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Integrated Agronursing Strategies to Mitigate Occupational Hazards among Global Agricultural Workers

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Abstract:
Agricultural occupational hazards pose escalating threats to farming populations globally, yet fragmented evidence limits cohesive clinical and policy responses. This systematic review synthesizes contemporary research to inform an integrated agronursing framework addressing occupational health and safety among farmers. Following PRISMA 2020 guidelines, we searched Scopus, PubMed, and ProQuest for English-language, open-access studies published between 2022 and 2026. Ten studies spanning eight countries underwent a Joanna Briggs Institute critical appraisal and narrative synthesis due to methodological heterogeneity. Results indicate strong positive correlations between hazard knowledge and safety behaviors, though high-risk practices persist, including pesticide overconcentration (74.6%) and inconsistent use of personal protective equipment. Panel regression analysis revealed a monotonic escalation in severe agricultural trauma above 20°C, increasing 123% beyond 30°C. Multicomponent educational interventions demonstrated significant short-term improvements in sun safety knowledge and protective behaviors. At the same time, qualitative evidence highlighted structural determinants, piece-rate compensation, infrastructure deficits, and cultural norms that independently mediate risk exposure. Media analyses further revealed tendencies to individualize injury responsibility, obscuring upstream regulatory drivers. These findings confirm that knowledge acquisition alone cannot sustain behavioral change without concurrent environmental and policy-level interventions. Consequently, agronursing practice must evolve from episodic clinical care toward proactive, ecologically grounded models integrating standardized psychosocial screening, climate-responsive surveillance, and advocacy for equitable safety protocols. This framework equips rural health systems with evidence-based strategies to implement contextually tailored interventions, ultimately safeguarding farmer wellbeing and strengthening global agricultural resilience.

Keywords:
agronursing, agricultural workers, heat stress, occupational health and safety, pesticide exposure

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INTRODUCTION

The escalating demand for global food production has intensified occupational hazards in agricultural systems, positioning agronursing as a critical discipline for safeguarding farming populations worldwide (Zhang & Kim, 2025). As operations expand in scale and complexity, workers encounter diverse physical, chemical, and psychological stressors that directly threaten occupational well-being (Garner et al., 2025). Nursing professionals operating within rural contexts are uniquely situated to address these challenges through community-embedded health surveillance, preventive education, and culturally responsive clinical interventions. Integrating occupational health principles

into agricultural practice is fundamental for sustaining workforce productivity and long-term public health outcomes (Li et al., 2025). Consequently, agronursing represents a strategic response to the recognition that farmer health is inextricably linked to food system resilience (Kurniyawan et al., 2026).

Across diverse agrarian settings, farmworkers routinely confront multifactorial risks, including chemical and thermal exposures, psychosocial stressors, and structurally mediated workplace hazards (Florez-Acevedo et al., 2025). Pesticide handling protocols frequently deviate significantly from recommended safety standards, with workers exhibiting inconsistent use of protective equipment and inadequate hazardous waste disposal (Najafi et al., 2025). Concurrently, extreme ambient temperatures exacerbate physiological strain, increasing the incidence of heat-related trauma and dermatological conditions (El Khayat et al., 2022). These environmental threats are compounded by organizational factors such as piece-rate compensation systems and limited access to occupational healthcare. The convergence of individual behavioral patterns and systemic workplace constraints creates a complex risk landscape demanding comprehensive, context-specific health interventions (Elliott et al., 2022).

Contemporary occupational health frameworks have increasingly recognized the need to integrate clinical surveillance, behavioral education, and environmental risk assessment to mitigate agricultural injuries (Castrillon et al., 2026). Recent empirical investigations demonstrate that targeted educational initiatives yield measurable improvements in hazard awareness and in the adoption of protective behaviors when tailored to local farming practices (Aslam et al., 2024). Advanced epidemiological modeling has clarified dose-response relationships between environmental stressors and trauma incidence, enabling predictive risk screening and climate-responsive work protocols (Werner et al., 2025). Multidisciplinary consensus methodologies have also proven effective in generating practical, worker-centered safety recommendations. These methodological advancements collectively establish a robust foundation for evidence-based agronursing practice and policy development (Maniago et al., 2026).

Despite advancements in hazard identification, existing literature remains fragmented by siloed disciplinary approaches that frequently overlook interactions between individual knowledge, structural determinants, and policy environments (Comi et al., 2022). Cross-sectional designs dominate the evidence base, inherently restricting causal inference and limiting understanding of long-term behavioral sustainability. Qualitative investigations, while rich in contextual insight, often lack standardized reporting of methodological rigor, including transparency in recruitment and researcher reflexivity. Furthermore, prevailing health communication strategies frequently individualize responsibility for injury, neglecting upstream regulatory and economic factors that shape occupational risk (Parasram & Choudhury, 2025). This conceptual fragmentation impedes the development of cohesive agronursing frameworks capable of addressing the full spectrum of agricultural health determinants (Susanto & Berdida, 2025).

Agronursing offers a novel, ecologically grounded paradigm that transcends traditional episodic care by synthesizing clinical expertise, participatory risk assessment, and advocacy-driven policy translation into a unified model. By positioning nursing practitioners as central coordinators within agricultural extension networks and rural healthcare systems, this approach enables continuous health monitoring and systematic evaluation of workplace safety protocols (Hayden et al., 2022). Integrating standardized psychosocial screening tools, environmental exposure biomarkers, and culturally adapted educational curricula facilitates a holistic assessment of farmer wellbeing (Derringer & Biddle, 2022). This interdisciplinary framework actively engages farmworkers and policymakers in co-designing interventions, ensuring recommended practices are economically feasible and structurally supported (Gunn et al., 2022).

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This study systematically synthesizes contemporary evidence on agricultural occupational hazards to construct a comprehensive agronursing framework aligning clinical practice with structural risk mitigation. Through a critical appraisal of recent empirical investigations, the research identifies consistent patterns in hazard exposure, behavioral determinants, and intervention efficacy across diverse geographic contexts (Shah & Alharthi, 2024). The synthesis explicitly maps intersections between environmental stressors, workplace organization, and health outcomes to generate actionable practice guidelines for rural healthcare providers (Drerup et al., 2022). By consolidating fragmented evidence into a cohesive theoretical model, the study establishes standardized protocols for agronursing assessment and advocacy adaptable to varying agricultural production systems.

Establishing an integrated agronursing approach is urgently required to bridge the knowledge-practice divide, address emerging climate-related occupational threats, and institutionalize equitable safety protocols (Tomar & Rao, 2025). As climate variability accelerates and agricultural labor demographics shift, the absence of coordinated health infrastructure leaves farming populations vulnerable to preventable injuries and psychological distress (Nnanna et al., 2025). Immediate implementation of evidence-based agronursing interventions will directly reduce acute trauma incidence, enhance workforce retention, and strengthen rural economic viability (Fortabong et al., 2025). Embedding nursing-led occupational surveillance within national agricultural policies will facilitate proactive risk management and promote equitable health outcomes across all tiers of the farming workforce (Shaban et al., 2024).

METHOD

Study Design and Reporting Standards

This study employed a systematic review design to synthesize and critically evaluate evidence related to occupational health and safety (OHS) among farmers. The review process was conducted in accordance with the PRISMA 2020 statement to ensure methodological transparency, reproducibility, and comprehensive reporting. The PRISMA framework guided all stages of the review, including literature identification, screening, eligibility assessment, and final study inclusion.

Search Strategy

A comprehensive literature search was conducted using three major electronic databases: Scopus, PubMed, and ProQuest. The search strategy incorporated both controlled vocabulary (such as MeSH terms) and free-text keywords to enhance retrieval sensitivity. The primary search terms included "occupational health and safety," "farmers," and "agricultural workers," combined using Boolean operators (AND, OR). Database-specific filters were applied to limit results to publications published within the last five years (2022–2026), written in English, and available in full-text open access. Additionally, a manual search of the reference lists of relevant studies was conducted to identify additional eligible articles.

Eligibility Criteria

Studies were selected based on predefined inclusion and exclusion criteria. Eligible studies included original research articles employing quantitative, qualitative, or mixed-method designs, published within the last five years, available as open-access full texts, and written in English. All included studies were required to focus on occupational health and safety among farmers or agricultural workers, to report ethical clearance, and to have a valid, active DOI. Studies were excluded if they were duplicates, abstracts without full text, case reports, conference proceedings,

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editorials, expert opinions, or review articles lacking primary data. Studies failing to meet methodological quality standards during appraisal were also excluded.

Study Selection Process

All retrieved records were imported into reference management software to facilitate organization and to remove duplicates. The selection process consisted of three sequential stages: title screening, abstract screening, and full-text review. Two independent reviewers performed the screening process to minimize bias, and any discrepancies were resolved through discussion or consultation with a third reviewer. The overall selection procedure was documented using the PRISMA 2020 flow diagram, which illustrates the number of studies identified, screened, assessed for eligibility, and included in the final analysis.

Data Extraction

Data extraction was carried out using a standardized form to ensure consistency and accuracy across studies. Extracted information included authorship and publication year, study location, research design, sample characteristics, types of occupational hazards (physical, chemical, biological, ergonomic, and psychosocial), key findings related to OHS outcomes and reported preventive interventions. Ethical approval statements and DOI information were also recorded. The extraction process was conducted independently by two reviewers, with discrepancies resolved by consensus.

Quality Assessment

The methodological quality of the included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist, with specific tools selected based on study design. Each study was evaluated across domains such as internal validity, risk of bias, confounding factors, and reliability of outcome measurement. Based on the appraisal results, studies were categorized as high-, moderate-, or low-quality. Only studies meeting acceptable quality standards were included in the final synthesis.

Data Synthesis and Analysis

A narrative synthesis approach was adopted due to heterogeneity in study designs, populations, and outcome measures. The findings were systematically organized into thematic categories: occupational hazards, associated health outcomes, risk factors, and preventive strategies in agricultural settings. Patterns, similarities, and differences across studies were critically analyzed to generate comprehensive insights and identify research gaps. Quantitative synthesis (meta-analysis) was considered but was not conducted due to variability in study characteristics and outcome reporting.

Ethical Considerations

As this study utilized secondary data from previously published research, ethical approval was not required. However, all included studies were required to have documented ethical clearance to ensure compliance with ethical research standards.

RESULT

The study selection process was conducted in accordance with the PRISMA 2020, ensuring a transparent, structured, and reproducible approach to identifying relevant literature. A

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comprehensive database search yielded 27,913 records, comprising 8,873 from Scopus, 824 from PubMed, and 18,216 from ProQuest. The large volume of initial records reflects a highly sensitive search strategy designed to capture a broad range of potentially relevant studies.

During the initial refinement stage, 16,739 records were removed prior to screening because they were not relevant to the farmer population. This substantial reduction indicates that while the search strategy was intentionally broad, it also retrieved a considerable number of non-specific results, highlighting the trade-off between sensitivity and specificity in systematic search design. Following this step, 11,174 records proceeded to the title and abstract screening phase, where an additional 1,506 records were excluded for not addressing occupational health and safety.

A total of 9,668 reports were then sought for full-text retrieval; however, 8,464 reports were excluded at this stage because they did not align with the nursing and health care focus of the review. This notable attrition suggests that the interdisciplinary overlap, particularly with agricultural, environmental, or industrial studies, requires further refinement to align with the study's healthcare-oriented scope. Subsequently, 1,204 full-text articles were assessed for eligibility, of which 1,194 were excluded based on predefined inclusion and exclusion criteria, including methodological limitations and lack of compliance with eligibility standards. Ultimately, 10 studies met all eligibility criteria and were included in the final synthesis, comprising 4 from Scopus, 4 from PubMed, and 2 from ProQuest. The relatively small number of included studies compared to the initial pool underscores the rigor of the selection process and the strict application of quality and relevance criteria, including appraisal using the Joanna Briggs Institute appraisal tools.

Overall, the PRISMA flow diagram demonstrates a highly stringent and methodologically robust selection process. While the substantial reduction in records across stages may indicate initial over-inclusiveness of the search strategy, it ultimately strengthens the validity of the review by ensuring that only high-quality, relevant studies were included. This rigorous filtering enhances the credibility of the findings. However, it may also reflect a limited availability of high-quality research specifically addressing occupational health and safety among farmers within the healthcare context.

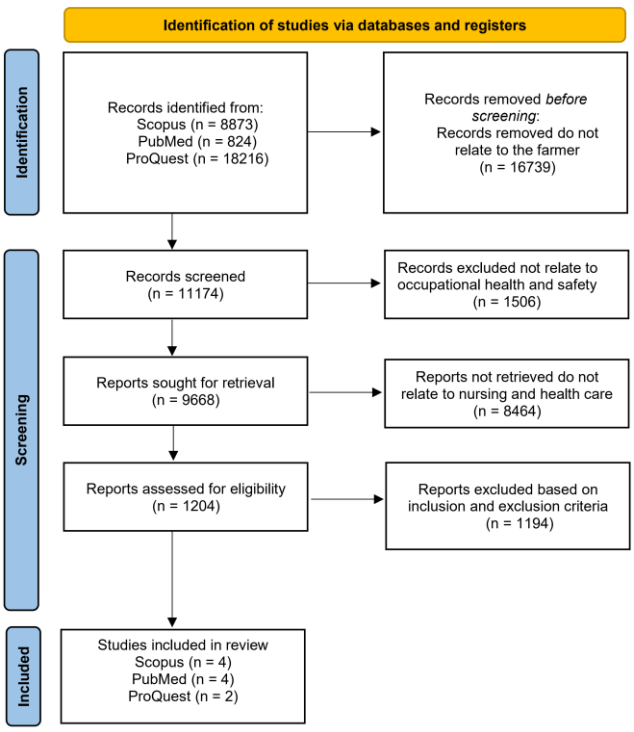

Figure 1. PRISMA flow chart for literature search

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The included studies in this systematic review highlight the multifaceted occupational safety and health (OSH) challenges faced by agricultural workers across diverse geographical and socioeconomic contexts. Pesticide exposure emerges as a predominant chemical hazard, with consistent evidence of suboptimal safety behaviors and overuse. Wongta et al. (2024) demonstrated a strong positive correlation between knowledge levels and safer pesticide handling practices among Thai farmers, underscoring the protective role of awareness. In contrast, Sookhtanlou et al. (2022) reported that 74.6% of Iranian potato farmers applied pesticides at concentrations exceeding recommended dosages, with those at higher health risk exhibiting poorer behaviors across purchase, storage, preparation, application, and post-application stages. Complementary qualitative insights from Norvivor et al. (2025) in Ghana revealed inconsistent awareness of dosage and expiry dates, alongside inadequate personal protective equipment (PPE) use, particularly for eye protection, and unsafe storage or disposal practices, resulting in prevalent symptoms such as eye and skin irritation, waist pain, and temporary vision loss. These findings collectively illustrate a persistent gap between knowledge and practice in pesticide management, often exacerbated by limited access to training and resources in low- and middle-income settings.

Physical and environmental hazards, including machinery-related accidents, sun exposure, and heat stress, further compound farmers' risks. Ekmekci and Yaman (2024) found that 33% of Turkish farmers experienced work accidents in the preceding year, predominantly linked to insufficient PPE (51.5%), extended working hours (>8 hours daily), and transportation issues. Sun safety interventions, as evaluated by El-Shafei and Said (2023) in Egypt, yielded significant post-intervention improvements in knowledge, protective behaviors (e.g., protective clothing, hats, breaks, and hydration), and barrier reduction, demonstrating the efficacy of targeted multicomponent programs. Emerging evidence also points to climate-related influences. Cho (2026) identified a monotonic increase in severe agricultural trauma incidence with rising temperatures in South Korea, with risks escalating sharply above 30°C and particularly pronounced for chemical exposure incidents. Qualitative data from Sexsmith et al. (2022) on U.S. Latino/a mushroom workers additionally emphasized infrastructure deficiencies (poor walkways and cool/damp conditions) and work organization factors, such as piece-rate systems and chemical application, as contributors to injuries and health concerns.

Psychosocial and systemic dimensions of OSH in agriculture received attention in several studies, revealing nuanced but sometimes inconsistent patterns. Rudolphi et al. (2025) reported moderate-to-high stress in nearly half of Illinois producers alongside an 8% injury prevalence, yet found no significant link between psychological measures (stress, anxiety, depression) and injuries. Media advocacy analyses by Milkovich et al. (2025) critiqued coverage for overemphasizing individual farmer responsibility while underplaying structural factors like policy and infrastructure. Tailored sun safety messaging developed by Fazel et al. (2023) for outdoor workers, including farmers, highlighted the value of context-specific, feasible recommendations addressing skin cancer, eye damage, and heat stress. Overall, the reviewed studies, predominantly cross-sectional and with varying sample sizes and designs, reveal common themes of inadequate PPE use, knowledge-behavior discrepancies, and vulnerability to environmental stressors, while also identifying promising intervention points, such as education, behavioral programs, and policy integration. Heterogeneity in methodologies and contexts limits direct comparisons but strengthens the case for context-adapted, multilevel OSH strategies in agriculture. Future research should prioritize longitudinal designs, standardized metrics, and evaluations of scalable interventions to effectively address these enduring risks.

Table 1. Results of included studies.

Author	Objectives	Study Design	Sample Size (N)	Instrument	Main findings
Wongta et al., 2024. Thailand	Evaluate the risk and determine the relationships among pesticide exposure, knowledge, attitudes, and safety behaviors.	Cross-sectional study	280 farmers.	Structured questionnaires and face-to-face interviews.	A strong positive correlation between knowledge and safety behavior was observed, indicating that greater awareness can lead to more cautious practices and safer pesticide use among farmers.
Sookhtanlou et al., 2022. Iran.	analyzes the health risks to potato farmers from the use of chemical pesticides.	A cross-sectional research design.	370 farmers.	Safety behavior was examined in four steps, namely, pesticide purchase and storage, preparation, application, and postapplication.	It was found that 74.6 percent of potato farmers used pesticides at concentrations higher than the recommended dosage. Farmers with a higher risk of health hazards displayed much lower safety behavior than other farmers at all stages of pesticide use.
Ekmekci & Yaman, 2024. Turkey.	occupational health and safety challenges arising from heavy machinery use, chemical exposure, and challenging environmental conditions.	Cross-sectional study.	366 farmers.	The questions were developed based on the researchers' literature review.	The study found that 33.0% of farmers experienced work-related accidents in the past year. Most accidents occurred during work shifts (28.8%) and in the fall season (34.8%). Factors contributing to accidents included lack of personal protective equipment (51.5%) and transportation-related issues (36.4%). Working more than 8 h daily, working 5 days or more per week, and using bus/minibus transportation significantly increased the likelihood of experiencing work accidents.
El-Shafei & Said, 2023. Egypt	screen for health hazards related to sun exposure and examine the effectiveness of a sun-safety multicomponent intervention designed specifically for Egyptian farmers.	A multi-component interventional study.	128 farmers.	A semi-structured questionnaire assessing sun exposure hazards and sun safety knowledge, behavior, and barriers.	After intervention, there was a statistically significant improvement in the participants' awareness regarding sun exposure-related hazards, all knowledge items about sun safety measures ($p < 0.01$), and some sun safety behaviors ($p < 0.05$), including wearing protective clothing, minimization of direct sunlight exposure, taking breaks, plentiful water intake, regular self-checking of skin, wearing wide brimmed hats, and job rotation. Furthermore, there was a statistically significant improvement in all sun protection barriers ($p < 0.01$), except for sunscreen- and sunglasses-related barriers ($p > 0.05$).
Rudolphi et al., 2025. USA.	characterize stress, injury, and chronic health conditions among agricultural	A cross-sectional survey.	1000 agricultural producers.	Stress (using the PSS questionnaire), anxiety (GAD-7), depression (PHQ-	Agricultural injuries were reported by 8.01% of respondents and were primarily minor or moderate. Nearly half (49.07%) reported moderate to high stress, and 10.83% had

Author	Objectives	Study Design	Sample Size (N)	Instrument	Main findings
	producers in Illinois.			9), and work-related injuries.	symptoms of moderate to severe anxiety. No significant associations were found between injury and stress, anxiety, or depression.
Sexsmith et al., 2022. USA.	analyze Latino/a immigrant mushroom workers' perceptions of how the workplace environment shapes occupational safety and health, examine whether and how those perceptions differ by gender, and identify future areas for research on occupational safety and health in the mushroom industry.	Qualitative study.	15 women and 45 men on 6 Pennsylvania mushroom farms.	Health and safety-related interview questions.	Approximately one-third of respondents had suffered an injury at work, and nearly half felt workplace factors affected their health and safety. The study found that Latino/a mushroom farmworkers perceive that risks are posed by the indoor infrastructure of mushroom production houses, including poorly maintained wooden walkways and cool indoor temperatures, and by the organization of mushroom production work, including the application of chemicals, including pesticides, physical demands of the job, use of small knives, contact with compost, and the piece rate payment system.
Norvivor et al., 2025. Ghana	explores the safety practices, perceived exposure levels, and awareness among rural farmers in the Hohoe municipality of Ghana.	A qualitative ethnographic approach.	13 farmers.	A semi-structured interview guide informed by prior literature.	Common health complaints included eye and skin irritation, waist pain, and temporary vision loss. While some farmers wore PPE such as boots and gloves, many lacked complete protective gear, especially eye protection. Pesticide containers were often stored at home, discarded on farms, or burned, indicating poor disposal practices. Awareness of pesticide expiry dates and proper dosage was inconsistent.
Milkovich et al., 2025. USA.	to examine how media is currently used to support OSH efforts, as well as opportunities for engaging with this strategy.	Ethnographic content analysis.	372 news articles about farm safety.	Lexisnexis and aginjurynews were used to collect news media.	In general, relevant news stories (n = 89) were published because of an event (such as a tractor overturn or a safety day). Many stories placed responsibility for both farm injury events and the need to increase safety measures solely on farmers, thereby missing an opportunity to understand how the broader societal context, such as legislation and government programs, shapes farm safety.
Fazel et al., 2023. Canada	to develop a set of tailored, practical, harm-reducing sun safety messages that will better support outdoor workers and their employers in reducing the risk of	Integrated knowledge translation approach and a modified Delphi method (which uses a survey-based	11 participants (construction workers, farmers, landscapers).	A semi-structured questionnaire via Zoom.	The tailored messages were created with the needs of outdoor workers in mind and provide users with key facts, recommendations, and tips for preventing skin cancer, eye damage, and heat stress, specifically when working outdoors.

Author	Objectives	Study Design	Sample Size (N)	Instrument	Main findings
	solar UVR exposure and UVR-related occupational illnesses.	consensus process).			
Cho (2026). Republic of Korea.	investigated the association between temperature variation and the incidence of severe agricultural trauma in South Korea.	Panel regression model.	dataset comprising 17 provinces observed daily (T = 2,192 days), yielding a total of 37,264 province–day observations.	Data from the 2016–2021 Community-Based Severe Trauma Survey (CSTS) in Korea.	Relative to 15–20°C, lower temperatures had little impact on the incidence of severe agricultural trauma, whereas higher temperatures increased incidence in a monotonic pattern, rising by about 39% at 20–25°C, 61% at 25–30°C, and 123% at >30°C. By trauma type, temperatures above 20°C monotonically increased trauma risk, with the strongest effect observed for exposure to or ingestion of harmful substances compared with transportation-related accidents and slips, trips, and falls.

The included studies demonstrate moderate-to-high methodological quality when appraised against the Joanna Briggs Institute (JBI) criteria, with analytical rigor varying by study design. Quantitative cross-sectional investigations (Wongta et al., 2024; Sookhtanlou et al., 2022; Ekmekci & Yaman, 2024; Rudolphi et al., 2025) generally employed validated instruments, such as structured questionnaires, the PSS, GAD-7, and PHQ-9, and appropriate statistical techniques to examine associations between pesticide exposure, safety knowledge, and occupational injury outcomes. Notably, Cho's (2026) panel regression model advanced causal inference by controlling for province-level fixed effects across 37,264 province-day observations, revealing a monotonic increase in severe agricultural trauma risk at temperatures exceeding 20°C. Qualitative and consensus-driven studies (Sexsmith et al., 2022; Norvivor et al., 2025; Fazel et al., 2023) exhibited strong philosophical and methodological congruity, with clear alignment between research aims, ethnographic or Delphi-based data collection, and interpretive analysis aimed at generating contextually grounded safety recommendations. The quasi-experimental intervention by El-Shafei and Said (2023) provided Level 2 evidence for the short-term efficacy of multicomponent sun safety education, though the absence of a control group and long-term follow-up limits conclusions regarding sustained behavioral change.

Despite these strengths, several methodological limitations warrant caution in interpreting evidence in synthesis. Cross-sectional designs inherently limit causal inference, particularly when confounding variables, such as farm size, socioeconomic status, or prior safety training, are not explicitly adjusted for in analyses linking knowledge to safety behavior (Wongta et al., 2024; Sookhtanlou et al., 2022). Qualitative studies, while rich in contextual insight, frequently omit reporting of participant recruitment strategies, data saturation thresholds, or researcher reflexivity, introducing potential selection and interpretation bias (Norvivor et al., 2025; Sexsmith et al., 2022). Similarly, the media content analysis by Milkovich et al. (2025) acknowledged framing bias but lacked inter-coder reliability metrics, potentially affecting the validity of thematic conclusions. Ethical reporting transparency was inconsistently addressed across studies, with several omitting details regarding institutional review board approval or informed consent procedures, a consideration increasingly emphasized in occupational health journals. Furthermore, ecological validity, while high within specific agricultural settings (Thai smallholders, Iranian potato growers, Pennsylvania

mushroom farms), limits direct generalizability across divergent regulatory, cultural, and economic contexts; local enforcement capacity, labor structures, and risk-perception norms profoundly mediate occupational safety behaviors.

Table 2. Joanna Briggs Institute (JBI) Critical Appraisal of Included Studies

Study (Author, Year, Country)	JBI Checklist Applied	Sample & Setting Clarity	Exposure/ Intervention Validity	Confounding / Bias Control	Outcome Assessment & Analytical Rigor	Ethical / Reporting Transparency	Items Met (Y/Total)	Overall JBI Rating
Wongta et al., 2024 (Thailand)	Analytical Cross-Sectional (8)	U	Y	U	Y	U	5/8	Moderate
Sookhtanlou et al., 2022 (Iran)	Analytical Cross-Sectional (8)	Y	Y	U	Y	U	6/8	Moderate
Ekmekci & Yaman, 2024 (Turkey)	Analytical Cross-Sectional (8)	Y	Y	Y	Y	U	7/8	High
El-Shafei & Said, 2023 (Egypt)	Quasi-Experimental (9)	Y	Y	N/A	Y	U	6/9	Moderate-High
Rudolphi et al., 2025 (USA)	Analytical Cross-Sectional (8)	Y	Y	Y	Y	Y	7/8	High
Sexsmith et al., 2022 (USA)	Qualitative Research (10)	Y	Y	Y	Y	U	8/10	High
Norvivor et al., 2025 (Ghana)	Qualitative Research (10)	Y	Y	N/A	Y	U	7/10	Moderate-High
Milkovich et al., 2025 (USA)	Text & Opinion / Content Analysis (adapted, 8)	Y	Y	U	Y	U	6/8	Moderate
Fazel et al., 2023 (Canada)	Qualitative / Modified Delphi (10)	Y	Y	N/A	Y	U	8/10	High
Cho, 2026 (South Korea)	Analytical Cohort / Panel Regression (adapted, 8)	Y	Y	Y	Y	U	7/8	High

Note. Y = Yes; N = No; U = Unclear; N/A = Not Applicable. Higher numbers of criteria met indicate higher methodological quality according to the relevant JBI Critical Appraisal Checklist.

From an evidence synthesis perspective, this corpus provides predominantly Level 3–4 evidence (analytical, observational, and qualitative) with emerging Level 2 support for targeted educational interventions. For systematic review inclusion aligned with JBI standards, we recommend full-text verification against complete checklist criteria, alongside formal risk-of-bias grading (JBI or ROBINS-I) prior to meta-analytic aggregation. Practically, the collective findings underscore that knowledge acquisition alone is insufficient to drive sustained safety behavior change; structural and policy-level interventions, such as engineered controls, piece-rate reform, heat-stress protocols, and strengthened PPE accessibility, must complement educational initiatives to address the multifactorial determinants of agricultural occupational risk. Future research should prioritize longitudinal cohorts, mixed-methods triangulation, standardized reporting of intervention

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fidelity and PPE efficacy, and implementation science frameworks to bridge the persistent gap between safety knowledge, workplace practice, and policy translation in global agricultural sectors.

DISCUSSION

The synthesized evidence from recent agricultural occupational health studies demonstrates a complex interplay between environmental exposures, behavioral determinants, and systemic workplace factors that collectively shape farmer safety outcomes. Across diverse geographic contexts, agricultural producers exhibit highly variable levels of hazard awareness and protective equipment utilization, with strong positive correlations consistently observed between risk knowledge and the adoption of cautious pesticide-handling practices (Wongta et al., 2024). Concurrently, substantial proportions of farmworkers engage in documented high-risk behaviors, including pesticide overconcentration (Sookhtanlou et al., 2022) and inadequate personal protective equipment compliance (Ekmekci & Yaman, 2024; Norvivor et al., 2025), while ambient temperature elevations exhibit a clear monotonic relationship with severe trauma incidence (Cho, 2026). Targeted multicomponent educational interventions have yielded measurable short-term improvements in sun safety knowledge and barrier reduction (El-Shafei & Said, 2023). However, persistent structural determinants, such as piece-rate compensation systems, deteriorating infrastructure, and logistical transportation challenges, continue to mediate injury risk and health disparities (Sexsmith et al., 2022). Collectively, these findings reveal that agricultural occupational hazards operate through multifactorial pathways requiring integrated clinical, educational, and policy-oriented agronursing responses.

These contemporary observations align closely with the established occupational health literature, which consistently identifies knowledge-behavior gaps as a primary barrier to effective hazard mitigation in agrarian settings. Historical agronursing and agricultural medicine research has long documented that awareness of chemical toxicity or ergonomic risks rarely translates into consistent use of protective equipment without concurrent environmental and economic enablers. The present synthesis reinforces this paradigm by demonstrating that farmers who perceive higher health risks from pesticide exposure exhibit significantly safer handling behaviors across all usage phases, yet systemic barriers such as cost, accessibility, and cultural norms surrounding self-reliance continue to impede widespread compliance (Sookhtanlou et al., 2022; Wongta et al., 2024). Furthermore, the documented disconnect between media narratives that individualize farm injury responsibility and the documented structural drivers of occupational harm echoes previous critiques of traditional health communication strategies that neglect upstream policy and regulatory frameworks (Milkovich et al., 2025). Consequently, the current evidence base substantiates the longstanding agronursing assertion that behavioral change models must be embedded within broader ecological and socioeconomic interventions to achieve sustainable safety outcomes.

The monotonic escalation of severe agricultural trauma risk at temperatures exceeding 20°C provides compelling empirical support for integrating thermoregulatory monitoring and heat-stress clinical protocols into routine agronursing assessments. Physiologically, sustained exposure to elevated ambient temperatures exacerbates cardiovascular strain, impairs cognitive decision-making, and accelerates dehydration, all of which compound the likelihood of acute injuries during mechanized operations or chemical handling. Cho's (2026) panel regression analysis substantiates this mechanistic pathway by demonstrating a 123% increase in severe trauma incidence above 30°C, with particularly pronounced risks for harmful substance exposure incidents compared to transportation or fall-related accidents. This temperature-injury trajectory aligns with occupational epidemiology findings that identify heat as a critical modifier of neurocognitive function and motor

coordination in outdoor labor populations (Stufano et al., 2025). Agronursing frameworks must therefore prioritize climate-responsive health surveillance, including pre-shift thermal risk screening, implementation of hydration protocols, and mandatory adjustments to the work-rest cycle during peak heat indices to mitigate physiologically mediated injury cascades.

The persistent prevalence of moderate-to-high stress, anxiety, and depressive symptoms among agricultural producers, despite the absence of a direct statistical association with acute injury reporting, highlights the critical need for integrated mental health screening within agronursing practice. Psychological distress in farming populations is frequently mediated by financial volatility, regulatory uncertainty, social isolation, and the compounding physical demands of seasonal labor, creating a latent vulnerability that may manifest as delayed injury reporting or reduced safety vigilance (Rudolphi et al., 2025). Although the cross-sectional survey did not detect significant correlations between injury occurrence and validated psychometric scales, the existing occupational health literature demonstrates that chronic stress impairs hazard perception, slows reaction times, and increases risk-taking behaviors during equipment operation and chemical application (Pooladvand & Hasanzadeh, 2023). Agronursing interventions must therefore transcend traditional physical hazard assessments to incorporate routine psychosocial evaluations, stress-reduction counseling, and peer-support network facilitation that address the invisible determinants of occupational safety and long-term farmer wellbeing.

Qualitative investigations into immigrant and marginalized farmworker populations consistently reveal that occupational safety perceptions are fundamentally shaped by organizational labor structures, infrastructural deficiencies, and compensation models that prioritize production speed over worker protection. Ethnographic and interview-based data from Pennsylvania mushroom facilities and Ghanaian rural cooperatives illustrate how piece-rate payment systems, poorly maintained walking surfaces, inadequate ventilation, and fragmented chemical handling protocols generate cumulative exposure risks that transcend individual knowledge deficits (Sexsmith et al., 2022; Norvivor et al., 2025). These structural determinants align with established sociotechnical safety models that position workplace design and economic incentives as primary drivers of hazard exposure, particularly among migrant and temporary agricultural laborers who frequently lack regulatory protections or occupational health coverage. Agronursing practice must therefore advocate for structural risk assessments that evaluate payment architectures, housing conditions, equipment maintenance schedules, and chemical storage protocols alongside individual health screenings to address the root environmental causes of agricultural morbidity.

The empirical convergence of behavioral, environmental, and structural risk factors necessitates a paradigm shift in agronursing from episodic injury treatment toward proactive, multidisciplinary occupational health programming that integrates clinical surveillance, environmental modification, and policy advocacy. Effective agronursing models should leverage validated assessment tools, such as the PSS, GAD-7, and PHQ-9, to establish baseline psychosocial and physical health profiles while simultaneously deploying context-specific educational interventions that address localized patterns of hazard exposure (Rudolphi et al., 2025; El-Shafei & Said, 2023). Furthermore, the development of tailored, consensus-driven safety messaging through modified Delphi methodologies demonstrates that collaborative stakeholder engagement yields more feasible, culturally congruent, and behaviorally actionable health recommendations than top-down regulatory mandates (Fazel et al., 2023). By embedding agronursing practitioners within agricultural extension services, occupational safety committees, and rural health networks, healthcare systems can operationalize continuous risk monitoring, facilitate rapid deployment of interventions during extreme weather events, and advocate for legislative

reforms that mandate comprehensive PPE provision, heat-stress protections, and equitable compensation structures for all farm laborers.

Despite the methodological strengths of several included investigations, the synthesized evidence base exhibits notable limitations that constrain the generalizability and causal interpretability of the observed safety-outcome relationships. Predominantly cross-sectional designs inherently restrict temporal inference, particularly regarding the directional relationship among safety knowledge, behavioral adoption, and injury incidence, whereas the absence of longitudinal follow-up in interventional studies limits conclusions about the sustainability of educational gains (Wongta et al., 2024; El-Shafei & Said, 2023). Qualitative and ethnographic studies, though rich in contextual nuance, frequently omit explicit reporting of recruitment strategies, data saturation metrics, and researcher reflexivity, introducing potential selection and interpretive biases that may overrepresent highly vocal or accessible farming subpopulations (Norvivor et al., 2025; Sexsmith et al., 2022). Additionally, media content analyses and ecological regression models, while valuable for identifying macro-level risk patterns and narrative framing, remain susceptible to ecological fallacy and unmeasured confounding variables such as individual mechanization levels, farm ownership structures, and regional regulatory enforcement capacity (Milkovich et al., 2025; Cho, 2026). These methodological constraints underscore the necessity for standardized reporting frameworks and rigorous confounder adjustment in future agricultural occupational health research.

Addressing these methodological constraints requires integrating longitudinal mixed-methods cohorts, implementation science frameworks, and standardized occupational exposure biomarkers into agronursing research protocols to establish definitive causal pathways between hazard mitigation strategies and health outcomes. Future investigations should prioritize prospective study designs that track behavioral adherence, physiological stress markers, and injury trajectories across multiple agricultural seasons while incorporating validated inter-coder reliability metrics and explicit ethical reporting standards to enhance methodological transparency (Eggert et al., 2025). Furthermore, agronursing scholarship must expand its analytical scope to examine intersectional vulnerabilities, including gender, migrant status, and farm scale, thereby ensuring that safety interventions are equitably distributed and culturally responsive to diverse agricultural labor demographics. By aligning clinical nursing competencies with advanced epidemiological modeling, participatory action research, and policy evaluation methodologies, the discipline can systematically bridge the persistent knowledge-practice divide and generate robust, transferable evidence that safeguards the occupational health of global farming communities.

CONCLUSION

The convergence of evidence on agricultural occupational hazards underscores the imperative for agronursing to evolve beyond traditional clinical care toward an integrated, ecologically grounded practice model that simultaneously addresses individual health needs, workplace determinants, and policy-level protections. By synthesizing insights on pesticide safety behaviors, heat-related trauma risks, psychosocial stressors, and structural barriers faced by diverse farming populations, agronursing practitioners are uniquely positioned to operationalize proactive health surveillance, deliver contextually tailored educational interventions, and advocate for systemic reforms that prioritize worker wellbeing alongside agricultural productivity. Embracing interdisciplinary collaboration with occupational health specialists, agricultural extension services, and policy stakeholders, agronursing can bridge the persistent gap between safety knowledge and sustainable practice, ultimately fostering resilient, equitable, and health-promoting agricultural systems that safeguard the livelihoods and dignity of farming communities worldwide.

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