education to patients
  - Cultural awareness of how upbringings, traditions, norms, religious beliefs and practices influence food safety adoption and adherence
  - Inclusive practice in food safety education
  - Timely provision of food safety education to patients
- Skill in conducting evidence-based information searches
- Presentation and communication skills

## 5.3 Knowledge of Food Safety to Prevent Foodborne Diseases

The review highlighted the crucial knowledge for food safety education, including the epidemiology of foodborne diseases, safe food practices, and safe pharmaceutical waste management.

In current food safety courses offered to pharmacy students in Cambodia, epidemiological knowledge of foodborne diseases appears in several courses, including toxicology, bacteriology, virology, parasitology, and immunology (Ministry of Health, 2007). While these courses focus on relevant topics, none specifically address the epidemiological knowledge of foodborne diseases, which remain a significant public health concern in Cambodia (Thompson et al., 2021). Studies report high prevalence rates of various pathogens in food products and markets; for example, *Salmonella enterica* was found in 25% of surfaces in informal markets (Schwan et al., 2021), and 42% of chicken and pork samples from markets were found to contain *Salmonella* spp. (Rortana et al., 2021). Further, outbreaks of gastrointestinal illness, such as the 2014 incident linked to contaminated Khmer noodles (Kimsean et al., 2017).

Nutrition and food safety are typically taught together, with a focus on imported and exported products and industrial best practices in large-scale production chains rather than on food safety knowledge and skills specific to safe food preparation for individual patients, caregivers, or the community (Ministry of Health, 2007). While this industrial-focused approach is valuable for ensuring safety at the market level, it has overlooked the critical need for pharmacists to have knowledge and specialised skills in advising patients on food safety practices. Such knowledge and these skills are particularly pivotal for vulnerable groups in the community, like young children, pregnant women, older people, or people with chronic or long-term conditions (Lund & O'Brien, 2011; Njoagwuani et al., 2023),

The WHO Manual Handbook on Five Keys to Safer Food Provides a practical, easy-to-use guideline on safe food practices, such as how to clean, cook, store, and reheat food (WHO, 2006). Additionally, WHO resources like ‘Five Keys for Safer Traditional Food Markets,’ ‘Five Keys to Growing Safer Fruits and Vegetables,’ and ‘Five Keys to Aquaculture Products to Protect Public Health’ (WHO, 2012, 2016, 2023b) offer essential guidelines for ensuring food safety and preventing foodborne diseases, especially relevant to the traditional market and aquaculture industries.

Studies, like one conducted in Iran, showed that food safety education based on the Five Keys to Safer Food Manual significantly improved the food safety knowledge, attitude, and behaviour of the female community health volunteers (Ghaffari et al., 2020). In a study in Indonesia, college students found a significant increase in food safety knowledge and attitude after students received education based on the WHO Five Keys to Safer Food Manual (Tenggana et al., 2020). Indeed, this WHO manual has been successfully applied to diverse contexts, such as street food vendors (Donkor et al., 2009), rural communities (Omari et al., 2014), and broader consumer education initiatives (Young et al., 2015).

Therefore, embedding these WHO resources into the nutrition and food safety curriculum or course within the pharmacy programme is essential. This integration will equip pharmacy students with the necessary knowledge and skills to use easy-to-use global guidelines to educate the community, especially vulnerable populations, to prevent foodborne diseases. Especially in rural areas

of Cambodia, people are at higher risk of foodborne diseases due to limited food safety knowledge and risky cultural food handling practices (Chen et al., 2023).

Pharmaceutical waste is often poorly managed in developing countries. Research in Africa found that 87% of patients keep expired or unused drugs at home, and 95.5% never return the medicine for proper disposal to hospitals. (Debrah et al., 2023). In Cambodia, little is known about how pharmaceutical waste is managed and how unused medications are disposed of, reflecting a dearth of studies on this important matter. Common disposal methods in various countries include throwing medicines in household trash and flushing them down toilets or sinks. (Gidey et al., 2020; Wang et al., 2021). The WHO (2014) Guideline on the Safe Management of Waste from Health-Care Activities recommends that unused medicines be returned to pharmacies or hospitals for safe disposal by specialist waste-treatment services. Given that pharmaceutical waste management is not currently included in the curriculum, it is crucial to prepare students to effectively educate the community on safe disposal of pharmaceutical waste.

## 5.4 Skills Required for Food Safety Education to Prevent Foodborne Diseases

The review highlights the critical importance of healthcare professionals' commitment and abilities to engage in food safety education, seek evidence-based information, and effectively present and communicate with patients and their caregivers. This finding concurs with Danielson et al. (2019), who emphasized that community pharmacies must proactively offer counselling and education using current, relevant information, and adapt their communication style and techniques to meet the specific needs of their patients and families, considering their socio-cultural-educational backgrounds (Danielson et al., 2019).

Enhancing patient-centred communication skills and services has become a significant research focus (Hache et al., 2022; Rusu et al., 2022; Wolters et al., 2021). Patient-centred care has effectively improved medication adherence (Haynes et al., 2008), and pharmacists' patient-centred consultations promote mutual understanding and foster non-judgemental discussions (Ng et al., 2020). Further, the need for life-long learning has been recognised as crucial for

pharmacists to maintain their competencies and skills (Rusu et al., 2022). Continuing Professional Development (CPD) is pivotal for pharmacists to uphold their competence and provide quality patient care (Ballaram et al., 2024).

## 5.5 Limitations of the Study

This review has a limitation. Firstly, due to the scarcity of qualitative studies specifically relevant to pharmacists and community pharmacy practice, the findings are primarily derived from other healthcare professionals' perspectives, and patients seeking treatment outside of community pharmacy. As a result, these findings may not represent the experiences and insights of pharmacists working in community pharmacy, suggesting the need for further research to explore the specific challenges, roles, and experiences faced by community pharmacists in food safety education and practices.

## 5.6 Recommendations: Future Policies, Practices and Research

Findings from this study offer recommendations for policies, practices, and research to enhance the knowledge and skills of pharmacist students in promoting food safety practices in communities to prevent foodborne diseases, a major public health issue in Cambodia.

Policies

- Conduct a comprehensive review of pharmacy curricula to integrate food safety, foodborne diseases, drug waste management, and emergency nutrition, focusing on vulnerable groups - young children, older people, and those with long-term and chronic conditions.
- Examine regulatory documents outlining pharmacists' roles in supporting the public health agenda, including preventing foodborne diseases, patient education, and emergency nutrition.
- Utilise professional regulatory standards and pharmacist organisations to address foodborne diseases prevalent in Cambodia, and safe disposal of unused, unwanted or expired drugs and medications in the community.
- Review WHO guidelines within the curricula to enhance students' knowledge and skills in food safety education and communication, especially for vulnerable groups.

Practice

- Introduce a 3-credit (45 hours) food safety course into B. Pharmacy curriculum, covering key knowledge, practical skills found and Cambodian regulations. Graduates should be equipped to advise patients on food safety and help prevent foodborne diseases.
- Develop targeted CPD professional development training for community pharmacists on foodborne disease epidemiology, common local illnesses, safe food practices, and cultural competencies for community-based education. The training should align with the Pharmacy Council of Cambodia's lifelong learning frameworks (PCC, n.d.).
- Create a user-friendly information platform offering pharmacists evidence-based food safety resources to support effective pharmacists-clients consultation.

Research

- Evaluate the training content and cultural competencies of pharmacy practitioners in providing effective communication and education on food safety.
- Research to examine pharmacy curricula, identifying facilitators and barriers to support community-based food safety education.

## 5.7 Conclusion

These review findings offer new insights into the food safety education needed for pharmacy students to help prevent foodborne diseases. Pharmacists should develop epidemiological knowledge of foodborne disease, safe food practices, pharmaceutical waste management, and communication skills such as proactive deliveries of information and education, evidence-based information gathering, and effective presentation. These competencies were identified as essential for promoting safe food practices in the community. It is recommended that pharmacists and other health professionals be equipped with this knowledge and take an active role in communicating and educating the community about food safety.

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