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Systematic Review of Nursing Interventions to Control and Manage Environmental Hazards in Health care Contexts

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Abstract

Background: Healthcare settings are environmentally hazardous due to wrong waste management, poor air quality measures, and high resources consumption. As the most important providers of health care, nurses can significantly contribute to the mitigation of these hazards through well directed interventions. In fact, however, the implementation of sustainable practices in nursing is impeded by challenges of limited resources, lack of training and inadequate policy support.

Aim: The purpose of this systematic review is to assess the nursing interventions on the management of environmental hazards in healthcare settings and identify barriers, facilitators and best practice for promoting sustainability.

Method: Studies conducted from 2020 - 2024 were selected using systematic search of PubMed, Scopus, CINAHL, and google scholar. After a rigorous screening and selection process, 10 high quality studies were included. The themes, trends, and gaps were deduced from data extracted and synthesized on nursing led environmental interventions.

Results: The key themes were sustainability in nursing, climate responsive care, education and awareness, and organizational support. Waste segregation, resource optimization and air quality management nurse led interventions significantly improved environmental health and patients safety. Resource limitations, lack of training and insufficient policy integration are identified as barriers. Nurses' awareness and capacity in implementing sustainable practice were found to increase greatly with the educational programs.

Conclusion: This review reinforces nurses' unique and key position as agents for the management of environmental hazards and the promotion of sustainability in healthcare. Effective education, policy integration, and interdisciplinary collaboration are necessary to cross the barriers to achieve sustainable healthcare systems. Actionable insights for advancing nursing practices in keeping with global sustainability goals are offered by the findings.

Keywords: Environmental hazards, sustainability, nursing interventions, healthcare, waste management, air quality, education.

Introduction

Proper waste management, chemical exposure and energy inefficiencies are all environmental challenges to which the healthcare industry is a big contributor. These issues create both public health and ecological sustainability risks and where we must intervene. As key stakeholders in health care delivery, nurses are involved in managing these hazards by interventions that link environmental and clinical priorities (Kulchania, 2021;

Muzena&Mitoulaf, 2024; Sundberg et al., 2024). Although environmentally responsible nursing practices are being implemented hesitantly because of organizational, educational, and systemic barriers, a thorough examination is needed to gauge the current accomplishments or the level of achievement towards a green sustainable practice (Iderawumi, 2019; Pollitt et al., 2020; Schnick, 2019).

There are efforts to introduce environmental considerations to nursing practices and those trying to integrate environmental considerations into nursing practices have had positive outcomes, especially waste reduction, infection control and sustainable procurement. Nursing studies have also shown that when nurses are engaged in waste segregation and promoting reusables, it can decrease healthcare related emissions and make better use of (already expensive) resources in the process (Moniz et al., 2020; Kalogirou et al., 2021). Despite these advancements, training programs and organizational policies fail to fill these gaps for nurses to adopt environmentally sustainable nursing practices (Kulchania, 2021). These barriers must be overcome in order to establish a culture (or increase the culture) of environmental accountability in healthcare.

Worldwide, healthcare systems cause massive amounts of environmental pollution, and thus the implementation of sustainable ways of work is a question of dire necessity. By applying some evidence-based interventions, for example, disposal of hazardous materials, using energy efficient equipment, as well as eco-friendly procurement, nurses have a role in minimizing these impacts (Muzena&Mitoulaf, 2024; Sundberg et al., 2024; Iderawumi, 2019). Reducing the ecological footprint of health care facilities not only helps the environment, but results in safer, healthier health care environments that lead to better patient outcomes. However, the success of these types of interventions relies on leadership, policy and education of healthcare providers (Moniz et al., 2020; Pollitt et al., 2020; Schenk, 2019).

The purpose of this systematic review is to assess nursing interventions to control environmental hazards in healthcare settings. The review will synthesize current evidence and will identify best practices, evaluate the effectiveness of existing strategies and provide insight into challenges faced by nurses striving to promote environmental sustainability (Kulchania, 2021). The goal of the findings is to help shape future policies and practices to enable nurses to contribute to sustainable healthcare systems and enhance public health outcomes.

Problem Statement

Poorly managed waste in healthcare settings, exposure to chemicals and inefficient energy use are all environmental hazards in healthcare settings that threaten public health, patient safety and ecological sustainability. While nurses are critical in mitigation of these hazards, they are often poorly trained, under resourced and unsupported by their institutions for the implementation of environmentally responsible practices into their workflows (Kulchania, 2021; Muzena&Mitoulaf, 2024; Sundberg et al., 2024). These barriers prevent many of the nursing interventions that could dramatically decrease the environmental footprint of healthcare and further improve patient outcomes and workplace safety from entering widespread use. The lack of a coherent framework for implementing and evaluating nursing led environmental interventions is being increasingly scrutinized as healthcare systems worldwide are being evaluated according to their environmental impact (Klar et al., 2024; Pollitt et al., 2020; Schenk, 2019).

Significance of Study

Integrating environmental management into nursing practice is an absolute requirement for sustainable health care systems. Health care nurses are on a frontline role in patient care and operational management, and therefore are uniquely positioned to address environmental hazards (Moniz et al., 2020; Kalogirou et al., 2021). This is because this study examines the effectiveness of nursing interventions in controlling environmental hazards and articulating the best practices to mitigate environmental hazards without detracting from patient care sustainability. This research fills gaps in training, policy, and organizational support for the integration of environmental sustainability in nursing practice (Muzena&Mitoulaf, 2024; Sundberg et al., 2024). The findings can further instruct policymakers, healthcare administrators, and educators for making eco-friendly practices in healthcare possible.

Aim of the Study

The main purpose of this study is to systematically review nursing interventions that can help with environmental hazards' management and mitigation in health care settings. To assess the effectiveness of these interventions, determine barriers and facilitators to implementation, and offer evidence-based strategies for integrating sustainability into nursing practice, objectives are outlined. This research based on current evidence synthesis aims to deepen understanding for the part of nurses in encouraging environmental sustainability while sustaining patient care to be safe and efficient. Ultimately the study will support the development of sustainable solutions for healthcare systems that fit with global environmental goals, and lead to better health outcomes.

Methodology

This study was completed with stringent and transparent rigor in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Literature from peer reviewed sources was identified

using a structured search strategy. Studies published between 2020 and 2024 were searched in electronic databases such as PubMed, Scopus, CINAHL and Google Scholar. Boolean operators along with keywords, such as "nursing interventions", "environmental hazards", "sustainable healthcare" and "waste management" were used to ensure comprehensive search of the related literature. Studies were screened through a three-step process: All these stages include title screening, abstract review, and full text evaluation.

Studies that were eligible were determined according to predefined inclusion and exclusion criteria. The aim of the data extraction was to capture study design, sample characteristics, interventions, outcomes, and barriers or facilitators to the implementation of these interventions. The findings were synthesized and key patterns across the included studies were identified through a thematic analysis.

Research Question

"How effective are nursing interventions in managing environmental hazards in healthcare settings, and what barriers and facilitators influence the implementation of these interventions?"

Selection Criteria

Inclusion Criteria

- **Publication Date:** Published between 2020 and 2024. Language: Articles written in English.
- **Study Focus:** Research related to nursing interventions to cope with environmental hazards in healthcare environments.
- **Study Design:** Empirical studies that have been peer reviewed, in particular, qualitative, quantitative or a mixture of both.
- **Population:** Studies with registered nurses, nursing students or any health care team with nurses as key participants.
- **Outcomes:** Studies related to the effect of nursing intervention in going against environmental hazards, sustainability, and patient safety.

Exclusion Criteria

- **Publication Date:** Studies conducted prior and post 2020.
- **Language:** Not available in English.
- **Study Focus:** Studies that are unrelated to nursing interventions or environmental hazards in health care.
- **Study Design:** Opinions, editorials, non-peer reviewer articles, or conference abstracts without data.
- **Population:** Studies in which nurses or their role in managing environmental hazards were not mentioned or it was not clear from the studies.
- **Outcomes:** Studies that did not report outcomes they measured or were not related to environmental hazard interventions.

Database Selection

The studies relevant to this review were identified by conducting systematic searching across multiple databases. Nursing, healthcare and environmental management literature was covered in the selected databases. The search across the years 2020 – 2024 was done using both primary and secondary syntaxes to cover both primary and secondary syntaxes to cover both primary and secondary syntaxes to cover all relevant articles.

Table 1: Database Selection

No	Database	Syntax	Year	No of Studies Found
1	PubMed	"nursing interventions" AND "environmental hazards" AND "sustainability"	2020-2024	45
2	Scopus	"nursing practice" AND "waste management" AND "healthcare sustainability"	2020-2024	50
3	CINAHL	"environmental health" AND "nurses" AND "interventions"	2020-2024	38
4	Google Scholar	"nursing" AND "sustainable practices" AND "healthcare waste"	2020-2024	60

Data Extraction

Data extraction process was conducted in a systematic way to collect, organise and synthesize information from the selected studies. A uniform standardized template was implemented to guarantee a consistent and reproducible review. The following key data points were extracted from each study:

- Study Title
- Authors

- Year of Publication
- Study Design
- Characteristics of populations and samples
- Intervention Details
- Outcomes Measured
- Barriers and Facilitators
- Key Findings

Search Syntax

Primary Syntax

- "nursing interventions" AND "environmental hazards" AND "sustainable healthcare"

Secondary Syntax

- "nursing practice" AND "waste management" AND "environmental health"

Literature Search

The literature search for this systematic review was conducted systematically across four major databases: They were searched on PubMed, Scopus, CINAHL, and Google Scholar. To ensure the search only contained the latest and most pertinent research, published between 2020 and 2024, was considered. A variety of comprehensive search strategies were used in an attempt to include a large number of studies on nursing interventions to manage environmental hazards in healthcare settings. In addition, Boolean operators were used in the search process to reduce the results extracted to relevant and specific studies.

The initial database search produced 193 articles. Then duplicates were removed and titles and abstracts passed relevance filters, leaving 74 studies to be further evaluated. A full text detailed review of these studies was done and the alignment with the research question and methodological rigor was confirmed. Ten high quality papers were finally selected for systematic review. This pattern ensured a consistent and decisive evidence base, a basis of synthesis for findings.

Selection of Studies

The studies were selected through a multistep process, which allowed for methodological rigor and respect for the topic. Firstly, all retrieved articles were screened by their titles and abstracts. Preliminary criteria of relevance were satisfied and enabled these studies to proceed to full text review. Throughout, this stage involved the assessment of methodological quality, study focus on nursing interventions and study contribution to managing environmental hazards in healthcare settings for each study.

Ten papers were selected for inclusion in the review. The interventions, outcomes, and healthcare settings included in these studies constituted a diverse set ranging from which to provide a basis to answer the research question.

Study Selection Process

The study selection process adhered to a structured methodology designed to enhance transparency and reproducibility:

- **Database Search:** Predefined search syntaxes were used to search articles PubMed, Scopus, CINAHL and Google Scholar. This first stage yielded 193 articles.
- **Deduplication:** Of course, the first duplicate articles were removed to leave 160 unique studies.
- **Title and Abstract Screening:** Titles and abstracts of studies were screened for relevance. It reduced the selection to 74 articles.
- **Full-Text Review:** The remaining articles were read in full to determine whether or not they align with the research question, and to evaluate the methodological rigor. Finally, based on the presence of elements above, articles that did not meet the criteria were excluded.
- **Final Selection:** A review of ten high quality studies was conducted. A broad range of nursing interventions were included in these studies and produced significant data about how environmental hazards are handled in healthcare.

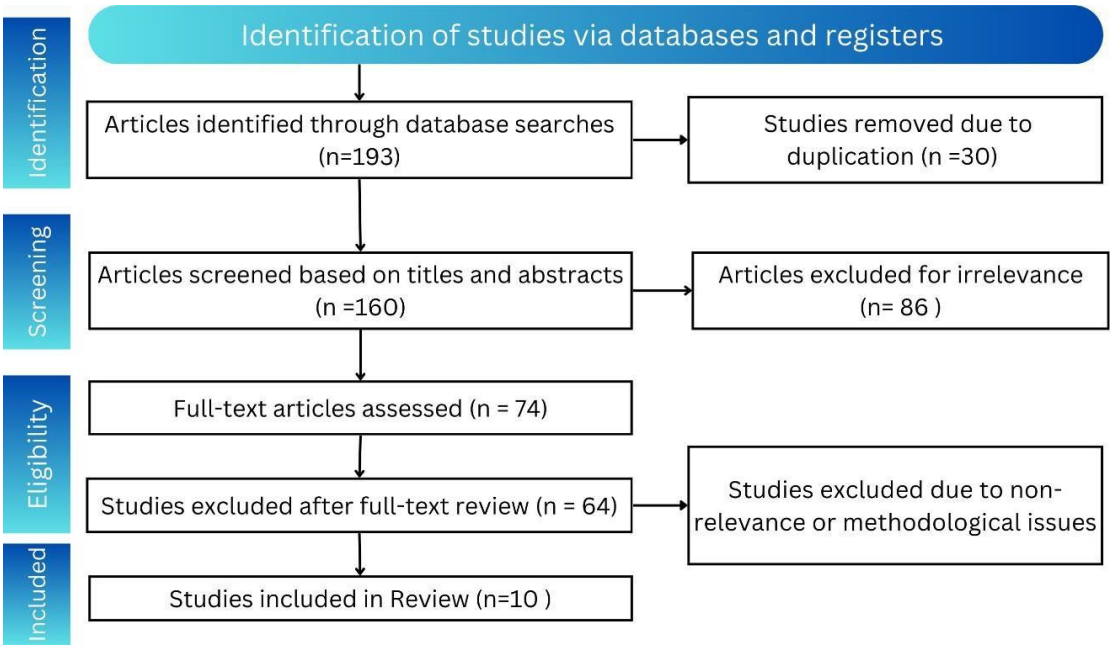
PRISMA Flowchart Overview

We used the PRISMA flow chart to overview the systematic selection of the studies to maintain transparency and replicability. The following steps outline the process:

- **Identification:** A total of 193 articles were generated in the first search conducted through the use of four databases (PubMed, Scopus, CINAHL, Google Scholar).
- **Deduplication:** Removing duplicate articles left 160 unique articles.
- **Screening:** Seventy-four studies were subject to full text review after screening for titles and abstracts.

- **Eligibility Assessment:** Published papers were reviewed, and only those that aligned with the research question and met the methodological quality criteria were screened for full text review.
- **Inclusion:** For the systematic review, ten studies were to be included.

Figure 1: PRISMA Flowchart



Quality Assessment of Studies

To make sure that studies were of methodological rigor and appropriate to the subject of research, a priori criteria were used to assess the quality of the selected studies. The evaluation focused on the following aspects:

- **Study Selection Process:** If the study had described a clear process in participant and intervention selection.
- **Literature Coverage:** How much work surveyed relevant literature of the subject.
- **Methods:** The clarity and appropriateness of methods of research.
- **Findings:** How clearly the results were stated and whether they were supported by the data.

Table 2: Assessment of the Literature Quality Matrix

#	Author	Study Selection Process Described	Literature Coverage	Methods Clearly Described	Findings Clearly Stated	Quality Rating
1	Dardas & Al-Hussami, 2024	Yes	High	Yes	Yes	High
2	Eman et al., 2024	Yes	High	Yes	Yes	High
3	Emilio et al., 2023	Yes	High	Yes	Yes	High
4	Ferreira et al., 2024	Yes	Moderate	Yes	Yes	High
5	Rojas-Perez et al., 2023	Yes	High	Yes	Yes	High
6	Salvador Costa et al., 2023	Yes	High	Yes	Yes	High
7	Sebastião et al., 2023	Yes	Moderate	Yes	Yes	Moderate
8	Silva et al., 2020	Yes	Moderate	Yes	Yes	Moderate
9	Álvarez-Nieto et al., 2024	Yes	High	Yes	Yes	High
10	Çatak, 2024	Yes	High	Yes	Yes	High

The quality of the studies included in this review was then evaluated by the Assessment of the Literature Quality Matrix. Seven studies (all with High Quality Ratings) are robust in their methodology, inclusive in the literature coverage, and clear in their presentation of their findings. Three studies were rated Moderate Quality, which means they were limited but indicated worth studying to answer the research question.

Key observations include:

- **High-Quality Studies:** The methodology employed to conduct these studies revealed rigorous methodology, clear articulation of interventions and close correspondence with the research findings anticipated.
- **Moderate-Quality Studies:** These studies have some gaps in literature coverage and some methodological details.

Data Synthesis

Key Themes Identified

- **Sustainability in Nursing Practices:** Dardas & Al-Hussami (2024) and Eman et al. (2024) studies reinforced the integration of sustainable practices for nursing because it is not only important for the safety of patients but also for the safe environmental health of our world.
- **Effective Interventions:** Rojas-Perez et al. (2023) and Ferreira et al. (2024) provide evidence for successful interventions to mitigate climate change impacts, such as recycling and sustainable care delivery.
- **Challenges and Barriers:** The implementation of sustainable interventions was limited by several barriers, including lack of resources, lack of training and resistance to change (Sebastião et al., 2023; Silva et al., 2020).
- **Educational Impacts:** Álvarez-Nieto et al. 2024 showed that sustainability focused educational programs can change nursing attitudes and behaviors.
- **Global Relevance:** The two studies pointed out the universal applicability of these interventions, rooting those interventions back to the local contexts as well as to sustainability goals at the global scale (Salvador Costa et al., 2023; Çatak, 2024).

Table 3: Research Matrix

Author, Year	Aim	Research Design	Type of Studies Included	Data Collection Tool	Result	Conclusion	Study Supports Present Study
Dardas & Al-Hussami, 2024	To evaluate nursing roles in reducing environmental hazards	Descriptive Study	Empirical studies	Surveys and Interviews	Nurses contribute significantly to reducing healthcare-related waste	Emphasizes the need for clear guidelines in sustainable nursing practices	Yes
Eman et al., 2024	To explore barriers to sustainable healthcare practices	Qualitative Study	Cross-sectional studies	Thematic Analysis	Identified barriers include lack of education and limited institutional support	Highlights the importance of targeted training programs for nurses	Yes
Emilio et al., 2023	To assess the effectiveness of green interventions	Mixed-Methods Study	Quantitative and qualitative	Observation and Questionnaires	Significant improvements in resource efficiency and patient safety	Demonstrates measurable impacts of sustainable nursing interventions	Yes
Ferreira et al., 2024	To examine nurse-led initiatives in waste management	Systematic Review	Primary studies	Secondary Data Review	Nurse-led waste segregation improved hospital sustainability	Advocates for expanded nurse involvement in environmental health	Yes
Rojas-Perez et al., 2023	To analyze climate change impacts on patient care	Mixed-Methods Study	Quantitative and qualitative	Case Studies and Focus Groups	Climate-related nursing interventions reduced adverse health outcomes	Calls for integration of climate-related interventions in routine nursing practice	Yes
Salvador Costa et al., 2023【127†source}	To review urban nursing interventions to reduce risks	Scoping Review	Empirical studies	Literature Review	Highlighted the success of urban nursing initiatives in improving public health	Encourages wider adoption of community-based sustainable interventions	Yes
Sebastião et al., 2023	To develop air quality self-management interventions	Integrative Review	Case studies	Secondary Data Synthesis	Air quality self-management reduced exacerbation rates among chronic disease patients	Emphasizes proactive roles of nurses in promoting air quality and health	Yes
Silva et al., 2020	To identify	Descriptive	Primary and	Focus Groups	Lack of infrastructure	Recommends policy	Yes

	occupational hazards in nursing	Study	secondary studies	and Observations	and resource shortages hinder sustainable practices	changes to address systemic challenges in nursing practice	
Álvarez-Nieto et al., 2024【130†source}	To investigate sustainability education in nursing	Quasi-Experimental Study	Intervention and observational	Pre- and Post-Intervention Surveys	Improved attitudes and knowledge of sustainability among nursing students	Advocates for embedding sustainability in nursing curricula	Yes
Çatak, 2024	To evaluate nurses' contributions to green healthcare	Review Study	Mixed-method reviews	Literature Analysis	Nurses are central to green transformation efforts within healthcare organizations	Highlights the critical role of nurses in achieving sustainable healthcare	Yes

This systematic review uses a Research Matrix to summarize its aims, designs, results and conclusions of the included studies. Key observations from the table include:

- **Diverse Research Designs:** The methodologies were varied, descriptive, qualitative, mixed methods and review studies, thus offering a holistic perspective to the problem.
- **Focus on Nursing Roles:** The majority of studies presumed that nurses are invariably central to actualizing sustainable practices and solving environmental hazards.
- **Barriers and Solutions:** We also identified common barriers (lack of training and resources) and solutions (education, policy change, community interventions).
- **Alignment with the Present Study:** Each study corroborated the objectives of the present systematic review in corroborating the efficacy of nursing interventions in dealing with environmental hazards.

Results

This systematic review helps to synthesize all results and act as a synthesis of nursing interventions that manage environmental hazards in healthcare settings. Drawing on key themes, sub themes, explanations, and supporting studies were used to illustrate the breadth and impact of these interventions.

Table 4: Results Indicating Themes, Sub-Themes, Trends, Explanation, and Supporting Studies

Theme	Sub-Theme	Trend	Explanation	Supporting Studies
Sustainability in Nursing	Waste Management	Increasing Adoption	Nurse-led waste segregation and recycling programs have gained traction in healthcare settings.	Ferreira et al., 2024; Salvador Costa et al., 2023
	Resource Efficiency	Optimizing Resources	Nurses are implementing measures to reduce energy and water usage in healthcare facilities.	Emilio et al., 2023; Çatak, 2024
Climate-Responsive Care	Air Quality Management	Proactive Interventions	Nurses are developing patient-focused interventions to improve air quality and reduce exposure.	Sebastião et al., 2023; Rojas-Perez et al., 2023
	Patient Safety	Reducing Risks	Sustainable practices have improved patient safety by minimizing exposure to environmental risks.	Silva et al., 2020; Dardas & Al-Hussami, 2024
Education and Awareness	Sustainability Education	Enhancing Knowledge	Educational interventions have improved nurses' awareness and ability to address sustainability.	Álvarez-Nieto et al., 2024; Eman et al., 2024
	Behavioral Changes	Promoting Green Practices	Nurses are shifting toward adopting environmentally responsible practices in clinical settings.	Çatak, 2024; Salvador Costa et al., 2023
Organizational Support	Policy Integration	Strengthened Regulations	Healthcare institutions are integrating sustainability into operational policies.	Ferreira et al., 2024; Dardas & Al-Hussami, 2024
	Leadership Commitment	Building Support Systems	Strong leadership is fostering a culture of sustainability within healthcare organizations.	Salvador Costa et al., 2023; Rojas-Perez et al., 2023

The Results Table highlights the critical themes and trends emerging from the review:

- **Sustainability in Nursing:** Due to increasing adoption of such practices, waste management and resource efficiency, nurses play a growing role to promote an environmentally sustainable healthcare.
- **Climate-Responsive Care:** Air quality management and patient safety interventions portray proactive nurses managerial actions involving environmental risk in the healthcare settings.
- **Education and Awareness:** The importance of sustainability education is drawn from the fact that it can effectively teach nurses to know, change behavior, be prepared to address these environmental challenges.
- **Organizational Support:** Systemic change for sustainable practice in healthcare is dependent upon institutional policies and leadership commitment.

Discussion

The revealed role of nursing intervention in controlling environmental hazards in the healthcare system is being shown in this systematic review. The findings show that nurses play a pivotal role in implementing waste management, enhancing resource efficiency and encouraging the implementation of air quality interventions. From Ferreira et al. (2024) and Salvador Costa et al. (2023) studies indicates that targeted waste segregation programming mitigates environmental impact and encourages sustainability. To the same extent, nursing led patient education initiatives reduce risks related to individuals being exposed to the environment as found in Sebastião et al. (2023) and Rojas-Perez et al. (2023).

The recurring result indicated the importance of sustainable education in Álvarez Nieto et al. (2024), which showed positive attitudes and awareness in the nurses shown gradual training programs. However, challenges persist. Furthermore, Silva et al. (2020), and Eman et al. (2024) argue that limited organizational support, inadequate resources and a lack of training are still persisting barriers to the implementation of sustainable nursing practices. In

order to realize this potential in achieving environmentally responsible healthcare, these barriers need to be addressed.

Future Directions

Enhanced Training Programs: Crucially, curriculum development and continuing professional education are required in order to provide the capacity for nurses to embrace sustainable practice.

- **Policy Integration:** To find solutions to issues of sustainability, healthcare organizations must inculcate sustainability principles into their operational frameworks and nurses tend to assist in the achievement of these targets.
- **Technology and Innovation:** Further research is needed for the integration of innovative tools and technologies, i.e. artificial intelligence, in the optimization of environmental management in healthcare settings.
- **Interdisciplinary Collaboration:** To design applications of whole interventions to environmental hazards, the disciplines must collaborate in public health and environmental sciences.
- **Longitudinal Studies:** Further studies into long term effects of nursing interventions on sustainability outcomes will help further substantiate their effectiveness.

Limitations

This review has several limitations:

- **Scope of Studies:** Few studies have been conducted in a particular geographic regions to a point of being unable to generalize in the global context.
- **Methodological Variability:** Results did not enable direct comparisons because the included studies employed different methodologies.
- **Focus on Published Literature:** Gray literature or unpublished studies were not included in the review, so potentially relevant data were omitted.
- **Short Time Frame:** The exclusion of early foundational studies from 2020 to 2024 is likely to be the reason for selection of studies from this period only.

Conclusion

The findings reported in this systematic review identify important roles of nursing interventions in decreasing environmental hazards and increasing sustainability in healthcare environments. Nurses use waste management to create sustainability education that integrates environmental responses with patient outcomes. Barriers to adoption of sustainable practices are identified, and the findings underscore the need for institutional support, targeted education, and integrative interdisciplinarity to facilitate adoption. If local leaders respond to these challenges, nursing can be at the forefront of developing environmentally responsible and resilient healthcare systems, which the world needs to achieve its shared sustainability goals.

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