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Bridging the Knowledge Gap: A Cross-Sectional Study on Sustainability Awareness Among Nurses

Authors **Ikram Zeyad Hamid[1] & Radhwan Hussein Ibrahim[2*]**

Affiliation
1. *College of Nursing, University of Mosul, City of Mosul, Iraq*
2. *College of Nursing, Ninevah University, City of Mosul, Iraq*

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Abstract

Background: Sustainability in healthcare is a growing global priority; however, the knowledge and integration of sustainable practices among nurses remain limited, especially in developing regions. Nurses play a critical role in promoting environmentally responsible behaviors in clinical settings.

Aim: This study aimed to assess the current level of knowledge among nurses regarding sustainability and evaluate the effectiveness of an educational intervention in enhancing their understanding.

Methods: A quasi-experimental pre-post design was used, involving 33 nurses from selected healthcare facilities in Mosul, Iraq. Data were collected through a structured questionnaire before and after a targeted educational training session on sustainability concepts, environmental health, patient advocacy, and practical implementation.

Results: Pre-intervention findings indicated low levels of knowledge in several key areas of sustainability. After the intervention, significant improvements were observed in understanding core sustainability principles, environmental health risks, and the role of nurses in promoting sustainable practices. However, gaps remained in areas such as renewable energy use and initial planning strategies for sustainability actions.

Conclusion: The educational intervention was effective in increasing nurses' knowledge of sustainability. Integrating sustainability education into nursing practice and curricula can empower nurses to contribute more actively to environmentally sustainable healthcare systems

What is already known about the topic?

- ***Sustainability in healthcare*** *is essential for reducing the environmental impact of health services, addressing climate change, and ensuring the long-term viability of healthcare systems.*
- *Nurses, as frontline healthcare providers, play a* ***crucial role*** *in implementing and advocating for sustainable practices within clinical settings.*

*** Corresponding author.** **Radhwan Hussein Ibrahim**
E-mail address: prof.dr.radhwan@uomosul.edu.iq
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Introduction

The healthcare sector plays a crucial role in promoting public health and well-being, but it also significantly contributes to environmental degradation through high energy consumption, excessive waste generation, and resource depletion (Karliner et al., 2020). In response, sustainable healthcare has emerged as a pivotal global objective, emphasizing the importance of reducing environmental impact while maintaining high-quality patient care (World Health Organization [WHO], 2017). Sustainability in healthcare involves integrating eco-friendly practices, such as proper waste management, energy conservation, and the use of renewable resources, into daily clinical operations to ensure long-term viability of health systems (Sherman et al., 2019).

Nurses, as the largest group of healthcare professionals, are uniquely positioned to lead sustainability efforts within healthcare institutions. Their frontline role enables them to influence clinical practices, patient education, and institutional policies toward environmentally responsible behaviors (Anåker & Elf, 2014). However, evidence suggests that many nurses lack the foundational knowledge necessary to actively engage in sustainable practices (Goodman et al., 2020). Limited awareness and training on sustainability have been identified as major barriers to implementing green healthcare initiatives (Richardson et al., 2019).

In Iraq and similar developing countries, the integration of sustainability into healthcare education and practice remains in its infancy. A growing need exists to assess and improve nurses' understanding of sustainability to align with international standards and support environmentally sound healthcare systems. By evaluating baseline knowledge and implementing educational interventions, healthcare institutions can foster a culture of sustainability that aligns with global goals, such as the United Nations' Sustainable Development Goals (SDGs), particularly SDG 3 (good health and well-being) and SDG 13 (climate action) (United Nations, 2015).

Aim of the Study

This study aims to assess the current level of knowledge related to sustainability among nurses and to evaluate the effectiveness of an educational intervention designed to enhance their understanding and application of sustainable practices in healthcare settings.

Methods

Study Design

This study employed a **quasi-experimental pre-post design** without a control group to evaluate the effectiveness of an educational intervention on nurses' knowledge regarding sustainability in healthcare. This design was selected to assess changes in participants' knowledge before and after the training program in a real-world clinical setting.

Setting of the Study

The study was conducted in selected healthcare facilities within Mosul City, Iraq. These facilities included hospitals and healthcare centers that provide both inpatient and outpatient services. The selection of sites was based on their accessibility, diversity of nursing staff, and relevance to sustainability-related practices in clinical environments.

Sample and Sampling Method

The study targeted registered nurses working in various departments of the selected healthcare facilities. A **non-probability convenience sampling** technique was used to recruit participants who were available, willing to participate, and met the inclusion criteria.

The final sample size included **33 nurses**, reflecting diverse demographic characteristics such as age, gender, educational background, and years of experience.

Inclusion Criteria:

- Registered nurses currently working in public or private healthcare settings.
- Willingness to participate and provide informed consent.
- Availability to attend both the pretest and the posttest sessions.

Exclusion Criteria:

- Administrative staff or nurses not involved in direct patient care.
- Nurses who were on leave or absent during the intervention.

Instrumentation and Data Collection Tools

Data were collected using a structured questionnaire developed by the research team based on current literature and expert consultation. The tool consisted of **multiple-choice questions and true/false items** designed to assess knowledge across six domains:

1. **Introduction to Sustainability**

2. **Sustainable Healthcare Practices**
3. **Environmental Health**
4. **Technology and AI in Sustainability**
5. **Patient Education and Advocacy**
6. **Practical Implementation and Monitoring**

Each item was scored as correct or incorrect, with no partial credit awarded. The same instrument was used for both pretest and posttest assessments to ensure consistency and comparability.

Educational Intervention

An **educational training session** was developed and implemented based on the knowledge gaps identified in the pretest results and relevant literature. The session included:

- Lectures and presentations (PowerPoint-based).
- Case-based discussions on sustainability practices.
- Interactive Q&A with real examples from local hospitals.
- Printed materials covering core concepts and best practices.

The duration of the intervention was **90 minutes**, conducted in a seminar room within the hospital premises to ensure accessibility.

Data Collection Procedure

The data collection process involved three stages:

1. **Pretest**: Administered immediately before the educational session.
2. **Intervention**: Delivered through an in-person training workshop.
3. **Posttest**: Conducted one week after the intervention to evaluate knowledge retention.

All questionnaires were coded and anonymized to maintain participant confidentiality. Participants were instructed not to discuss their answers with others to prevent response bias.

Validity and Reliability

The content validity of the questionnaire was established through expert review by professionals in nursing education, public health, and environmental sustainability. A pilot test was conducted with a small group of nurses (excluded from the main sample) to ensure clarity and appropriateness of the items. The internal consistency of the

questionnaire was measured using Cronbach's alpha, which yielded an acceptable value of ≥ **0.70**.

Results

The study included a total of 33 nurses, with the majority (72.7%) aged between 22 and 30 years. Male participants represented 63.6% of the sample, while females comprised 36.4%. Most of the nurses (69.7%) resided in city centers, and the distribution of experience was nearly even, with 48.5% having less than 5 years of experience and 51.5% having more. Regarding educational background, 45.5% of participants held a bachelor's degree, followed by 33.3% with diplomas and 21.2% who completed secondary school.

The pretest findings revealed that nurses demonstrated limited baseline knowledge of sustainability in healthcare. For example, only 42.4% correctly identified the concept of sustainability, and just 18.2% recognized its three fundamental pillars. Practical knowledge was slightly better, with 54.5% identifying the role of sustainability in improving patient outcomes and 63.6% understanding the importance of renewable energy. However, a large portion of participants struggled with topics such as sustainable waste management and water usage reduction. Following the educational intervention, posttest results showed marked improvement across all areas. Notably, 90.9% correctly identified the three pillars of sustainability, and 90.9% understood how sustainability improves patient outcomes. Additionally, 78.8% demonstrated knowledge of waste management practices, and 81.8% understood the importance of renewable energy.

In terms of technology and artificial intelligence (AI) in sustainability, the pretest indicated moderate awareness, with 51.5% of nurses identifying the role of technology and only 45.5% recognizing the use of AI in sustainability practices. These percentages increased to 66.7% and 63.6%, respectively, after the training session, suggesting moderate but meaningful gains in this domain.

Environmental health knowledge among nurses also improved significantly. In the pretest, awareness of environmental factors affecting air quality and chemical exposure was moderate (51.5%–54.5%). However, knowledge about practical strategies to reduce environmental health risks was limited, with only 18.2% answering correctly. Post-intervention, 100% of participants correctly identified strategies to reduce risks, and over 80% showed improved understanding of air quality, chemical exposure, and the role of nurses in promoting environmental health.

Knowledge regarding sustainable healthcare practices also improved notably. Prior to training, the majority of nurses were familiar with types of medical waste (72.7%) but showed poor knowledge of water conservation (15.2%) and renewable energy sources (15.2%). After the intervention, correct responses increased to 93.9% for waste types, 54.5% for water conservation, and 39.4% for renewable energy sources. Knowledge of sustainable purchasing criteria and patient education goals also improved, though less dramatically.

The results also demonstrated a significant increase in knowledge related to patient education and advocacy. Initially, 60.6%–78.8% of participants understood the nurse's role in promoting sustainability and how to communicate it to patients. Posttest results showed 93.9% of nurses correctly answered all questions in this domain, reflecting comprehensive improvement in advocacy-related knowledge.

Lastly, practical implementation knowledge also improved. While 93.9% of nurses were already aware of the healthcare team's role in sustainability, only 15.2% initially knew the first step in creating a sustainability action plan. Posttest data showed increased awareness of practical aspects such as resource allocation (87.9%), community engagement (93.9%), and use of case studies (87.9%). However, knowledge of the first planning step remained low, with only 30.3% answering correctly, indicating a continued gap in foundational implementation strategy.

Overall, the intervention was effective in enhancing nurses' knowledge of sustainability across all domains, with the most significant gains observed in foundational concepts, environmental risk strategies, and advocacy efforts. However, specific areas such as renewable energy and initial planning steps still require further educational reinforcement.

Table 1: Demographic Characteristics of Participants

Variables	No	%
Age 22-30	24	72.7
Age 31-40	7	21.2
Age 41-50	2	6.1
Male	21	63.6
Female	12	36.4
City Center	23	69.7
Rural	10	30.3
Less Than 5 Years	16	48.5
More Than 5 Years	17	51.5
Secondary School	7	21.2
Diploma	11	33.3
Bachelor	15	45.5

Table 2: Pretest vs Posttest - Sustainability Concepts

Statement	Pretest Correct (%)	Posttest Correct (%)
Concept of sustainability in healthcare	42.4	69.7
Three pillars of sustainability	18.2	90.9
Sustainability improves outcomes	54.5	90.9

Table 3: Posttest Results - Environmental Health Knowledge

Statement	Correct (%)
Factors affecting air quality	78.8
Health effects of poor air	78.8
Chemical exposure	81.8
Diseases from climate change	84.8
Nurse's role in environmental health	81.8
Environmental risks for nurses	78.8
Strategies to reduce environmental risks	100.0

Discussion

The present study aimed to assess the level of knowledge related to sustainability among nurses and evaluate the effectiveness of an educational intervention. The findings revealed a significant improvement in nurses' understanding of sustainability concepts, environmental health, patient advocacy, and practical implementation following the

intervention, demonstrating the value of targeted educational programs in promoting sustainable healthcare practices.

Before the intervention, baseline knowledge among nurses was limited across several domains. Only 42.4% of participants correctly identified the concept of sustainability in healthcare, and just 18.2% recognized its three fundamental pillars. This aligns with previous research that has highlighted a general lack of sustainability training in nursing education, particularly in low- and middle-income countries (Richardson et al., 2019; Anåker & Elf, 2014). Nurses often lack exposure to structured education on topics such as environmental health, climate change, and sustainable clinical practices, which hinders their ability to contribute effectively to sustainability initiatives within healthcare institutions (Goodman & East, 2020).

Post-intervention results demonstrated substantial gains in knowledge across all areas. Understanding of the three pillars of sustainability improved to 90.9%, and comprehension of the role of sustainability in improving patient outcomes also rose to 90.9%. This indicates that brief, well-structured educational interventions can significantly enhance awareness, even among those with initially low baseline knowledge. These findings are consistent with Karliner et al. (2020), who emphasized that education is a critical driver for integrating sustainability into health systems.

Knowledge related to environmental health also improved notably. Prior to the intervention, only about half of the participants were aware of air quality factors and chemical exposure. After the training, over 80% of nurses correctly answered questions on these topics, and 100% accurately identified strategies to reduce environmental risks. These outcomes highlight the growing recognition among healthcare workers of the connection between environmental hazards and public health, especially in the context of global climate challenges (Sherman et al., 2019).

Despite the improvements, some areas still showed knowledge gaps. For instance, understanding of the first steps in creating a sustainability action plan remained low, even after the intervention (30.3%). This may indicate that while general awareness can be raised quickly, deeper strategic thinking and planning skills require more sustained and

experiential learning approaches. Similarly, knowledge regarding renewable energy and sustainable purchasing remained relatively limited post-intervention, suggesting the need for more focused training in these domains.

An encouraging finding was the high level of post-intervention knowledge related to patient education and advocacy. More than 90% of nurses showed improved understanding of their role in educating patients and promoting sustainable health behaviors. This is crucial because nurses are in a unique position to influence patient behavior and support environmentally conscious decision-making in healthcare settings (WHO, 2017; United Nations, 2015).

In summary, the results demonstrate that nurses are receptive to sustainability education and that such interventions can substantially increase their knowledge across various domains. However, for long-term impact, sustainability should be integrated into ongoing professional development programs, nursing curricula, and institutional policies.

Conclusion

This study aimed to assess the level of knowledge related to sustainability among nurses and to evaluate the effectiveness of an educational intervention in improving that knowledge. The findings revealed that nurses initially possessed limited understanding of sustainability concepts, particularly in areas such as the foundational principles of sustainability, environmental health risks, and the practical steps for implementing sustainable practices in healthcare settings.

However, the educational intervention led to significant improvements across all assessed domains. Participants demonstrated notable gains in their understanding of sustainability's role in improving patient outcomes, environmental health strategies, and the importance of advocacy and education in promoting sustainable behaviors. These results underscore the effectiveness of structured, targeted training in raising awareness and empowering nurses to engage in environmentally responsible healthcare practices.

Despite the overall improvement, certain areas such as strategic planning and the integration of renewable energy remained weak even after the intervention. This suggests the need for continuous, long-term educational efforts and integration of sustainability into nursing curricula and professional development frameworks.

In conclusion, enhancing nurses' knowledge of sustainability is both feasible and impactful. By empowering nurses with the knowledge and skills to implement sustainable healthcare practices, institutions can make meaningful contributions toward environmental protection, patient safety, and the achievement of global sustainability goals.

Conflict of interest

I declare that there are NO conflicts of interest

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Institutional Review Board Statement

Ethical approval was obtained from the **College of Nursing, University of Mosul** (Code: CCMRE-Nur-24-4). Administrative permission was secured from the Nineveh Directorate of Health (**Approval No. 39**). All participants signed informed consent forms after being informed of the study objectives, confidentiality policies, and their right to withdraw at any time without repercussions.

Data privacy and participant confidentiality were maintained throughout the study. Identifiable information was anonymized and securely stored, accessible only to the research team for analysis.

Informed Consent Statement**:** Not applicable.

Data Availability Statement: Available from the corresponding author upon reasonable request.

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