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GREEN EDUCATION IN HEALTHCARE: WHAT DOES IT MEAN? FINDINGS FROM A LITERATURE REVIEW

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Sustainability is an emerging issue in many contexts, including education: the targets of the World Health Organization's Agenda 2030 have pushed for sustainable development of health systems, including training and digitalization. The aim of the study was to identify green and sustainable strategies in different health education settings, in particular in the digital field, through a literature review. Sustainable healthcare was defined as the evaluation of resources, recycling strategies and taking care of nature, while green education focuses on the skills needed to carry out consciously sustainable actions. Some identified digital strategies were simulations, online lectures and tests. There is an urgent need to address the effects of the climate crisis and promote a sustainable health model starting from professionals who have a crucial role.

Keywords:
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1 Introduction

Healthcare professionals are pivotal in each country and setting, having several contacts with citizens and providing health promotion strategies. Awareness and skills about sustainability and green are crucial in this field, not only because of the potential benefit to healthcare facilities, but also because patients may achieve better outcomes.

Several international position statements, such as United Nations Organization's (UN) 2030 Agenda in its 17 goals, have recommended to include green education in the undergraduate and postgraduate programs, including recycling and reuse strategies, knowledge about the impact on health and how to manage it (United Nations General Assembly, 2015). As a global emergency in the last decades, there is an urgent need to prepare healthcare professionals to deal with the concepts of sustainability and green health care, and to prepare educators to shape appropriate programs by embodying these concepts.

Sustainability affects many interconnected fields such as environmental, economic, social, ethics, normative; the UN Commission, though, defined it as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development [WCED], 1987). Green education is also applicable to different sectors and stages of education. The Council of the European Union in 2022 adopted a Recommendation on learning for the green transition and sustainable development: green education is about learning and teaching for personal, societal and environmental well-being starting from now to the future, where all subjects and disciplines contribute (Council of the European Union, 2022). This achievement requires interventions as hands-on and action-based learning fostering knowledge, practical skills, critical thinking, and empathy.

1.1 Sustainability in healthcare systems and education

Healthcare systems worldwide are under pressure to adapt to rapidly changing conditions, such as overpopulation, increasing chronic diseases and diseases linked to climate change and pollution, new technologies, staff shortages and unequal

distribution of health resources, patients' role in the care process (Directorate-General for Health and Food Safety, 2021).

Identifying the skills and competencies that healthcare professionals need to recognize these concerns in the long term includes an effective approach to new technologies and digital transformation, which make healthcare systems more accessible and functional through the redefinition of the relationship between service providers and citizens to create a system that provides high-quality care. A standardized protocol for health professionals training has not yet been defined, nor are there shared digital infrastructures or outcome-based guidelines that encourage the effective use of digital and technological tools. Although, they already play an important role in care continuity (for example telemedicine) requiring professionals to be adequately prepared to use them. Investing in digitalization (from electronic health records to artificial intelligence applications) results in better quality of care and should be a guaranteed process without exclusions: robotic surgery, for example, is already performed worldwide and not only reduces the variation in outcomes, but also limits blood losses, decrementing post-surgery pain and shortening the hospitalization stays (Directorate-General for Health and Food Safety, 2021).

Special attention should be paid to increasing patients' confidence in these new tools, providing sufficient and understandable information for independent reflection and informed decision making: the European Society of Radiology believes that quality indicators related to continuing education and the university syllabuses need to include knowledge about artificial intelligence and skills in digital communication (Directorate-General for Health and Food Safety, 2021). A teaching-mediated digitalization strategy is important in developing curricula for medical and health professions students, especially because at present healthcare systems' reorganization is based on primary care and the family and community nurse, who needs essential knowledge, skills and attitudes for practice transcending the limits of the professional figure, in particular: adaptability to different settings and models of care; person-centered communication and empathy; digital skills; basic understanding and analysis of clinical data health; managerial and administrative skills; and ability to work in multidisciplinary teams (Directorate-General for Health and Food Safety, 2021).

The aim of the study was to summarize evidence regarding the sustainable and green education strategies documented in healthcare education settings, in particular the ones based on digital development.

2 Methods

A literature review was conducted, which included qualitative and quantitative primary studies concerning students in the first, second and third degree of health education and describing strategies to implement and promote sustainable and green education and its impact on patients. No limits on publication year or language were set.

The research was conducted in 2024, in three databases: PubMed, Scopus and Cumulative Index to Nursing and Allied Health Literature. The keywords have been used in combination with the boolean operators.

The synthesis of the extracted data was narrative and summarized the definitions of sustainability and green education reported in the selected studies, and the digital strategies described to implement green education and green learning.

The studies selection was conducted according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines by two independent reviewers (MC and RM) and a supervisor (SC) for conflict resolution.

From 9,820 results, all the duplicates were removed, and the remaining documents were screened. Of 52 eligible studies, 20 were included in the review. The software supporting this phase was Rayyan.

3 Results

The included studies were published in English [n=18] and Spanish [n=2] between 2016 and 2024; they were mostly qualitative [n=6] and reviews [n=6] in the design. Cross-sectional [n=4] and mixed methods [n=4] studies were also represented.

The authors' affiliations were mainly linked to universities, hospitals and research institutes.

Based on the aim of the studies included, the following areas for the synthesis of results were identified:

- Definitions of sustainability and green education in the studies.
- Digital strategies identified and implemented to integrate sustainability and green education in health curricula.

3.1 Definitions of sustainability and green education in healthcare

Most of the included studies [n=11/20, 55%] did not report any definition of sustainability nor green education, some [n=9/20, 45%] reported a definition: [n=6/10, 60%] only defined green education, [n=2/10, 20%] only defined sustainability and [n=1/10, 10%] reported both definitions (see Table 1).

Table 1: Summary of definitions of sustainability and green education

Definition	
Green Education	Skills and abilities for sustainable actions *(Chinene et al., 2024; Mohamed et al., 2024)* Pedagogical approaches to understand the ecosystem - people's health link *(Teherani et al., 2023)* Green healthcare: anticipate and manage health effects of climate change and share preventive interventions *(Cogen et al.,2024)* Sustainable healthcare education: approaches to teach knowledge and skills based on the ecosystem – health link *(Brand et al., 2021)*; education on the impact of climate change on health and of the healthcare industry on ecosystem *(Bray et al., 2023; Gupta et al., 2022 both citing Teherani, 2017)*
Sustainability in education	Environmental care *(Chinene et al., 2024)* Resource use and anti-waste strategies in healthcare *(Marsden et al., 2021)* Holistic knowledge to maintain health for present and future generations *(Aronsson et al., 2023)*

The Sustainable Development Unit of the British National Health System defines sustainable health as "the work of the entire health system and partners to provide health care that delivers financial, social and environmental performance outcomes": this involves investing in sustainable care models, promoting health and prevention, and adopting corporate social responsibility (Marsden et al., 2021).

The definitions of sustainability and green education are still heterogeneous and focused on different aspects, which represents a barrier to keeping up with an extremely fast digital and technological evolution. The need is therefore to identify multi-dimensional sustainability indicators that assess the sustainability of hospitals, including strategic, economic, social, environmental and technical aspects, combining resource optimization with environmental impact monitoring and mitigation (Galvão et al., 2023). All these aspects need to be transferred into the healthcare professionals' education.

3.2 Digital strategies to integrate sustainability and green education in health curricula

The identified digital strategies have been collocated into 4 macro areas, covering respectively: strategies applied in the academic or institutional field; strategies concerning teaching and learning methods; clinical strategies and other, where strategies not belonging to the other categories have been included (see Table 2).

Table 2: Digital strategies identified and implemented to integrate sustainability and green education in health curricula

Macro area	Strategies
Academic / institutional	Networking/multidisciplinary Enhancing the training/leadership of educators Lectures from environmental experts Fostering international partnerships
Teaching / learning methods	Projects that provide extra credits Case studies Simulations Innovative teaching/learning methods Tests on learned content Peer education
Training / clinical practice	Clinical skills/ skills training Sustainable evidence-based clinical practice
Other	Taking action to mitigate climate change Green campuses

The included literature analyzed the relevance of sustainability and green education in health curricula, identifying the most suitable strategies for their inclusion in health education through a structured educational action to train health professionals to contribute to a more sustainable health system.

The main challenge is to overcome existing barriers and develop effective teaching methods. For example, an interdisciplinary and collaborative approach is essential to achieve this goal, possibly involving environmental experts in lectures (Chinene et al., 2024; Véliz-Rojas et al., 2023). Moreover, comprehensive training is needed for educators, who often rely on social media for information on sustainability (Mohamed et al., 2024). Tools such as archives of updated content (Cogen et al., 2024) and continuing education projects (Teherani et al., 2023) may support them. The introduction of sustainability into existing programs through case studies and research projects may also be relevant (Brennan & Madden, 2023). Finally, an online curriculum and a partnership with different faculties and universities may facilitate interprofessional education (Véliz-Rojas et al., 2023). It is therefore relevant for the integration of sustainability principles, to create greener learning environments by adopting eco-friendly practices in campuses and classrooms (Álvarez-Nieto et al., 2017).

Despite the importance of innovative healthcare education, there does not seem to be a clear consensus on how to best integrate sustainable healthcare into health professions curricula (Gupta et al., 2022). This underlines the need to develop shared guidelines and methodologies to teach sustainability.

Despite the rapid technological development, which is increasingly attentive to green practices, there does not seem to be emerging strategies specifically focused on the digital and technological field. This is a gap that should be developed more in depth in the future.

4 Conclusions

Sustainable health issues are complex: understanding the link between environment and health and the impact of health systems on climate issues is essential and make digital transformation a necessity.
There are many options to include sustainability in health care workers' education; however, none of them has been identified as more used or effective, as they often result from poor adoption and integration of digital tools by institutional organizations.

Healthcare students show a growing interest in sustainability and want to acquire skills to promote sustainable health practices; however, they face several barriers, as for example overloaded curricula lacking in multidisciplinary contents and inadequate verification of the learned issues.

However, there are other opportunities to attain sustainability by developing new technologies and sustainable healthcare models, which are still lacking or not adequately applied.

In conclusion, this study highlights the urgent need for collective action to promote a sustainable health model through innovation: health professionals play a crucial role, and their training is essential to make them change agents.

4.1 Study limits and implications for research and education

This review has some limitations. First, only three databases were screened, so it may have limited the research. Second, the studies included were not evaluated qualitatively, thus it could have led to an incorrect evaluation of the included results. Furthermore, comparisons were not available within health systems where sustainability has already been integrated and health systems where this transition has not yet taken place.

To implement clinical practice results, specific tools for the health field need to be developed and integrated into accreditation standards assessing the quality of care to analyze their impact on both health system and patients' health.

Similarly, research and innovation should be promoted to explore new technologies for more sustainable health: this would provide an overview of existing programs through which identify and develop good sustainable practices.

In the education field, a standard curriculum on sustainability would identify the most effective teaching and learning strategies through the regulated assessment of skills and attitudes acquired by health students. Similarly, homogeneous training for educators and clinical supervisors would provide tools to integrate sustainability into educational practice.

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