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Review Article

Food Safety Education for Elementary School Students Worldwide

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Abstract

Context: Foodborne disease is one of the leading causes of early childhood death and childhood diarrhea worldwide. Providing food safety education is believed to be of necessity to prevent foodborne diseases among school-aged students; however, limited studies have addressed food safety education worldwide, particularly for elementary school students. Hence, we conducted this comprehensive review to examine the availability and impact of food safety education for elementary school students worldwide and identify areas that are still needed for future research.
Evidence Acquisition: Our inclusion criteria comprised all the studies on elementary school students (aged 5-12) and food safety components that have been published in English between 2010 and 2020, without geographic restriction. In this review project, we utilized nine major data sources, including PubMed, Science Direct, MEDLINE, and CINAHL.
Results: Food safety guidelines and educational resources have been established worldwide; however, limited food safety education has been targeted to elementary school students, particularly in developing countries. There is a lack of additional findings concerning food safety behaviors among elementary school students, and insufficient food safety training for teachers.
Conclusion: There is an urgent need to provide effective food safety education to elementary school students, which specifically focuses on improving their behaviors. Furthermore, sufficient food safety training and professional development needs to be provided for school teachers.

Keywords: Food hygiene, Foodborne diseases, Elementary school students, Primary school students, School-aged students

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1. Context

The epidemic of foodborne disease has been a growing concern around the world, according to the World Health Organization (WHO) (1). Nearly one out of ten people have suffered from foodborne diseases around the world annually. Specifically, 77 million (M) Americans, 91M Africans, 23M Europeans, 100M Eastern Mediterraneans, 150M South-east Asians, and 125M Western Pacific people struggle with foodborne diseases annually (2). Furthermore, 420,000 people worldwide, including nearly 30% of children under the age of five, die from foodborne diseases annually (1, 2).

These diseases are defined to be mainly caused by bacteria, viruses, parasites, or chemical substances, which enter the human body through the consumption of contaminated food or drink. This could result in over 200 diseases, including cancer, and even death (1, 3). Foodborne diseases can affect all age groups; however, children are more susceptible since their immune systems are still developing (4). In fact, childhood diarrhea, which is mainly caused by foodborne diseases, not only impacts childhood malnutrition and severe dehydration, but is also one of the leading causes of early child death worldwide (5).

Even though foodborne disease is known as a challenging issue worldwide, it is preventable by handling food safely and practicing personal hygiene properly (2). Providing food safety education (FSE) is believed to be an effective and targeted food safety prevention strategy among school-aged children (6, 7); it is defined as a combination of learning experiences to help an individual in preparing, handling, and storing food safely in order to minimize the risk of individuals becoming ill from foodborne diseases. Childhood is a critical period to learn food safety, and the sanitation knowledge they learn and hygiene habits they establish would carry on to their adulthoods, thereby impacting their life-long health (8, 9). The WHO claims that having adequate knowledge of food safety plays a critical role in maintaining health and preventing foodborne diseases (1, 2). Nonetheless, many people, particularly

children and the young, do not have adequate food safety knowledge to consume and prepare food safely. In fact, school-aged students in the United States receive less than eight hours of nutrition and food education yearly, which is significantly below the minimum of 40-50 hours required for making an impact on their behavior (10-12). Experts suggest that schools should integrate FSE into nutrition education; meanwhile, limited FSE programs among elementary school students have been conducted worldwide and most health-related programs were targeted to older students, such as high school or college students (13-16). Hence, to have a better understanding of FSE for elementary school students, this study aimed to review FSE literature published within the last decade, discussing what FSE has and has not accomplished, analyzing the results and research gaps, and providing conclusions and recommendations to improve future FSE for elementary school students.

Importance of FSE for Elementary School Students

Providing proper FSE, for school-aged children in particular, is one of the strategies to prevent foodborne diseases (6-8). The following rationale explains why providing FSE for elementary school students is important for their health and safety. Primarily, children's immune systems are not yet fully developed and they have smaller body weight; thus, a smaller dose of a foodborne pathogen could make them sick (13, 17, 18). Secondly, children often have inadequate existing food safety knowledge and do not often receive proper food safety training; therefore, they may be at a higher risk of foodborne diseases due to mishandling food without proper supervision (9). In addition, children have limited control over their food preparation and are not aware of the risk of food safety (8). Moreover, children are still establishing dietary behaviors. If FSE could be implemented properly during early childhood, it would make a positive impact on children's behaviors before they have established, and these behaviors will persist through their adulthoods and impact their optimal growth (9, 19). In addition, elementary school students' cognitive functions are well-developed, which means that they have enough capability and interest to absorb and learn food safety knowledge and share it with their parents and friends (8, 20, 21). Furthermore, providing FSE not only impacts children's health, but also benefits their academic performance. Stage and colleagues found that children have better performance in mathematics, science, and nutrition knowledge provided that they receive nutrition and food education in the classroom (22). Ultimately, most FSE programs are designed for older students, high school or college students for instance; however, limited food safety research has been undertaken among younger children, such as elementary school students (14-16). Thus, it is critical to implement FSE for school-aged students, specifically for elementary school students, who are more susceptible to food poisoning and develop serious foodborne diseases, and receive less FSE compared to older children and adults.

Objectives

The present comprehensive review article aimed to investigate the availability and impact of current FSE among elementary school students worldwide.

Objective 1: Assessment of the current food safety guidelines, standards, and educational resources that are available for elementary school students worldwide.

Objective 2: Examination of the outcomes, effectiveness, and components of current FSE programs among elementary school students worldwide.

Objective 3: Identification of the areas where research is still needed in FSE for elementary school students worldwide.

2. Evidence Acquisition

PubMed, Science Direct, MEDLINE, CINAHL, ProQuest Public Health, ABI/INFORM Global, Biological Science Collection, BioMed Central, and Agricultural and Environmental Science Collection were searched for the studies that have been published in English between 2010 and 2020. We also had access to the websites of government agencies and non-profit organizations so that we could learn more about FSE and resources for elementary school students. The following search key terms were used for this study in multiple combinations: food safety, food hygiene, foodborne, intervention, education, program, strategy, guidelines, standards, curriculum, resources, courses, elementary, primary, children, students, pupils, and school-aged students. In order to meet the purpose of this review project, only the studies that have included food safety components and elementary school students (aged 5-12) were eligible for inclusion. To have a better understanding and identifying the current status of FSE for elementary school students, there were no specific limitations regarding the study design and instruments. Moreover, geographic location was not restricted, which means all the FSE studies conducted worldwide were included.

Summary of Study Selection Process

The first selection identified 14,569 articles through selected database search. After reviewing research titles, abstracts, removing duplicates, 4,794 articles were identified for screening. Afterwards, we applied the following exclusion criteria: non-human studies, not focusing on the particular age range as in our study (5-12 years old), not being completely written in English, not primarily focusing on food safety education for elementary school students, and not being available online; as such, 44 articles were included in this review project (Figure 1).

3. Results

Food Safety Guidelines and Resources Worldwide

Several international food safety guidelines and resources have been established and widely used, such as Hazard Analysis and Critical Control Point (HACCP) (23) adopted by the Codex Alimentarius Commission and Five Keys to Safer Food (7) developed by the WHO. Additionally, each country has developed educational resources to prevent foodborne diseases among school-aged students. For instance, *Fight BAC!* developed by the partnership for food safety education (24) in the U.S. and *e-Bug* developed by Public Health England (25) are two well-known FSE programs worldwide; yet, little FSE resources were found in developing countries, specifically in Africa. In the following, there are various examples of established food safety guidelines and resources worldwide.

In the U.S., the National Agricultural Library and *Nutrition.gov*, developed by the United States Department of Agriculture (USDA), offer nutrition and FSE curricula and lesson plans for school-aged children and educators (26, 27). *Foodsafety.gov* delivers the latest food safety news and educational resources to the public (28). Furthermore, the Government of Canada established food safety guidelines and provides food safety tips for all individuals, including school-aged children (29, 30). In Europe, the European Union offers the latest food safety information on its website and has published a complimentary food safety e-book for the public (31). The European Food Safety Authority

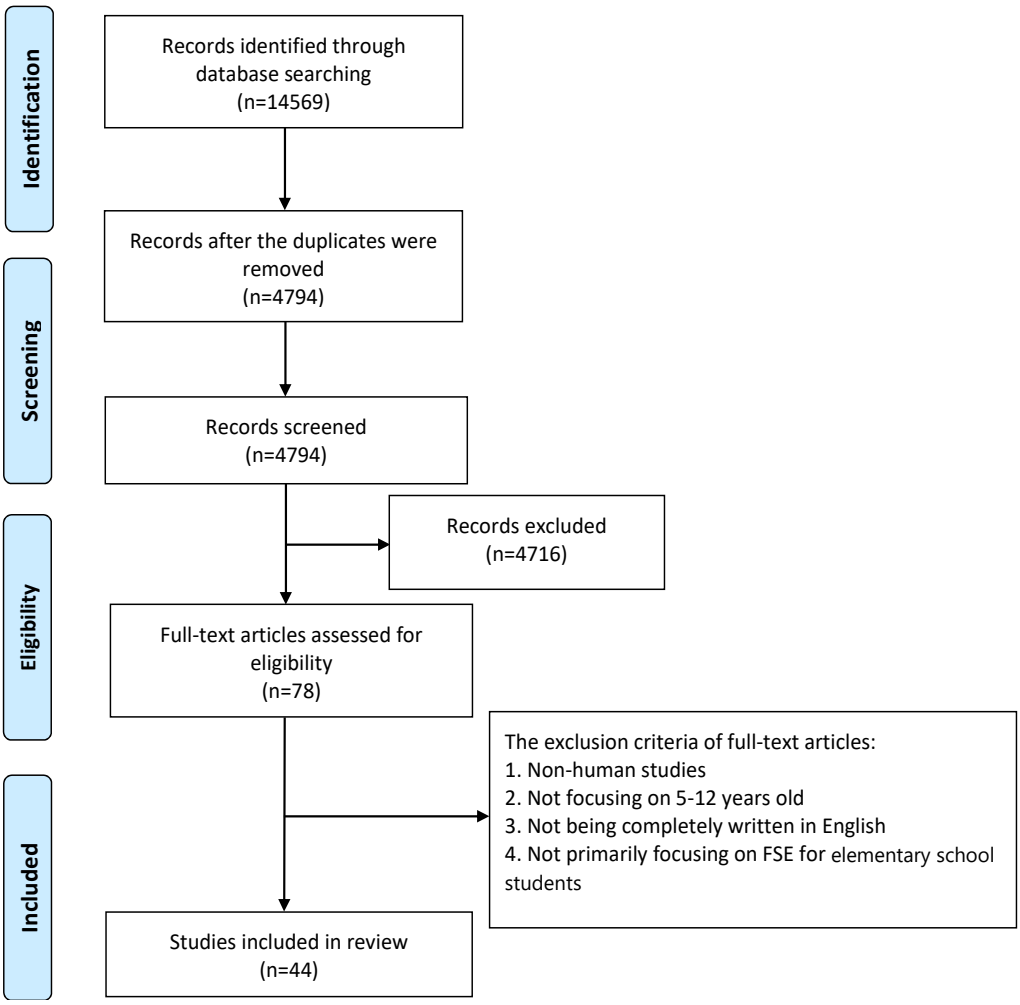

Figure 1: The flow chart shows the article selection process.

has provided science-based food safety suggestions by collaborating with other international authorities (32). In Asia, the *Food Safety Asia* platform allows countries to collaborate and share food safety knowledge and experiences (33). The Ministry of Health in Japan has provided FSE educational materials for children and the public (34). Moreover, the National Center for Food Safety Education and Research (NCFSER) in Taiwan has provided FSE materials and training courses for school-aged students (35). The Ministry of Food and Drug Safety in the Republic of Korea has provided food safety guidelines and resources (36). The Centre for Food Safety in Hong Kong has also provided various educational resources to promote its food safety campaigns (37). In Australia**,** the Department of Education in South Australia has published a healthy eating curriculum kit, including food hygiene, and storing and handling food safely, for children aged 3-8 years old (38). Furthermore, the *Healthy Kids* website in Australia has provided kid-friendly educational materials and activities, including healthy eating, food safety, and hygiene to help children live and eat healthily and safely (39). In Africa, most countries have established food safety guidelines or standards. For example, the Ministry of Health in the Republic of Kenya has established the national food safety policy to ensure food safety (40). The Department of Health in the Republic of South Africa has a food control section (41). Although the governments in Africa are aware of the importance of food safety, FSE resources and educational materials for elementary school students have rarely been found. Despite the fact that the WHO has reported more than 40% of people in sub-Saharan Africa still use unimproved or shared sanitation facilities, FSE has not yet received sufficient attention, particularly for elementary school students (42). In summary, there are food safety guidelines and resources in different countries worldwide. However, educational resources are limited for elementary school students, specifically in Africa.

Outcomes of FSE Programs Worldwide

The findings of FSE programs concerning elementary school students not only raise elementary school students' awareness regarding food safety, but also improves their knowledge and behavior toward food safety. Although the primary goal of FSE programs is similar among nations, which is increasing knowledge of food safety to minimize the risk of being affected by foodborne diseases in children, the intervention components and focus are different.

In the United States, FSE is often combined with nutrition or school gardening. A school-based FSE program that included nutrition and school garden components in the U.S. reported that knowledge of food safety was augmented in the majority of the participating students and they shared their knowledge with their parents (43). A pilot study including FSE with school gardening activities revealed that food safety knowledge improved among its participants after working on the food safety curriculum, including short videos, activities, quizzes, and lessons (44). Furthermore, a church-based FSE for 4th graders found that the culinary skills, such as safe food handling, improved among the subjects and the frequency of home meal preparation increased after attending a summer camp (45). The findings of another summer camp in the U.S. revealed an increase in the students' knowledge concerning science, food science, and food safety; an increase was also observed in their interests in learning more about these subjects (46).

In Europe, a classroom-based food safety intervention, called *e-Bug*, has significantly improved knowledge of food safety among children in England, France, and the Czech Republic, through providing interactive food hygiene activities (25). A workshop was conducted in Slovenia, whose results suggested that in the participating children in the intervention group, the knowledge and practices regarding food safety significantly improved, particularly washing hands with soap to prevent microbiological food-related risks in domestic kitchens (21). A study conducted in Italy found that providing FSE through experimental activities significantly improved knowledge and behaviors of food safety among elementary school students (8). *Mission on the invisible world*, a relevant FSE program for 5th graders in Italy, found that all food safety classes, either theoretical or practical, provided benefits regarding foodborne disease prevention by raising children's awareness and improving knowledge and behaviors in terms of food safety (20).

In Africa, there is limited information regarding FSE programs for elementary school students. Instead of teaching food safety principles, personal hygiene education is the primary focus of FSE-related programs. The *Water, Sanitation, and Hygiene* campaign (WASH) is the most widely used program among school-aged students in Africa (47). One of the WASH programs conducted in Ethiopia reported that elementary school students who received hygiene lessons showed a significant improvement in their knowledge and practices, compared to the control group (48). Another intervention conducted in Kenya reported that hand

sanitizing behaviors were significantly improved: 82% of elementary school students in the intervention group sanitized hands after using the bathroom, compared to 37% of the students in the control group (49). Unlike other hygiene interventions that utilized water and soap to teach hand washing techniques, this study provided a waterless hand sanitizing education, since traditional handwashing is difficult in some schools in Africa where the water resources are limited.

In Australia, food and nutrition topics should be delivered through the Health and Physical Education curriculum; however, extensive FSE studies have not been conducted for elementary school students in Australia (50). Instead, most food safety-related interventions are implemented as parts of nutrition and cooking programs for primary students. For example, Drummond conducted a weekly nutrition and cooking workshop, including a food preparation component, for elementary school students in Australia (51). After attending the workshop, the participants demonstrated an increase in their skills regarding how to prepare, cook, store, and serve healthy food appropriately (51). Other studies have explained that school teachers with insufficient food-related training might be one of the main reasons why insufficient nutrition and FSE has been conducted among school-aged students in Australia (52).

In Asia, FSE has been implemented with multiple components, such as nutrition, cooking, and school gardening. A study conducted in India found that food safety knowledge significantly improved after receiving FSE: less than 13% of the students were aware of the fact that diarrhea from foodborne illness could be fatal, but 100% of them were aware of the issue after the intervention (53). An intervention that involved nutrition and food safety components was conducted in China and found that both knowledge and behavior scores of nutrition and food safety improved among elementary school students after participating in the program (54). A study implemented for 705 students aged 8-17 in Nepal found that a school garden program with health, nutrition, and hygiene interventions made several positive impacts, including improvement of their hand washing with soap (from 74% to 97%), decrease in the prevalence of parasite infection (from 37% to 9%), and increase in the awareness of fruit and vegetable consumption among children (55).

To prevent foodborne diseases among elementary school students in Asia, several food safety interventions have mainly focused on street food safety, considering the food culture in Asian countries. In fact, a study in Indonesia revealed that up to 70% of school-aged students consumed street food for their breakfast (56). Street food is popular since it is convenient and affordable (57); however, street food is often contaminated because limited water resources and the unfavorable surroundings, such as dust and vehicle emissions, might carry microbiological hazards, particularly in developing countries (58-60). A study in Indonesia tested street food vendors around elementary schools and reported that approximately 45% of these street food samples were contaminated (61). There are some other studies claiming that most school-aged students have insufficient knowledge regarding street food safety and vendors often have poor knowledge and practices of food safety (61, 62). Thus, several food safety interventions in Asia have been implemented to improve knowledge and behaviors regarding food safety among elementary school students and street food vendors who operate around elementary schools. Another study in Indonesia found that participation of students in these programs increased their knowledge, attitude, and practice of street food safety after receiving FSE through reading books and watching videos (60).

Components and Strategies of Implementing FSE

Multiple components with experimental activities: To effectively implement FSE for elementary school students, research recommended including multiple components and experimental activities to motivate students to improve their knowledge and behaviors (8, 16, 63, 64). Among these effective FSE interventions targeting elementary school students, nutrition education, cooking activities, and school gardening are the most common components that have been implemented together with FSE. For example, Calberry and colleagues implemented the Food Safety and School Garden Program (FSSGP) in the U.S., providing interactive nutrition activities with food safety components, showing the improvement of food safety knowledge among students (43). A 2020 study conducted in Nepal randomly assigned students into three groups: 1) school garden with health, nutrition, and hygiene education (WASH); 2) school garden only; 3) and no intervention (55). In the group who received school garden with nutrition and hygiene education intervention, personal hygiene significantly improved and parasite infection decreased compared to the other two groups (55). An FSE study on elementary school students in Italy was conducted following two approaches: lectures and experimental activities for the students in the practical lessons received, and

in contrast, only lectures for those in the theoretical approach (8). The students who were in the practical classes were found to have greater improvement in terms of knowledge and behaviors of food safety compared to those in the theoretical group.

Multidisciplinary Media and Game-based Learning: Studies have suggested that FSE programs, in which multidisciplinary methods are applied, such as lectures in the classroom, educational games, video watching, and digital media, might motivate students toward learning (64-66). For example, *e-Bug*, not only provides learning modules, educational games, interactive activities, and learning worksheets for students, but also utilizes the concepts of peer education to improve students' knowledge regarding food safety and hygiene (25, 67). Another FSE study reported that participants who attended traditional lectures with social media components, such as Facebook, have effectively improved knowledge, attitude, and behaviors of food safety (68). To promote FSE among school-aged students, game-based learning (GBL) has been widely used effectively worldwide (9, 69, 70). For instance, *Ninja Kitchen* is an online game to help school-aged students to learn food hygiene by playing interactive food handling games; the player receives points if their food is prepared safely; however, the player loses points if their cooking causes customers to get foodborne disease (70). In addition, *Chicken Surprise*, one of the most popular web-based food safety games developed by *e-Bug*, helped school-aged students learn food hygiene by making a chicken sandwich safely (65).

Integration with Academic Curricula*:* To implement nutrition and food education for school-aged students, time limitation and academic competence are the major challenges for teachers and students (10, 22). Thus, recent studies have suggested to integrate nutrition and FSE into multiple academic subjects, such as math or science, which not only helped teachers to minimize their time limitation while supporting students' exposure to nutrition and food education in existing syllabi, but also increased students' knowledge of food safety and enhanced their understanding of other academic subjects (10, 22). For example, a food-based curriculum designed by registered dietitians and educators in the United States revealed that providing nutrition and FSE during curriculum time not only helped students gain food safety knowledge, but also improved their academic knowledge regarding mathematics and science (22). Furthermore, Carraway-Stage and colleagues implemented the Food, Math, and Science Teaching Enhancement Resource (*FoodMASTER*) Intermediate (FMI) curriculum for 3rd to 5th graders. They found a significant improvement in the total nutrition knowledge score, including food safety, among the intervention group (10). Integrating FSE into other curricula could help teachers provide nutrition and food education efficiently with limited curriculum schedules. It could also help improve students' performance on standardized tests as well as their health (10, 22).

Research Gaps and Future Implications

Limited FSE Studies for Elementary School Students

Despite the fact that food safety guidelines and educational resources have been established, FSE programs for elementary school students have not been well studied or addressed, particularly in developing countries. Most health-associated educational programs are designed for older students, such as high school or college students; limited food safety research has been implemented among younger children, such as elementary school students (14-16). Moreover, food and nutrition education is often not mandatory in the school curriculum, and has not been a core element to be taught at school because of schedule limitations and academic competence for teachers and students (10, 71). The fact that foodborne diseases are still a serious problem in the U.S. and around the world necessitates implementing FSE for all elementary school students who are at risk of foodborne diseases more than other age groups (71, 72). Providing FSE for elementary school students would result in advantageous situations, not only improving students' knowledge and behavior in food safety, but also impacting students' lifelong health. Hence, FSE should not be under-recognized in the educational system; it should be a core element of school-based programs (71, 73).

Lack of Behavior Uptake of Food Safety

Most FSE for elementary school students concerns increasing students' knowledge of food safety; however, certain improper behaviors have been found among elementary school students, specifically incorrectly practicing hand washing before meals and during food handling. A food hygiene study conducted in 21 schools in the United Kingdom found that students were aware of hand washing during food handling; however, most of these students did not actually wash their hands (19). A food safety intervention in Indonesia reported that 97% of students were aware of the need to wash hands before eating snacks; yet 63% of them did not know

how to wash hands correctly (74). A study in Ethiopia reported that 99% of students washed hands before eating meals, but less than 37% of students washed hands with soap (75). In that study, although more than 75% of the subjects were aware of the importance to wash hands after defecation, less than 15% of them did that (75). Washing hands with soap is the most effective way to prevent childhood diarrhea, particularly before preparing food or after using the bathroom, which could possibly reduce diarrhea by 47% (76). However, the rate of children that actually performed hand washing with soap before food preparation is low despite their awareness of the importance of this food hygiene behavior (76). Thus, future FSE programs for elementary school students should focus more on practicing food safety behaviors, taking hand washing into account rather than only improving students' knowledge.

Insufficient Food Safety Training for Teachers

School teachers play important roles in implementing FSE for elementary school students; however, insufficient food safety training, lack of self-efficacy, limited skills and knowledge in the nutrition and food curriculum, and time limitations are the main barriers for teaching nutrition and food subjects at school (22, 52, 67, 77). Ovca and colleagues concluded that in addition to a quality food safety curriculum, having qualified teachers who have sufficient knowledge of food safety is the key factor to determine if the educational objectives of FSE programs would be achieved or not for students aged 6-18 years (78). To effectively implement FSE, school teachers must initially receive sufficient support and professional development. Hence, there is an urgent need to improve the knowledge and self-efficacy of school teachers by providing proper nutrition and food-related training in order to enhance their confidence to help elementary school students improve food safety-associated knowledge and behaviors (22, 52, 78).

4. Conclusion

Foodborne disease, the main cause of childhood diarrhea and early childhood death, is still a serious problem around the world. Even though foodborne disease is a challenging issue, it is preventable by practicing proper food safety and personal hygiene. To reduce the incidence of foodborne diseases worldwide, it is pivotal to implement FSE for school-aged students. However, there is a lack of studies on FSE worldwide, for elementary school students in particular, who are more likely to face severe consequences from consuming contaminated food and are still establishing life-long health behaviors that will make an impact on their optimal growth. Thus, this review examined the availability and effectiveness of the current studies. The obtained results revealed that although food safety guidelines and resources are established worldwide, limited FSE programs have been targeted to elementary school students, particularly in developing countries. Furthermore, improving knowledge of food safety has been the primary outcome among recent FSE programs; however, elementary school students are not actually practicing food safety behaviors despite having the knowledge.

Considering the serious issue of foodborne diseases worldwide, there is an urgent need to provide more effective FSE programs for elementary school students, specifically in developing countries. To effectively implement FSE for elementary school students, the goal of future FSE should concentrate more on the behaviors; thus, preventing foodborne diseases might be possible by having elementary school students practice food safety principles correctly. Additionally, FSE programs should combine multiple components with experimental activities, such as safe cooking preparation, game-based learning, and delivering educational messages by multidisciplinary media, to enhance students' learning experiences of food safety. Moreover, integrating FSE into other established curricula and providing school teachers sufficient food safety trainings are recommended to reduce the challenges and barriers of implementing FSE at school. Lastly, it is recommended that children's food safety knowledge and practices be evaluated before and after the food safety implementations to measure the effectiveness of the FSE program.

Overall, the prevalence of foodborne diseases and diarrhea remains high worldwide; meanwhile, limited FSE programs have been targeted for elementary school students who are in a critical learning period when the behaviors they establish will persist to their adulthood. Studies have highlighted the significance of addressing and implementing FSE among elementary school students in order to prevent serious childhood epidemics around the world. By following the above-mentioned recommendations, researchers will be able to develop and implement more effective FSE for preventing foodborne diseases and reducing childhood diarrhea.

Conflicts of interest: None to declare.

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