

# Promoting Safety in Culinary Training Laboratories: A Systematic Review of Strategies, Barriers, and Facilitators

Turmaningsih Surya Pratama<sup>1</sup>, Bagoes Widjanarko<sup>1</sup>, Daru Lestantyo<sup>1</sup>, Yuliani Setyaningsih<sup>1</sup>

<sup>1</sup>Faculty of Public Health, Diponegoro University, Indonesia

Email: [turmaningsih.surya@gmail.com](mailto:turmaningsih.surya@gmail.com)

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**Abstract.** Educational kitchen laboratories present unique occupational safety challenges, yet systematic evidence on effective safety promotion remains fragmented. Young trainees are particularly vulnerable, with recent data indicating that workers aged 15-24 experience work-related injuries at rates up to 2.3 times higher than their adult counterparts. This underscores a pressing need for evidence-based safety interventions within vocational culinary education. This systematic literature review aimed to analyze safety promotion strategies and identify common barriers and facilitators in educational and vocational kitchen settings to propose an integrated safety framework. Guided by the PRISMA 2020 framework, a systematic search was conducted across the Scopus, PubMed, and Google Scholar databases for studies published between January 2015 and August 2025. From 5,124 initial records, 22 relevant studies were selected for synthesis after a rigorous screening process involving explicit inclusion/exclusion criteria. Thematic analysis was performed to synthesize the findings. The analysis revealed six key strategy themes: (1) educational interventions, (2) behavioral models, (3) technology-enhanced learning, (4) ergonomic improvements, (5) community-based learning, and (6) policy frameworks. Key barriers included persistent cognitive misconceptions (e.g., optimistic bias) and inadequate physical infrastructure. Conversely, critical facilitators involved the use of interactive and visual tools, strong institutional support, and stakeholder engagement. Promoting safety in culinary training environments requires a multidimensional approach that integrates behavioral, technological, and infrastructural strategies. This review synthesizes these determinants into a comprehensive framework, offering an evidence-based map for designing safer and more effective vocational education programs. Effective implementation is critical for fostering a resilient safety culture.

**Keywords:** Culinary Education, Culinary Training, Occupational Safety, Safety Strategies, Systematic Review

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## INTRODUCTION

Educational culinary laboratories, such as those in vocational schools and training centers, present notable safety risks for students and staff due to their dual function as both learning spaces and simulated workplaces. While global data on accidents in these specific settings are limited, available studies indicate a high incidence of injuries (Nasrallah et al., 2022; Sukri et al., 2024; Margheritti et al., 2025; Samarasinghe & Heenatigala, 2024; Hancko et al., 2025). Young

trainees are particularly vulnerable; data from the National Institute for Occupational Safety and Health (NIOSH) confirms that young workers experience occupational injuries at rates up to 2.3 times higher than older adults (National Institute for Occupational Safety and Health., 2023). This vulnerability has been potentially exacerbated in the post-COVID-19 era, with global bodies like the World Health Organization (WHO) and the International Labour Organization (ILO) highlighting disruptions in vocational training and increased risks for young workers entering the workforce (ILO Brief, 2020; Citaristi, 2022; Fergusson & Yeates, 2025; Chacaltana et al., 2022). These environments expose learners to a spectrum of hazards including cuts, burns, scalds, slips, and falls, which directly mirror the risk profiles seen in professional food service industries (Shendell et al., 2018; Wassif et al., 2024a; Gupta, 2024). This evidence underscores a pressing global concern that necessitates prioritizing safety interventions within the core of culinary education curricula (Thomas et al., 2024; Sathatip et al., 2025; Limon et al., 2022).

Given the unique, dual nature of these kitchens, promoting occupational health and safety (OHS) must extend beyond mere compliance. It requires embedding robust behavioral change strategies within the curriculum and daily operational routines. Despite the prevalence of these educational programs worldwide, systematic evidence on effective safety promotion strategies remains fragmented. An initial analysis of the literature reveals a significant geographical bias; of the 22 studies ultimately included in this review, nearly two-thirds originate from high-income countries, leaving a critical gap in understanding the unique challenges and resource constraints of Low- and Middle-Income Countries (LMICs). While individual studies on specific interventions exist, there has been no comprehensive synthesis that specifically examines the intersection of pedagogy, technology, and policy within this unique context.

Furthermore, addressing this gap is not merely an academic exercise; it is a crucial step toward achieving Sustainable Development Goal 8 (SDG 8), particularly Target 8.8, which calls for the protection of labor rights and the promotion of safe and secure working environments for all workers. This systematic literature review, therefore, aims to fill this critical gap by: (1) analyzing the strategies that have been proposed and implemented to promote occupational safety in educational or vocational kitchen laboratory environments; and (2) identifying and synthesizing the common barriers and facilitators reported in implementing such strategies. The novelty of this study lies in its construction of an integrated framework of safety determinants, offering an evidence-based foundation for designing safer curricula and institutional policies (Transforming Our World: The 2030 Agenda for Sustainable Development, 2015).

## **METHODS**

This study adopted a systematic literature review (SLR) method, guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 framework to ensure methodological rigor, transparency, and replicability (Page et al., 2021). The review was structured to identify, appraise, and synthesize all relevant empirical evidence on the topic. A comprehensive search was conducted across three major electronic databases: Scopus, PubMed, and Google Scholar. This multi-database approach was chosen to ensure extensive coverage of peer-reviewed literature and to mitigate the selection bias associated with a single-database search. The search covered English-language studies published between January 2015 and August 2025. The search strategy employed Boolean operators with keyword combinations designed to capture a broad range of relevant literature, such as: ("occupational safety" OR "safety promotion" OR "accident prevention") AND ("educational lab" OR "kitchen" OR "culinary training").

The study selection process, depicted in Figure 1, followed a multi-stage approach. First, all records identified from the databases were aggregated, and duplicate records were removed. Subsequently, two reviewers independently screened the titles and abstracts of the remaining records to assess their relevance against predefined criteria. Any disagreements during this process were resolved through discussion to reach a consensus. The inter-rater reliability for the screening phase was calculated using Cohen's Kappa, yielding a score of  $\kappa = 0.88$ , which indicates

substantial agreement. The inclusion criteria for full-text assessment were: (1) empirical studies (qualitative, quantitative, or mixed-methods) or systematic reviews; (2) research conducted in educational, culinary, or vocational kitchen-based settings; and (3) studies that specifically addressed occupational safety strategies, interventions, or frameworks. Studies were excluded if they (1) focused exclusively on industrial or hospital workplaces, (2) lacked relevance to the educational context, or (3) did not report any intervention or outcome related to safety promotion. It is important to note that no studies were excluded based on their access status (e.g., open vs. subscription-based); all potentially relevant articles were sought for full-text retrieval.

The initial combined search yielded 5,124 records. After removing duplicates and conducting the screening process, 22 articles were deemed eligible and included in the final synthesis. A structured data extraction sheet was used to systematically collect key information from each included study, covering publication details, research context, strategy type, reported outcomes, and identified barriers and enablers. A thematic synthesis approach was then applied to categorize findings under recurring themes, allowing for a rich comparative analysis across the varied contexts. Ethical review and approval were not required for this study as it is a systematic literature review based on previously published and publicly available data.

## RESULTS AND DISCUSSION

The systematic search and screening process, summarized in the PRISMA flow diagram (Figure 1), resulted in the inclusion of 22 studies that met the eligibility criteria. Thematic analysis of these studies identified two primary categories of findings: (1) the core strategies proposed and implemented to promote occupational safety, and (2) the key barriers and facilitators influencing the success of these implementations.

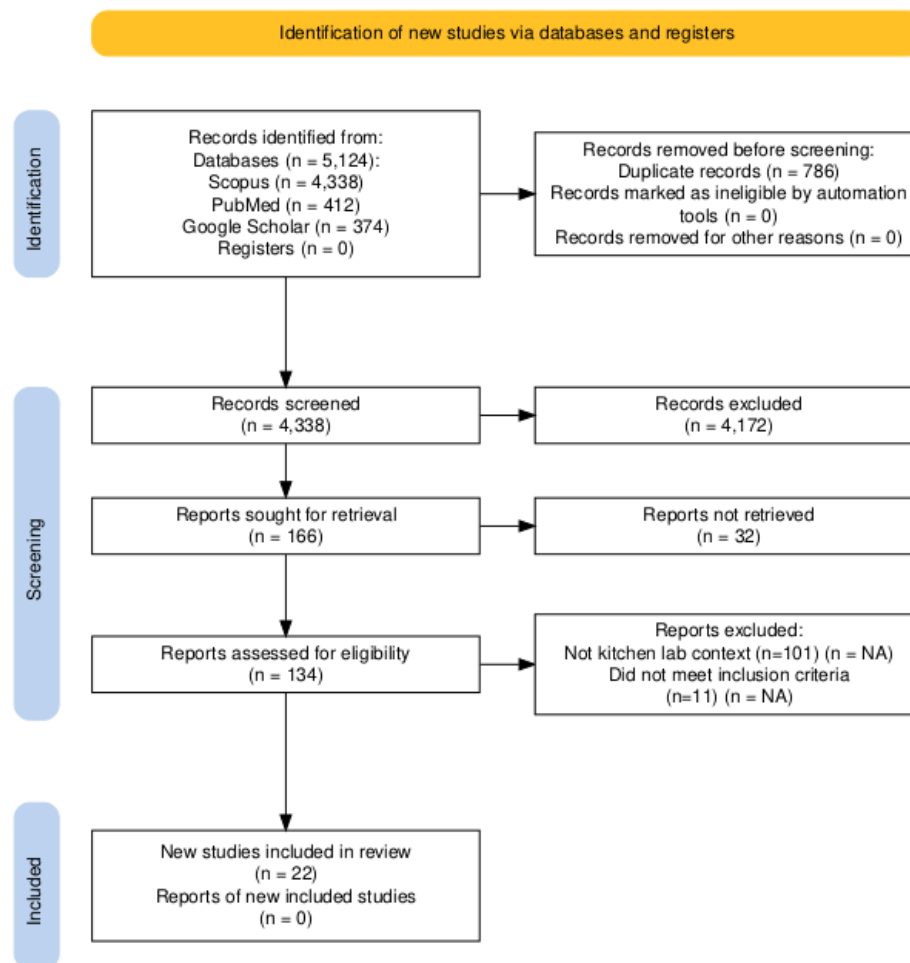


Figure 1. PRISMA 2020 flow diagram of the study selection process

## Strategies to Promote Occupational Health and Safety

The analysis identified six major themes of safety promotion strategies across the 22 included studies. However, beyond their numerical distribution, a more critical pattern emerges regarding the *nature of evidence production in this field*. Educational and knowledge-based interventions dominated the literature (45.5%), but this prevalence should not be interpreted solely as evidence of effectiveness. Rather, it likely reflects a methodological preference for interventions that are easier to design, implement, and measure quantitatively (e.g., pre–post knowledge assessments), compared to more complex structural or policy-level interventions.

This trend suggests a potential evidence bias, where individual-level interventions are overrepresented, while system-level strategies such as ergonomic redesign (9.1%) and policy frameworks (18.2%) remain underexplored despite their potentially greater long-term impact. In other words, the literature appears to prioritize *measurable change over structural transformation*, which may limit the overall effectiveness of safety promotion efforts.

A cross-study synthesis further reveals a consistent knowledge–practice gap across diverse geographical and contextual settings. For example, studies conducted in Iran (Fariba et al., 2018), Saudi Arabia (Asmahan et al., 2021), and Ghana (Odonkor et al., 2020) all report improved knowledge following training, yet persistent unsafe practices. This convergence suggests that the gap is not context-specific but rather structural, indicating that cognitive improvement alone is insufficient to drive behavioral change without reinforcement from environmental, social, and policy mechanisms.

Technology-enhanced interventions, particularly gamification and augmented reality, demonstrate relatively consistent positive outcomes across studies (Koch et al., 2022; Nadeem et al., 2020; Steele et al., 2025). Unlike traditional educational approaches, these methods appear to influence both engagement and behavioral retention, suggesting that interactivity may play a mediating role in translating knowledge into practice. However, their effectiveness is contingent upon accessibility and usability, which may limit scalability in low-resource settings.

Community- and family-based approaches (27.3%) highlight the importance of social reinforcement mechanisms, particularly in shaping long-term behavioral norms. Studies consistently show that interventions involving family engagement or co-creation processes yield more sustainable outcomes, indicating that safety behavior is socially embedded rather than purely individual. The synthesis indicates that no single strategy is sufficient in isolation. Instead, the most effective approaches are those that integrate educational, technological, environmental, and social dimensions supporting a shift toward a systems-based model of safety promotion.

### Synthesis Across Studies

While Table 1 presents detailed individual study findings, a higher-level synthesis reveals several important cross-cutting patterns: 1) Consistency of Behavioral Gaps Across multiple countries and study designs, improved knowledge does not consistently translate into safe practices. This suggests that behavioral change is constrained by factors beyond awareness, including habit formation, environmental limitations, and cultural norms; 2) Convergence in Effective Intervention Features: Interventions that incorporate interactive, visual, or experiential elements (e.g., videos, games, AR) consistently outperform passive learning approaches. This indicates that *mode of delivery* is as important as content; 3) Context-Independent Barriers: Key barriers such as optimistic bias, inadequate infrastructure, and weak policy enforcement appear across both high-income and low- and middle-income countries. This suggests that certain safety challenges are universal rather than context-specific, although their intensity may vary; 4) Emerging Role of Structural Factors: Studies addressing environmental or policy-level factors, although fewer, tend to report more direct links to injury prevention (e.g., rest breaks, PPE availability). This indicates that structural interventions may have higher impact but are underrepresented in the literature.

This synthesis transforms Table 1 from an annotated listing into an integrated evidence base, highlighting convergence, gaps, and priorities for future research.

### Addressing Heterogeneity of Evidence

The included studies exhibit substantial heterogeneity in terms of design, sample size, and context. Importantly, not all evidence contributes equally to the strength of conclusions. Small-scale educational interventions (e.g., classroom-based training) primarily provide insight into short-term cognitive and behavioral changes but are limited in external validity. Multi-site or policy-level studies (e.g., Lee et al., 2023; Wassif et al., 2024) offer stronger evidence regarding systemic determinants of safety outcomes. Experimental and quasi-experimental designs (e.g., gamification studies) provide more robust evidence of causal relationships compared to descriptive or cross-sectional studies.

This variation suggests that the current evidence base is skewed toward lower-level interventions, with relatively limited high-quality evidence on long-term, system-wide impacts. As such, caution is required in interpreting the overall effectiveness of reported strategies.

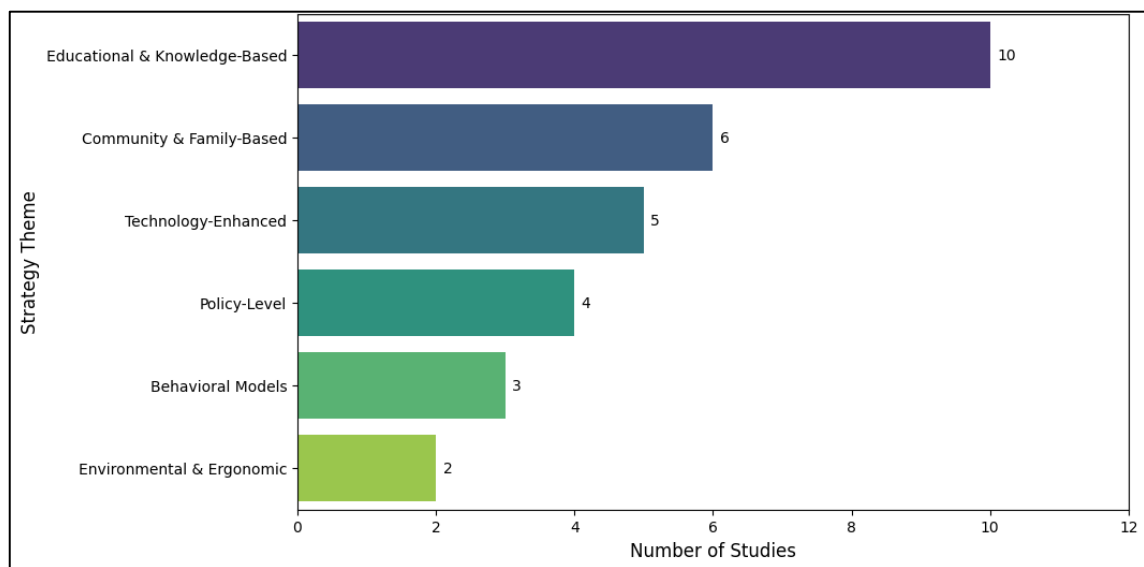


Figure 2. Prevalence of Safety Strategy Themes in Included Studies (n=22)

Table 1. Summary of Included Studies and Key Strategies

No.	Author(s) & Year	Country / Setting	Strategy Theme(s)	Key Findings / Outcomes
1	(Fariba et al., 2018)	Iran / Semi-industrial training kitchen	Educational & Knowledge-Based	Training improved overall KAP scores, but a persistent misunderstanding of safe food temperatures remained, indicating a knowledge-to-practice gap.
2	(Ebadi Vanestanagh et al., 2019)	Iran / Households	Behavioral Models	A majority of participants were in the pre-contemplation or contemplation stages of change, suggesting interventions must first raise awareness.
3	(Evans et al., 2019)	UK / Domestic kitchens	Behavioral Models (Risk Perception)	Identified a strong optimistic bias and "illusion of control" among older adults, leading them to underestimate risks in their own kitchens.

4	(Odonkor et al., 2020)	Ghana / Hospitality industry	Educational & Knowledge-Based	Found that while workers had moderate food safety knowledge, their actual practices were poor, identifying a critical need for continuous practical training.
5	(Barrett et al., 2020)	USA / Multiple states, classrooms	Educational & Knowledge-Based (Video)	A video-based intervention significantly increased both food safety knowledge and risk perception among students, proving its effectiveness as a scalable tool.
6	(Park et al., 2021)	South Korea / Commercial kitchens	Environmental & Ergonomic	Insufficient rest breaks were significantly associated with a higher risk of Musculoskeletal Disorders (MSDs), highlighting an environmental policy failure.
7	(Asmahan et al., 2021)	Saudi Arabia / University students	Educational & Knowledge-Based	Structured training improved knowledge significantly, but a persistent gap between knowledge and actual safe behavior was observed.
8	(Yemane et al., 2022)	Ethiopia / Households	Environmental & Infrastructural	Consistent access to handwashing facilities near food preparation areas was strongly associated with safer food handling practices.
9	(Evans et al., 2022)	UK / Home caregivers	Community-Based (Co-creation)	Co-creation process with caregivers identified a strong preference for multi-format, visual, and non-patronizing safety materials.
10	(Koch, K., et al., 2022)	Norway & UK / Adult consumers	Technology-Enhanced (Gamification)	Game-based learning proved more effective than video-based learning alone in improving safe handling behaviors and debunking common food safety myths.
11	(Kanaan et al., 2023)	Iraq / Urban & rural areas	Educational & Knowledge-Based	Despite training, unsafe food handling behaviors persisted due to low knowledge of contamination risks and deeply ingrained habits.
12	(Lee et al., 2023)	South Korea / School foodservice	Policy-Level (Needs Assessment)	Used the Borich model to identify 8 high-priority safety training topics, including chemical safety and fall prevention, for foodservice employees.
13	(Wassif et al., 2024a)	Egypt / University hostels	Policy-Level (Risk Assessment)	High rates of injury (77.3%) and illness (81.3%) were directly linked to systemic policy failures, such as inadequate PPE and lack of training.
14	(Nadeem et al., 2020)	New Zealand / Engineering lab	Technology-Enhanced (AR)	An Augmented Reality (AR) application for lab orientation significantly increased student motivation, engagement, and comprehension of safety rules.
15	(Steele et al., 2025)	USA / Chemistry classrooms	Technology-Enhanced (Gamification)	A lab safety card game led to high student engagement and increased familiarity with the location and use of lab safety tools.

16	(Brandão et al., 2023)	Brazil / Middle school	Educational & Community-Based	Workshop-based education for 7th-grade students led to a significant (21%) increase in their food safety knowledge.
17	(Teixeira, R., et al., 2024)	Brazil / Public health workers	Technology-Enhanced (Digital Tools)	Validated digital videos and graphics for health promotion achieved high usability and clarity scores among public health professionals.
18	(Rosas et al., 2020)	Portugal / National experts	Policy-Level (Framework Dev.)	Developed a comprehensive food literacy framework identifying 9 domains and 8 key influencing factors to guide policy and education.
19	(Olfert et al., 2019)	USA / Parents & children	Community & Family-Based	Identified parent modeling of safe behaviors and assigning age-appropriate tasks as key facilitators for developing safety skills in children.
20	(Kelly et al., 2024)	USA / College food pantry	Educational & Knowledge-Based	Familiarity with the MyPlate nutritional guide was linked to higher confidence in building healthy meals, suggesting a role for established visual aids.
21	(Horst et al., 2024)	International / Mixed countries	Community & Family-Based (Review)	A systematic review of cooking programs found that interventions with active family involvement yielded better health and safety outcomes.
22	(Zuercher et al., 2024)	USA / California schools	Community & Family-Based	Found that parental perceptions, such as concerns about meal quality or social stigma, strongly influenced student participation in school meal programs.

### ***Barriers and Facilitators to Strategy Implementation***

The categorization of barriers and facilitators into five domains cognitive, infrastructural, policy, sociocultural, and technological provides a useful starting point. However, a deeper analysis reveals that these domains are not independent; rather, they form an interconnected system of influence. A key insight from the synthesis is that structural factors (infrastructure and policy) often act as upstream determinants that shape cognitive and behavioral outcomes. For example: a) Inadequate infrastructure (e.g., lack of handwashing facilities) directly constrains the ability to perform safe practices, regardless of knowledge level; b) Weak policy enforcement reduces accountability, reinforcing unsafe norms and lowering risk perception.

Similarly, sociocultural factors mediate how individuals interpret and respond to safety information. For instance, optimistic bias and reliance on sensory judgment are not merely cognitive errors but are reinforced by habitual practices and social norms. Technology functions as both a mediator and amplifier, capable of enhancing engagement and knowledge retention, but only when supported by adequate infrastructure and user accessibility. From this perspective, the most decisive barriers are not individual-level cognitive limitations, but rather structural and systemic constraints that limit the translation of knowledge into action. This shifts the analytical focus from “changing individuals” to reconfiguring the environments in which behaviors occur. Thus, the barriers and facilitators identified in this review should be understood not as isolated factors, but as components of a dynamic, multi-level system, where effective intervention requires alignment across domains. A comparative synthesis of these factors is provided in Table 2.

Table 2. Summary of Key Implementation Barriers and Facilitators

Theme	Key Barriers	Key Facilitators	Example Studies
Cognitive & Behavioral	<ul style="list-style-type: none"> <li>- Misconceptions about risk (e.g., reliance on senses)</li> <li>- Optimistic bias / low risk perception</li> <li>- Overconfidence in self-assessed knowledge</li> <li>- Low motivation / pre-contemplative stage</li> </ul>	<ul style="list-style-type: none"> <li>- Tailored, stage-based interventions</li> <li>- Framing safety as a personal responsibility</li> <li>- Use of visual, engaging, and emotional triggers (e.g., disgust)</li> <li>- Repeated testing and reminders</li> </ul>	(Ebadi Vanestanagh et al., 2019; Evans et al., 2019; Fariba et al., 2018; Koch, K., et al., 2022; Koch, Mønster, et al., 2022)
Infrastructural & Environmental	<ul style="list-style-type: none"> <li>- Outdated or poorly maintained equipment</li> <li>- Lack of basic sanitation (sinks, soap)</li> <li>- Poor ergonomic design</li> <li>- Insufficient rest break policies</li> </ul>	<ul style="list-style-type: none"> <li>- Well-designed, safe physical layouts</li> <li>- Consistent access to PPE and tools</li> <li>- Evidence-based policies (e.g., break scheduling)</li> <li>- Strong administrative commitment to infrastructure</li> </ul>	(Lee et al., 2023; Park et al., 2021; Wassif et al., 2024b; Yemane et al., 2022)
Policy & System	<ul style="list-style-type: none"> <li>- Absence of standardized training protocols</li> <li>- Weak enforcement of existing policies</li> <li>- Fragmented systems, lack of cross-sector collaboration</li> <li>- Low visibility of safety programs on campus</li> </ul>	<ul style="list-style-type: none"> <li>- Strong institutional and administrative support</li> <li>- Alignment of interventions with national policies</li> <li>- Use of validated assessment models (e.g., Borich)</li> <li>- Clear, institutional follow-through</li> </ul>	(Kelly et al., 2024; Park et al., 2021; Rosas et al., 2020)
Sociocultural & Family	<ul style="list-style-type: none"> <li>- Cultural stigma (e.g., regarding free school meals)</li> <li>- Time scarcity and parental safety fears</li> <li>- Rigid domestic roles hindering skill transfer</li> <li>- Negative peer or family influence</li> </ul>	<ul style="list-style-type: none"> <li>- Active family and community involvement</li> <li>- Culturally sensitive and tailored messaging</li> <li>- Use of peer modeling and mentoring</li> <li>- Co-creation of materials with stakeholders</li> </ul>	(Horst et al., 2024; Olfert et al., 2019; Zuercher et al., 2024)
Technology & Engagement	<ul style="list-style-type: none"> <li>- Device incompatibility or accessibility issues</li> <li>- Information overload and short attention spans</li> </ul>	<ul style="list-style-type: none"> <li>- Interactive and gamified learning elements</li> <li>- High-quality, intuitive user interface design</li> </ul>	(Evans et al., 2019, 2022; Koch, K., et al., 2022; Koch, Mønster, et al., 2022; Nadeem et al., 2020; Teixeira, R., et al.,

	- User skepticism toward digital sources - Technical glitches or poor usability	- Multi-format delivery (visual, text, video) - Real-time feedback and personalization	2024; Teixeira, Camanho, et al., 2024)
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This systematic review moves beyond identifying safety strategies by revealing a fundamental and theoretically significant phenomenon: the persistent knowledge–practice gap. While this gap is frequently reported in individual studies, the present synthesis demonstrates that it is not an incidental finding but a structural pattern across contexts, populations, and intervention types. This suggests that the failure of knowledge to translate into safe behavior is not merely a limitation of specific interventions, but a deeper issue rooted in how human behavior is formed and sustained.

From a theoretical perspective, this gap can be interpreted through multiple complementary lenses. First, risk perception theory helps explain why individuals may not act on safety knowledge; optimistic bias and the “illusion of control,” identified across several studies, lead individuals to underestimate personal risk even when they possess adequate knowledge. Second, behavioral change models, such as stage-based frameworks, indicate that individuals in pre-contemplative or contemplative stages are unlikely to translate knowledge into action without targeted motivational triggers. Third, insights from habit formation theory suggest that routine practices in kitchen environments are often automatic and resistant to change, meaning that informational interventions alone are insufficient to disrupt entrenched behaviors.

Taken together, these perspectives indicate that knowledge functions as a necessary but insufficient condition for behavioral change. Effective safety promotion, therefore, requires interventions that not only inform but also reshape perception, disrupt habits, and modify the environments in which behaviors occur. In this sense, the knowledge–practice gap should be understood as a systemic failure of alignment between cognitive, behavioral, and structural determinants.

### Limitations and Future Research

The findings of this study should be considered in light of its limitations. The primary limitation of the initial search was its reliance on a single database (Scopus). To enhance comprehensiveness in this revised version, the search was expanded to include PubMed and Google Scholar, although this may not have captured all relevant literature indexed elsewhere. Furthermore, the heterogeneity of the included studies in terms of methodology and context makes direct comparison challenging. A significant limitation, as noted, is the underrepresentation of research from LMICs (36.4% of included studies), which underscores a geographical bias in the existing literature and restricts the applicability of some findings to these regions.

Future research should aim to address these gaps. There is a pressing need to empirically test and validate integrated intervention models, such as the one proposed, within specific educational settings. To establish causality and determine real-world efficacy with high confidence, we strongly recommend that future validation studies employ robust experimental designs, preferably Randomized Controlled Trials (RCTs). Such trials could compare the triadic model against standard safety training to measure its impact on injury rates, safety behaviors, and safety culture over time.

### Operationalizing a Systems Perspective

The findings of this review strongly support a systems-based understanding of safety behavior, but this perspective must be articulated in operational terms. Rather than treating behavioral, technological, and institutional components as parallel factors, the evidence suggests that they interact in a causal and reinforcing manner. At the core of this system is a dynamic interaction: a) Behavioral components (knowledge, perception, motivation) determine an

individual's *capacity and willingness* to act safely; b) Technological components (e.g., gamification, AR, visual tools) function as *mediators*, enhancing engagement, reinforcing learning, and providing feedback loops that support behavior change; c) Institutional and environmental components (policy, infrastructure, supervision) act as *enabling or constraining conditions*, shaping whether safe behavior is feasible, rewarded, or sustained over time.

Importantly, these components do not operate independently. For example, even highly engaging technological tools may fail in the absence of institutional support or adequate infrastructure. Conversely, strong policies without behavioral engagement may result in compliance without internalization. This interdependence suggests that safety outcomes emerge from a configuration of aligned system elements, rather than from isolated interventions. Thus, the systems perspective advanced in this review is not merely conceptual but implies a causal architecture, where effective safety promotion depends on the alignment and mutual reinforcement of behavioral, technological, and structural domains.

### **Grounding and Justifying the Triadic Model**

Building on this systems synthesis, the proposed triadic intervention model comprising (1) video-based instruction, (2) routine safety talks, and (3) peer mentoring can be more explicitly grounded in the evidence.

Each component corresponds to a recurring and convergent pattern identified in the results: a) Video-Based Instruction (Cognitive & Engagement Layer) Derived from consistent evidence that visual and interactive educational tools improve both knowledge and risk perception. Studies using video and digital media demonstrate scalability and effectiveness in capturing attention and standardizing content delivery; b) Routine Safety Talks (Behavioral Reinforcement Layer) Grounded in findings that one-off training fails to sustain behavioral change. Repeated, structured reinforcement particularly in workplace-like settings addresses habit formation and keeps safety salient in daily routines; c) Peer Mentoring (Social & Cultural Layer) Supported by evidence from community- and family-based interventions showing that behavior is socially embedded. Peer influence functions as a powerful mechanism for modeling, accountability, and norm formation.

The selection of these three components is therefore not arbitrary, but reflects a strategic integration of the most consistently effective mechanisms identified across studies: engagement, reinforcement, and social embedding. Moreover, the model is intentionally designed to be low-cost and adaptable, making it particularly suitable for resource-constrained environments. By explicitly linking each component to evidence patterns, the triadic model can be understood as an evidence-informed synthesis, rather than a speculative proposal.

### **Contextualizing Findings in Low- and Middle-Income Countries (LMICs)**

A critical contribution of this review lies in highlighting the underrepresentation of LMIC contexts in the literature. However, beyond identifying this gap, it is necessary to consider how contextual constraints shape the feasibility and effectiveness of safety interventions. In many LMIC settings, infrastructural limitations—such as inadequate facilities, limited access to protective equipment, and overcrowded training environments—directly constrain the implementation of safety practices. Even when knowledge is present, the absence of enabling conditions renders safe behavior impractical. Similarly, resource constraints limit the adoption of advanced technological interventions, creating a reliance on low-cost educational approaches.

Cultural factors also play a significant role. Practices related to food handling, perceptions of risk, and hierarchical relationships within training environments may influence how safety messages are received and enacted. For example, strong deference to authority may inhibit peer-based correction, while deeply ingrained habits may resist externally imposed guidelines. These contextual realities suggest that safety interventions must be adapted rather than transferred. Models developed in high-income settings may not be directly applicable without modification. The triadic model proposed in this study attempts to address this by emphasizing scalability,

cultural adaptability, and minimal resource dependence, but further empirical validation in LMIC contexts remains essential.

### **Engaging with Contradictions in the Literature**

An important insight from this review is the presence of apparent contradictions across studies, which, rather than weakening the evidence base, provide opportunities for deeper understanding. For instance, while several studies report improvements in knowledge without corresponding behavioral change, others demonstrate behavioral improvements through technology-based or community-driven interventions. This divergence can be explained by differences in intervention design and mechanism.

Knowledge-based interventions primarily target cognitive domains, which, as discussed, are insufficient on their own. In contrast, technology-enhanced and community-based approaches tend to engage multiple levels simultaneously—including emotional engagement, social influence, and environmental cues—thereby increasing their effectiveness. Similarly, contradictions in outcomes may reflect contextual moderators, such as infrastructure availability or institutional support. An intervention that succeeds in a well-resourced environment may fail in a setting where basic facilities are lacking.

Therefore, rather than viewing inconsistencies as methodological weaknesses, they should be interpreted as evidence that effectiveness is contingent upon alignment between intervention type and contextual conditions. This reinforces the central argument of this review: that safety promotion must be approached as a context-sensitive, system-level challenge.

### **CONCLUSION**

Promoting occupational health and safety in culinary training environments is a complex challenge that demands a holistic, integrated approach, moving beyond single interventions. This review synthesizes evidence showing that effective safety promotion synergizes behavioral, technological, infrastructural, and socio-cultural strategies, all of which must be anchored by robust institutional policies and unwavering administrative support. The framework of determinants presented in this review offers a comprehensive, evidence-based map for educators and administrators to design safer vocational education programs.

However, the development of this framework is only the first step. The true measure of success lies in its effective implementation and validation. Therefore, we conclude with a strong call to action for future research to move from synthesis to practice. A crucial next step is to pilot the proposed triadic model (video-based instruction, routine "safety talks," and peer mentoring) in a real-world setting, for instance, across several vocational schools in Indonesia, using a pre-post injury tracking design. Such a study would provide invaluable data on the model's efficacy. To facilitate this, collaboration with key stakeholders, including educational institutions and government bodies such as the Ministry of Education and the Ministry of Health, will be essential to secure funding and institutional support. Ultimately, rigorous validation research is critical to transform these evidence-based findings into scalable, impactful policies that will protect the culinary professionals of tomorrow.

### **AUTHOR CONTRIBUTIONS**

Conceptualization, T.S.P. and B.W.; methodology, T.S.P.; formal analysis, T.S.P.; investigation, T.S.P.; writing original draft preparation, T.S.P.; writing—review and editing, T.S.P., B.W., D.L., and Y.S.; supervision, B.W., D.L., and Y.S. All authors have read and agreed to the published version of the manuscript.

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The authors declare no conflict of interest.

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