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Environmental sustainability, healthcare workers and healthcare students: a literature review of attitudes and learning approaches

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REVIEWS

Environmental Sustainability, Healthcare Workers and Healthcare Students: A Literature Review of Attitudes and Learning Approaches

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Abstract

Purpose: Today, increased attention has been placed on the healthcare industry and its workers in the wake of the global COVID-19 pandemic. Increases in facemask production, personal protective equipment, and the number of patients admitted into hospitals have resulted in a sharp rise in medical waste and environmental concerns. This has led to a greater interest by the research community to study the type of training and education that healthcare workers and students receive which could facilitate the implementation of sustainability activities during their work.

Design/methodology: We have conducted a literature review (2010–2024) on healthcare worker knowledge and attitudes in environmental sustainability and reviewed educational initiatives –independent or academic–that have been proposed to implement training in sustainability for health professionals. For article retrieval, we used standard and non-standard search engines and databases including Pubmed, Web of Science, medRxiv, and Google Scholar.

Findings: The results indicate the important impact of worker attitudes towards sustainability and increased awareness of this issue affecting their work, but also limitations in knowledge and ability to participate in specific practical activities without organizational implementation.

Conclusion: This review provides insights into the multiple academic, professional, and independent educational initiatives in sustainability that have been launched in the last decade in almost all areas of care and the limitations of healthcare workers to include these initiatives in their daily practices, due to multiple barriers for their actual implementation.

Keywords: Attitudes, Education, Healthcare workers, Environmental sustainability, Sustainable hospitals, Healthcare industry

1. Introduction

Given the stress that the COVID-19 global pandemic has created on the healthcare industry and its workers, there has been a renewed emphasis on novel approaches to increase environmental sustainability within this industry. An influx of patients has led to healthcare professionals working around the clock, using more resources, requiring more materials, affecting their well-being and mental health, and substantially increasing waste and environmental impact [1]. This has been

particularly the case with face masks and other personal protection equipment [2]. McCauley *et al.* (2023) in their study concluded that sustainability in the healthcare system can be achieved by the implementation of policies and designing programs, and projects which push the healthcare industry to move towards sustainability. Sustainable healthcare systems minimize the negative environmental and economic impacts of healthcare workers' activities by incorporating eco-friendly materials and processes and enhancing waste management practices [3]. Considering discarding the wide range of

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medical waste by healthcare organizations, the importance of sustainability in healthcare systems is no less significant than in the manufacturing industries [4].

Unsustainable healthcare environmental practices are being recognized as a general problem in the industry and specific healthcare settings, including intensive care units nursing, primary care, oral healthcare, social work, and the veterinary field [5–10].

To help address this complex issue, published research suggests there is a growing opinion among researchers that maintaining a competent workforce that can implement sustainable healthcare practices is necessary. However, the current and future healthcare workforce may have a limited understanding of the relationships between waste management, health, climate change, and sustainability. A method to address and implement changes in sustainability in healthcare systems –particularly seeking outcomes in the medium- and the long term-is to increase the participation of healthcare workers in sustainable practices. Multiple suggestions for the development of core competencies in this area have been put forward. They include broad conceptual frameworks [11], proposals focusing on increased awareness of sustainability using educational tools for current healthcare workers, faculty, and current healthcare students [12,13], and using indicators to measure and monitor the inclusion of climate change and environmental sustainability in health professions education [14].

To know more about the current state of knowledge and attitudes on sustainability from healthcare professionals, we have examined recent literature mentioning current students' and workers' attitudes towards sustainability in the healthcare industry. We have combined information on both healthcare worker and student attitudes and on learning programs on sustainability from varied sources that included surveys, workshops, and literature reviews and present a review of the scholarly literature on two fronts: a) determining current attitudes of workers regarding sustainability in their workplace, and b) education and training tools used to educate current and future healthcare workers and students about sustainability in the industry. We also present a summary of the main barriers to the implementation of sustainability found in the reviewed literature. We also discuss current proposals to increase the participation of healthcare workers in sustainable practices, in light of the fact that in the United States, the healthcare industry employs over 18 million Americans, with about 80% of the workforce being female [15].

2. Methods

2.1. Databases, search terms and search strategy

On overview of the search methodology is presented in the flowchart in Fig. 1. A survey of the literature was performed oriented towards a narrative review and discussion article. We used standard search engines and databases -Pubmed, Web of Science, ScienceDirect, Scopus-, to explore published journals, book chapters and other publications for articles relating sustainability, healthcare education, healthcare workers and healthcare students. Scholarly works were identified using the following keywords and phrases: “healthcare worker and attitudes and sustainability”, “environmental sustainability and healthcare workers”, “sustainability education in healthcare”, “health professionals and sustainability attitudes”.

We also extended our search to other non-standard search engines -Google Scholar-, non-peer reviewed archives, -medRxiv- or novel aggregators -Dimensions.ai-, where links to non-standard types of publications, outside of the normal peer-review literature databases, can be found. While the use of preprint servers by healthcare researchers was common before the onset of the pandemic in 2020, the number of research papers published in preprint servers has increased substantially in the last two years, and we considered necessary to perform searches also in medRxiv, which at the time of writing (2024) already hosted more than 35,000 research papers in health sciences. However, we were not able to find any relevant article within medRxiv. Finally, there are now a small number of independent search engines using artificial intelligence methods to find scholarly works, for example dimensions.ai, which are being utilized by an increased number of researchers.

In many cases records were found in the tens of thousands, but a perfunctory analysis displaying the search results by relevance indicated that most of them had little relation with the objective of our search a combination of environmental sustainability, education, healthcare worker, and attitudes-, likely because sustainability and healthcare are words used extensively in the scientific literature. As a multitude of articles were available, it was necessary to restrict the searches to the Title/Abstract, excluding the boolean operator “OR” inside the search terms, and selecting articles that focused on environmental sustainability for healthcare workers, educational curriculum for sustainable healthcare, and students and healthcare worker attitudes in sustainability. This process helped in discarding

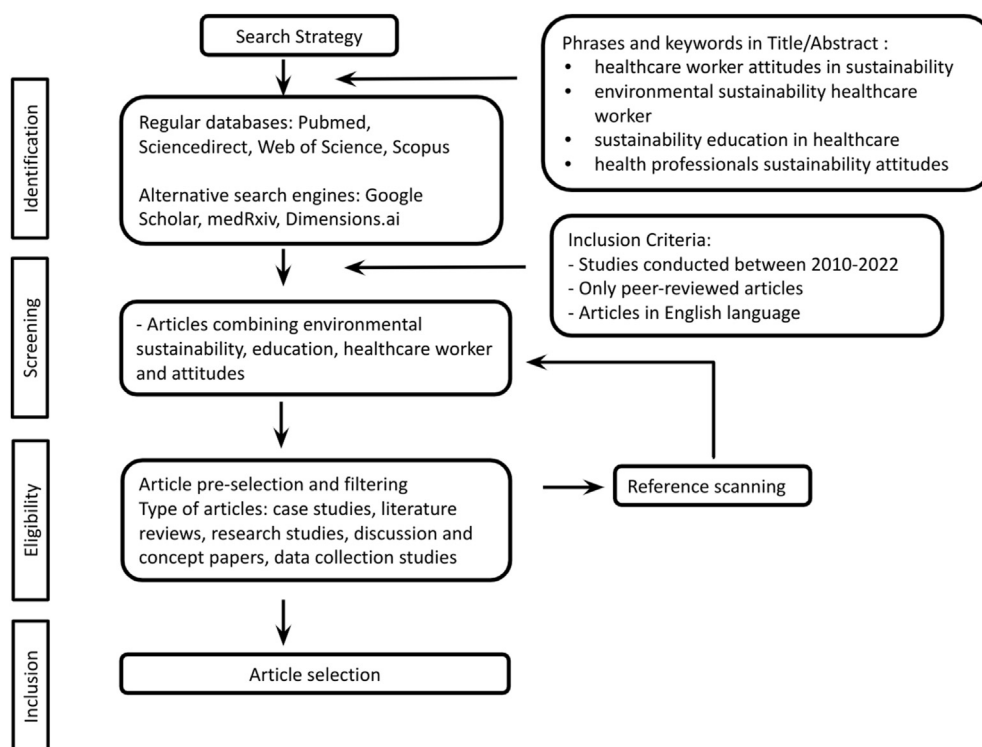


Fig. 1. Search strategy flowchart.

articles not compatible with the objectives of the review. Additional studies were found by reviewing reference lists in the articles and while reading the selected articles Relevant in-article references not returned in the searches were also considered.

2.2. Inclusion and exclusion criteria

“Environmental Sustainability” is a broad topic. In this study, we focus on investigating previous studies that address the position of environmental sustainability among healthcare workers. We retrieved papers on how healthcare workers' knowledge about environmental sustainability and the negative impacts of climate change can be empowered through education. Additionally, we included articles on the effects of education on modifying healthcare workers' attitudes toward implementing sustainable and eco-friendly programs and policies in their workplace. Furthermore, we looked at similar research in different countries, including developed and developing nations.

We selected peer-reviewed articles published in English between 2010 and 2024. We considered case studies, cross-sectional studies and review articles, but articles inconsistent with the topic and abstracts available only as conference papers were excluded. We also excluded articles that described education

for sustainable development initiatives not related to healthcare professions, as this was out of the scope of the review. Publications such as letters, abstracts, or editorials were also excluded. A total of 34 articles were selected from the mentioned databases and search engines. We separated the results into two broad groups: one related to the attitudes of healthcare workers including 17 articles, and the other on training and educational programs in sustainability implemented for workers and students including 17 articles. We note that some studies had mixed content. The type of articles selected were literature reviews (4 articles), discussion or concept papers (9 articles), and studies presenting quantitative or qualitative results from surveys, questionnaires, or other forms of data collection from healthcare workers and students regarding sustainability knowledge and practices (21 articles).

3. Results

Table 1 presents the list of reports selected for analysis in this review, separated into the two main topics of attitudes of healthcare workers, and educational initiatives to train healthcare workers and students on sustainable practices. During our analysis, we also found that some articles discussed barriers to the implementation of sustainable

Table 1. List of studies selected in the literature review.

	Author(s), year	Type of Study ^{a, b, c}	Study Purpose
Attitudes of healthcare workers on sustainable healthcare	Alashe, 2011	Research	Survey to assess the perceptions of medical professionals towards sustainability and acceptability of eco-friendly medical scrubs
	Anâker <i>et al.</i> , 2014	Discussion	To provide a definition of the concept of sustainability in nursing
	Anâker <i>et al.</i> , 2015	Research	Explore nurses' perceptions of climate and environmental issues and examine how nurses perceive their role in contributing to the process of sustainable development
	Dunphy, 2014	Research	Research study to investigate the key obstacles to healthcare professionals supporting environmental sustainability, and ways to overcome these obstacles
	Dupraz & Burnand, 2021	Literature	Examined the preparedness and role of healthcare professionals to inform about the impact of climate and the effectiveness of interventions mediated by health professionals aiming at reducing the environmental impact of human activities
	Goodman, 2016	Discussion	Provided additional conceptual framework of sustainability in nursing
	Griggs <i>et al.</i> , 2017	Literature	Searched studies on nurses views on global warming and sustainable healthcare, and physical and psychological barriers to implementing sustainable healthcare
	Harris <i>et al.</i> , 2021	Research	Survey to investigate attitudes and behaviours of surgeons towards climate change, or perceived barriers towards sustainable practice
	Hubbert <i>et al.</i> , 2020	Research	Qualitative study to assess health professionals' interest and perceptions in sustainability efforts in their workplace
	Jagals and Ebi, 2021	Discussion	Theoretical framework proposing that the health workforce can be supported to better understand and use climate information for health decision-making; conduct research and interventions; and effectively manage evolving risks to health and health system performance
	Leppänen <i>et al.</i> , 2021	Research	To investigate how nurses implement sustainable development principles in perioperative work
	Martin <i>et al.</i> , 2021	Literature	Extensive literature review to find current state of environmental sustainability in dentistry and barriers to its implementation
	Petre <i>et al.</i> , 2019	Research	Surveyed 426 anesthesiologists on attitudes towards recycling operating room waste, identifying barriers, and exploring educational programs
	Polivka <i>et al.</i> , 2012	Research	Study of knowledge and attitudes of public health nurses on climate change and their role in addressing health related impacts of climate change
	Schiavone <i>et al.</i> , 2022	Research	Survey on sustainable behaviors practiced and/or taught in veterinary hospitals
	Venesoja <i>et al.</i> , 2021	Research	Study of frontline healthcare workers' attitudes towards environmental and sustainability issues

(continued on next page)

Table 1. (continued)

	Author(s), year	Type of Study ^{a, b, c}	Study Purpose
Educational approaches to train healthcare workers and students on sustainable practices	Alvarez-Nieto <i>et al.</i> , 2018	Research	Observational study on how digital education materials helped students and working professionals obtain high scores in the sustainability sessions
	Alvarez-Nieto <i>et al.</i> , 2020	Research	Cross-sectional study of nursing students' attitudes towards climate change and sustainability
	Argento <i>et al.</i> , 2020	Research	How sustainability is integrated into the courses of higher education institutions in Sweden
	Aronsson <i>et al.</i> , 2020	Research	Educational sessions on sustainability helped student nurses apply sustainability practices in clinic
	Barna <i>et al.</i> , 2012	Discussion	Describes education for sustainability initiatives in varied health professions and share resources for curriculum development in nursing
	Cruz <i>et al.</i> , 2018	Research	Describes factors influencing Arab nursing students' attitudes toward environmental sustainability
	Huss <i>et al.</i> , 2020	Research	Cases studies showcasing how sustainable education can be integrated into the training of varied future health professionals to help with the transition to clinical practice
	Kitt-Lewis <i>et al.</i> , 2019	Discussion	Outlines strategies to implementing environmental sustainability in nursing education
	Madden <i>et al.</i> , 2020	Discussion	Proposes the use of indicators to measure the inclusion of environmental sustainability in health professions' education
	Noy <i>et al.</i> , 2017	Research	Case study of interdisciplinary sustainability training at an Australian University
	Orme and Dooris, 2010	Discussion	Discuss the higher education sector as catalyst to integrate health and sustainability
	Patrick <i>et al.</i> , 2016	Research	Study on capacity-building needs of public health professionals to address environmental sustainability
	Rambaree, 2020	Research	Inquiry of attitudes towards sustainability of students in social work
	Richardson <i>et al.</i> , 2015	Research	Three-month study with nursing students incorporating sustainability and health skills sessions
	Richardson <i>et al.</i> , 2019	Research	Three-year study of nursing and midwifery students introduced to sustainability in the context of health care through scenario-based learning sessions
	Schwerdtle <i>et al.</i> , 2020	Discussion	Transdisciplinary approach in education for sustainable healthcare
	Tun <i>et al.</i> , 2020	Discussion	Sustainability programs for medical faculty development

^a Research: indicates survey, study or data collection paper.

^b Discussion: indicates discussion or concept paper.

^c Literature: indicates literature review paper.

practices, while others were proposing specific or broad solutions to these barriers. For this reason, we have included summaries of the most common barriers and problems regarding sustainability in the health professions as described in the reviewed literature (Table 2), and a group of ideas and solutions for their implementation (Table 3).

3.1. Attitudes, knowledge, and experiences of healthcare workers on sustainable healthcare

In the literature about “attitudes”, two separate themes were identified. First, reports that propose or deal with theoretical frameworks on implementing sustainability in the health professions. The

Table 2. Issues/Barriers for the implementation of sustainability practices in healthcare professions and selected references.

Attitudes of workers	<ul style="list-style-type: none"> • Lack personal or institutional resources available. Economic limitations or not currently implemented at work. Daily life practicalities and high prices of many products and limited production are amongst the factors affecting resource availability. Many healthcare workers are not provided with sustainable products in their workplaces, and cannot independently afford substitution with greener materials. At the institutional level, broad implementation of sustainable practices could be costly (McGain <i>et al.</i>, 2021; Petre <i>et al.</i>, 2019; Schiavone <i>et al.</i>, 2020; Aronsson <i>et al.</i>, 2020) • Not a priority at work, but more interested personal live. Many surveys found that respondents were more likely to apply sustainability principles at home rather than in the workplace (Dunphy <i>et al.</i>, 2014; Petre <i>et al.</i>, 2019; Richardson <i>et al.</i>, 2016) • Blindness to related to global human health and disconnect between local actions and global impact. Most professionals see sustainability participation at the local level but find more difficult to see how that can have global impact (Griggs <i>et al.</i>, 2017; Hubbert <i>et al.</i>, 2020; Polivka <i>et al.</i>, 2012; Barna <i>et al.</i>, 2012; Venesaja <i>et al.</i>, 2021; Anåker <i>et al.</i>, 2015) • Resistance to change in the working practices. Due to work culture, established policies or attitudes of the staff or leadership, nurses students and professionals found difficult or impossible to implement sustainable practices at work (Aronsson <i>et al.</i>, 2020; Harris <i>et al.</i>, 2021) • Lack of confidence in ability to do something effective. Healthcare professionals and students do not have the educational foundations to make connections between climate change, health, and sustainability. This leads to a lack of confidence on part of healthcare professionals to make educated recommendations to institute sustainability practices in their workplaces. (Dupraz and Burnand, 2021; Aronsson <i>et al.</i>, 2020; Alvarez-Nieto <i>et al.</i>, 2018) • Lack of specific knowledge in sustainability (Anåker <i>et al.</i>, 2015; Leppänen <i>et al.</i>, 2021)
Educational Approaches	<ul style="list-style-type: none"> • Lack of curriculum development. There exists a lack of content expertise, and concerns about adding to an already full curriculum. (Barna <i>et al.</i>, 2012; Orme and Dooris, 2010; Gershberg <i>et al.</i>, 2021) • No multidisciplinary training or collaboration with other colleagues in other disciplines (Goodman, 2016; Argento <i>et al.</i>, 2020; Schwerdtle <i>et al.</i>, 2020) • Students show interest in learning, but maybe insufficient for change (Cruz <i>et al.</i>, 2018; Aronsson <i>et al.</i>, 2020) • Program effectiveness (Richardson <i>et al.</i>, 2015)

second group includes reports that investigated health workers' attitudes on clinical work, mostly discussing methods to reduce medical waste, reusability, environmental life-cycle analysis, and similar approaches. We mention studies in multiple practice areas, although a majority were in nursing.

3.1.1. Theoretical frameworks on implementing sustainability in health professions

Within the group of reports discussing conceptual frameworks for sustainability, Goodman (2016)

suggested that to better understand sustainability it would be of interest for nurses to access non-nursing scholarly works, as there is not enough research in this area in the nursing literature [16]. Dunphy (2014) investigated 64 Australian health professionals in varied disciplines via questionnaires and found a disparity between personal and professional activities and attitudes on environmental sustainability, indicating a clear commitment to practice in their personal lives, but appearing more reluctant to implement in professional [17].

Table 3. Non-exhaustive list of educational initiatives to implement training and educational programs in sustainability, with selected references.

Standard academic	<ul style="list-style-type: none"> • Health and Environmental Adaptive Response Taskforce. (Canadian Federation of Medical Students, 2016) • Nursus Toolkit (Nursus Toolkit, 2014) • Greener Anesthesia and Sustainability Project (GASP, 2018)
Broad theoretical frameworks	<ul style="list-style-type: none"> • Implementation at institutional level (College of Nursing) (Kitt-Lewis <i>et al.</i>, 2019) • Tips to teach environmental sustainability to health professionals (Schwerdtle <i>et al.</i>, 2019). • Broad competency framework (Jagals and Ebi, 2021; Huss <i>et al.</i>, 2020) • Embedding sustainability through all medical education (Tun <i>et al.</i>, 2020) • Monitoring implementation of sustainability initiatives via indicators (Madden <i>et al.</i>, 2020)
Other educational and awareness initiatives	<ul style="list-style-type: none"> • Centre for Sustainable Healthcare (https://sustainablehealthcare.org.uk/) • Health Care without Harm (https://noharm-global.org/) • Nordic Center for Sustainable Healthcare (https://nordicshc.org/vision.html) • Sustainable Healthcare Coalition (https://shcoalition.org/) • Alliance of Nurses for Healthy Environments (https://envirn.org/) • Similar initiatives exists from professional associations (i.e. Royal College of Nurses, https://www.rcn.org.uk/about-us/sustainability-and-greening-the-workplace)

Griggs *et al.* (2017) performed a literature search in nursing and concluded that there are important physical and psychological barriers to implementing sustainable healthcare. Among the issues summarized in Griggs' review were the imprecise meaning of sustainability or the inaction of nurses due to social norms to avoid potential political controversies, among others [18]. But, as pointed out by Anåker *et al.* (2015) in primary care and emergency services, and more recently by Leppänen *et al.* (2022) in perioperative work, most nurses and nurses' managers require training and education in environmental issues to get involved in mitigation to adapt to protect human health [19,20]. A short survey with 16 participants occupying varied positions in a hospital conducted by Hubbert *et al.* (2020) found that participants naturally linked sustainability to the reduction of waste, but not to preserving human health, and responded of having little knowledge of how to be more sustainable [21].

It is worth mentioning the study conducted by Polivka *et al.* (2012) using an online survey with 176 public health nurses, as they obtained responses that specifically mentioned particular disease areas that, in the opinion of the participants, would be impacted by climate change. As reported "More than half of respondents identified vector-borne diseases, flooding-related displacement, mental health conditions, and air quality-related illnesses as increased because of climate change; however, approximately half did not identify malnutrition and water availability-related illnesses as affected by climate change" (Fig. 1 in that study) [22]. Dupraz and Burnand (2021) conducted a review of the literature looking for the effectiveness of interventions or programs that healthcare professionals have implemented to help communities adapt to environmentally friendly lifestyles, but found that while many health professionals are alerting patients about the potential impact of climate on health, there were few reports on the effectiveness of such programs [23].

3.1.2. Health workers' attitudes and experiences with sustainability in practice

The second group of reports was oriented toward healthcare worker experiences dealing with materials and medical waste, the impact of single-use materials, recycling, environmental life-cycle analysis, and similar approaches. Venesoja *et al.* (2021) reported that some workers consider the environmental values of facemasks less important (plastic-based or not) than their protection properties, as most people placed short-term safety concerns

ahead of long-term problems (environmentally friendly products) [24].

Previously, Alashe (2011) performed a survey to assess the perceptions of medical professionals towards sustainability and acceptability of eco-friendly medical scrubs. First, the author identified eco-friendly materials available to healthcare workers, which included recycled polyester, organic cotton, and bamboo. With guidelines in place for use in medical textiles, fiber choice is limited, and further limited when environmental consciousness is put in place. The survey results found that females were more oriented towards sustainability than males, as well as those of greater age and higher work experience, and that workers who were oriented towards sustainability were willing to pay themselves more for eco-friendly material and were not concerned with properties such as color, comfort, and material [25].

Analysis of attitudes has also been studied within surgery. A recent survey of UK and Irish surgeons' (Harris *et al.*, 2021) mentioned the scarcity of information on attitudes, behaviors, and barriers to change to implement environmental sustainability [26]. Petre (2018) focused specifically on the sustainable attitudes and practices of anesthesiologists. The purpose of their study was to ascertain current practices, attitudes towards, and barriers to operating room waste recycling and sustainability efforts. The operating room is responsible for 20–30% of medical waste produced daily in the US, while anesthesia represents about a quarter of that (see McGain *et al.* (2020) and references thereof). Forty percent of operating room waste has been identified as potentially recyclable and includes textile materials [27,28].

Surveys of anesthesiologists have identified that there is an interest in recycling but found barriers like inadequate facilities, staff reluctance, and lack of information on what/how to recycle. Petre's (2018) study surveyed 426 anesthesiologists on attitudes toward recycling operating room waste, identifying barriers, and exploring educational programs. The results indicated that 88.6% of respondents agreed that the environmental impact should be considered when conducting anesthesia practice [27].

In other areas of care, for example, veterinary science, a recent survey conducted by Schiavone and colleagues (2021) indicated that respondents believe this is an important topic, but there is little evidence that sustainable behaviors are being practiced in veterinary hospitals. Respondents were most interested in working to increase recycling and reduce general waste and energy consumption within their hospitals. In addition to a lack of

educational resources, funding was a commonly identified barrier to incorporating more environmentally sustainable practices [10].

3.2. Educational methods to train healthcare workers and students on sustainable practices

The second broad group of results was in studies evaluating educational initiatives to train both current healthcare workers and students in sustainability. Judging by the number of publications, this seems to be an area of increased interest and research. Previous projects have investigated sustainability training in varied educational and professional settings, demonstrating the barriers to implementation. Barna *et al.* (2012) discussed the widespread concerns of climate change undoing the public health gains seen over the past 100 years. The article cites a variety of sources claiming that nursing education has fallen short in preparing students to understand the connections between climate change, public health, and sustainability—especially how their individual choices in practice can contribute to positive change and recommends each nursing program should support a basic level of ‘sustainability literacy’ [29].

Richardson *et al.* (2015) conducted a three-month study with nursing students, with one group incorporating sustainability and health skills sessions using evidence-based scenarios and the other group as a control group with a routine curriculum. After three months of sessions, both groups completed surveys to determine their attitudes toward sustainability in nursing and the nursing curriculum. The results showed that there was no statistically significant difference between nursing students who participated in the sustainability sessions, and those who had not, indicating that sustainability classes implemented into the nursing curriculum did not impact nurses’ sustainable decision-making. Students were more likely to implement sustainability into their personal lives and habits, and less likely to implement sustainability into their nursing practice [30]. In a more recent study (Richardson *et al.*, 2019), a cohort of nursing and midwifery undergraduate students at the University of Plymouth (UK) was introduced to sustainability in the context of health care through scenario-based learning sessions, and after three years there were clear indications the students would apply sustainability principles in actual nursing/midwifery practice [31].

Similarly, Aronsson *et al.* (2020) implemented a three-year cohort study on nurses specifically looking at whether undergraduate nursing students would apply sustainability into their practice, and

challenge unsustainable practices during clinical placements. The resulting study included 240 participants, 83% of whom were “unable to challenge unsustainable practices in my work environment” after the second year of nursing school. By year three, only 50% of participants saw no change in their ability to challenge unsustainable practices. Identified barriers to changing practice included a lack of confidence, resistance to change, practicalities, and student attitude. Students identified waste management and the use of resources as the areas where they could best change their practices [32].

Argento *et al.* (2020) conducted a study in Sweden—where higher education institutions are legally required to include sustainability in their programs—indicating that collaborating with and learning from colleagues who specialize in other disciplines should be of interest, as the curriculum for nursing students did not cover topics presented in other disciplines, like environmental science. Participation, and interest, by nursing students in including climate change issues in nursing curricula is also mentioned by Cruz *et al.* (2018) in a survey conducted in Arab countries, with about 50% agreeing to the idea [33,34].

An example of the integration of sustainability in a College of Nursing is described by Kitt-Lewis *et al.* (2020) at Penn State University. Started in 2015, the project includes sustainability service projects, continuing education, and curriculum development in cooperation with the Sustainability Institute at Penn State, with the objective of creating “a generation of sustainable nurses” as the authors describe it [35]. In contrast, a survey conducted by Gershberg *et al.* (2021) among 378 dental students in the US indicated that only 5% of students were receiving environmental sustainability education in their programs, which the students considered “quite” or “extremely” important (83%) [36]. A more novel area of inquiry of attitudes towards sustainability is in social work. In a recent qualitative methodological study to analyze students’ attitudes towards sustainability in Sweden, Rambaree (2020) argues for environmental sustainability education within the social work curricula, supporting a global call for social work education to shift from an anthropocentric to an eco-centric paradigm [37].

3.3. Summary of barriers to the implementation of sustainability

We found many reports discussing the implementation of sustainable practices in healthcare settings or academia. Identifying barriers to that implementation was a common theme in many of

these studies. The exact terminology may differ between authors, but the general concept is the same. We have separated the results for the two groups of articles mentioned above, attitudes of workers, and educational approaches, and summarized some of the barriers in [Table 2](#).

Ramirez *et al.* (2013) findings demonstrated that healthcare managers can implement strategies to offer multidisciplinary in-service learning experiences, enabling staff to adapt to continuous changes and foster a culture of sustainability. A component of these multidisciplinary learning experiences can focus on the advantages and benefits of the sustainability movement within the workplace. This includes educating staff on the hazards associated with discarded waste and the methods for managing medical waste to reduce risks to themselves, society, and future generations. Additionally, it is crucial to teach them how to conduct internal environmental audits, drawing from the experiences of other industries, to assess their sustainability initiatives since Carnero (2015) believes that a proper objective model is not existing to evaluate the environmental sustainability in healthcare systems [\[4,38\]](#).

3.4. Proposed educational solutions

We also found many reports describing educational tools and solutions to better educate the healthcare workforce, summarized in [Table 3](#). Proposals and educational initiatives regarding education for sustainable healthcare have been suggested previously by multiple authors.

A paper by Orme and Dooris (2010) described the central, catalyst role of the higher education sector to help integrate health and sustainability, and already mentioned curriculum development in sustainability as part of the core contribution to sustainable development. Higher Education institutions in multiple countries have been updating or developing plans to integrate sustainable healthcare into health professions education either as part of the curriculum or as external or continuing education programs [\[39\]](#). A survey among public health practitioners in Australia clearly concluded that environmental sustainability should be incorporated into the university curriculum within public health courses [\[40\]](#). In the US, Vicent *et al.* (2017) reported that several hundred higher education institutions are hosting more than two thousand varied interdisciplinary programs that include sustainability, some of them in relation to health [\[41\]](#). Current examples are in medical faculty development [\[42\]](#), in nursing [\[31,35\]](#), or more generally in “education for sustainable health care” [\[13,43\]](#).

Huss *et al.* (2020) mentioned how sustainable education can be integrated into the training of varied future health professionals to help with the transition to clinical practice: a) the Health and Environmental Adaptive Response Taskforce, launched for medical students in Canada (Canadian Federation of Medical Students, 2016); b) the Sustainability Literacy and Competency (SLC) Framework (Nursus Toolkit, 2014), a software designed to improve the level of knowledge and skill regarding sustainability and climate change in the nursing profession, created for both students, educators, and those who wish to refresh their skills; and c) the Greener Anesthesia and Sustainability Project (GASP, 2018), which for example helps interested students connect with clinicians open to advancing sustainable health care practice. Nayna Schwerdtle *et al.* (2020) emphasize the need for multidisciplinary, interprofessional approaches to education for sustainable healthcare, integrating health, social, and natural sciences, as well as economics and political science disciplines [\[13,43,44\]](#).

In an extensive observational study Alvarez-Nieto *et al.* (2018) indicated that digital education materials helped students and working professionals obtain high scores in the sustainability sessions. A more recent, cross-sectional multisite analysis of 846 nursing students comparing attitudes toward climate change was performed by Alvarez-Nieto *et al.* (2022). They found increased awareness and interest in sustainability in nursing students from the seven Universities included in the study, and also a substantial increase in the number of students that think sustainability should be included in the nursing curricula between 2014 and 2019 [\[45,46\]](#).

A number of more general ideas have been proposed recently. Jagals and Ebi (2021) recently put forward a broad six-domain competency framework consisting of core competencies in which healthcare workers are required to cope with rising climate-related health impacts. These competencies can be strengthened with training, education, mentoring, and knowledge sharing. The authors propose that the health workforce can be supported to better understand and use climate information for health decision-making. Tun *et al.* (2020) suggest that faculty in the health sciences can rapidly acquire knowledge and skills in sustainability, and integrate that knowledge into their course curriculum “embedding sustainability through all of the medical education”. Other authors suggest using a set of indicators to measure and monitor the inclusion of climate change and environmental sustainability in health professions education [\[11,14,42\]](#).

In addition to the learning activities mentioned above, alternative curriculum, courses, research materials and training in sustainable healthcare are being offered in different specialties and with varied approaches by non-profit organizations, like the UK-based Centre for Sustainable Healthcare (<https://sustainablehealthcare.org.uk/>). Several other organizations involved in addressing healthcare sustainability and workers' attitudes are the Health Care Without Harm (<https://noharm-global.org/>); the Nordic Center for Sustainable Healthcare (<https://nordicshc.org/vision.html>) or the Sustainable Healthcare Coalition (<https://shcoalition.org/>).

Professional organizations have been also promoting sustainability programs. The Royal College of Surgeons in England (2021) launched the “Sustainability in Surgery Strategy” group to ‘embed financial, environmental, and social sustainability with ethical purchasing’ into surgical practice. The Royal College of Nursing (2022) lists several resources for sustainable nursing practices and has announced the creation of an online education program in sustainability [47,48].

In addition to the mentioned solution, some approaches can be considered due to the prevalence of emerging green products and technologies in the healthcare industry. Consequently, the importance of green training would be more noticeable to embrace these innovations. For instance, some novel biodegradable materials that can be replaced with petroleum-based plastics such as polylactic acid (PLA) have been introduced for years [49,50]. However, Saffari and Kamali Miab (2016) added antibacterial properties to PLA textiles by using a sustainable process which is water-saving and the energy consumption is less in comparison with the traditional wet process. They emphasized that it is feasible to make sustainable medical textiles like bed sheets and patient gowns [51]. These kinds of valuable findings could be widely adopted by hospitals. If healthcare workers and decision-makers are informed and adjust their approaches with a focus on environmental sustainability, the healthcare industry can play a positive role in the reduction of greenhouse gas emissions and make this portion of their waste biodegradable.

While the ideal approach to waste management focuses on minimizing waste or recycling and reusing materials, some innovative methods offer how to generate energy from waste. Many recent initiatives aimed at improving medical waste management have focused on medical textile waste, such as masks, gowns, and other PPE, which were produced and discarded on a large scale during the COVID-19 pandemic. Khandaker *et al.*, 2022 introduced some of

them in their paper. These kinds of novel solutions not only assist the healthcare system in reducing medical waste but also produce energy that directly diminishes the need for fossil fuels. All materials are not able to be used in this energy production. So this cannot be performed efficiently without the knowledge of healthcare workers about the post-consume items separation as valuable and recyclable waste. Educating them plays a contributory role in enhancing the efficiency of existing and potential energy-generating plans and programs [52].

4. Discussion

For our analysis, we selected a heterogeneous group of articles studying the attitudes, preparedness, and role of healthcare professionals and students in the context of sustainability. Most of the published literature on “sustainability” relates to economic, social, scientific and technical environmental impact, but less has been reported on healthcare worker attitudes and knowledge in this area, and how training and education could impact sustainability efforts.

The term sustainability is still not clearly defined in many healthcare areas and in some cases it incorporates other concepts. Sustainable development is concerned with providing a framework whereby groups, communities, and individuals have access to resources and opportunities and can exercise their rights to create infrastructures that promote healthy communities [53]. For others “... sustainable healthcare involves ensuring the ability to provide good quality care for future generations by balancing the economic, environmental, and social constraints and demands within healthcare settings” [48].

For the above reasons, we decided to conduct the study combining results from two perspectives: a) experiences, knowledge, and attitudes of healthcare workers on sustainable healthcare and b) available or proposed educational methods to train healthcare workers and students on sustainable practices. Due to the heterogeneous and open nature of the search, some reports discussed both elements. Within the period of our analysis (2010–2024), the number of studies of healthcare professionals' perspectives on environmental sustainability has been steadily increasing, with the majority published in the last two to three years. Publications were found in multiple areas of healthcare, but mostly in nursing. This was somewhat expected as they are the practice area that is more directly in contact with aspects of sustainability -i.e. materials that need to be disposed of-, and represent the largest percentage of workers -almost 50%- within the healthcare workforce [54].

In general, the literature reviewed indicated that a majority of healthcare workers and students are concerned with the impact of healthcare on the environment and climate change [20,34]. With some exceptions [33], there are not many comparative studies separated by healthcare area, or whether there is more participation on this issue by some healthcare professionals than others, i.e. surgeons or nurses. A transdisciplinary evaluation carried out in Australia asked healthcare professionals from multiple practice areas, but the authors did not provide a breakdown of attitudes by specialty [17].

As summarized in Table 2, a large number of studies have described the main barriers to implementing sustainability programs in healthcare. Some of them were regarding workers' attitudes and included lack of resources, unwillingness to change working protocols, lack of confidence in the ability to implement sustainable practices, lack of correlation between work and global environmental issues, restrictions by social norms, and psychological issues of responsibility. Attitudes may also be different depending on the country and cultural background of the workers. From the studies considered, most participants indicated that sustainability is important to be incorporated into the workplace, yet they also mention it is not always done [30].

Protocol changes can be stressful to an environment if they require a completely new routine. This attitude can be attributed to work cultures and norms, policies, and staff attitudes. It can be theorized however that medical workers are more inclined to make sustainable decisions with materials within their control: healthcare workers were willing to invest in scrubs made from sustainable materials, as long as they were financially able to [25]. The study conducted by Aronsson *et al.* (2020) noted that 66% of nurses in their second year of education showed a lack of confidence in challenging unsustainable practices, but this number decreased to 53% among nurses in their third year. The lack of confidence was attributed to hierarchies in the workplace [32]. Barna *et al.* (2012) addressed this necessary change in curriculum by adding that there exists a lack of content expertise and concerns about adding to an already full curriculum. Survey respondents believed that the educational components “generated critical thinking” as both healthcare professionals and as private citizens interested in sustainable development [29,45].

Different problems were detected regarding the implementation of learning programs, as shown in Table 2. In standard academic courses, a general hypothesis is that sustainability education may play

a role in the willingness or ability to implement sustainability in the workplace, thereby reversing negative or apathetic worker attitudes to sustainability. This has been shown in educational seminars [30] or via E-learning [45]. However, educational tools were successfully implemented into the nursing curriculum in most cases but did not translate into practice [32]. To address the issue of lack of interdisciplinary training to teach sustainability to healthcare students, it may be of interest to implement the techniques reported by Noy *et al.* (2017) in a case study of interdisciplinary learning inside an Education for Sustainability undergraduate course involving science, arts, business, and health students at an Australian university [55].

Nowadays, individuals all around the world have been aware of the negative effects of climate change sustainability. So it is valuable to include more case studies from around the world. Africa as a vulnerable region against the adverse impacts of global warming, could get severe damage. Lister and co-workers (2022) in their case study investigated the South African healthcare workers' approaches toward environmental sustainability and their interest in the application of green and eco-friendly programs in their healthcare sectors. Over a hundred healthcare workers participated in their study. The results confirmed that they are interested in environmental sustainability and their attitudes toward solving climate change problems by implementing eco-friendly policies and green plans. However, there are barriers which do not allow the green movement to happen in the South African healthcare system. Lister *et al.* realized some of those barriers from the participants' data. The most noticeable obstacle is the lack of knowledge and green policies which can be directly improved by education [56].

Richardson *et al.* (2019) subjectively evaluated the effectiveness of sustainability education for students at the University of Plymouth in the United Kingdom, who were in the nursing and midwifery program. The data collected from 363 questionnaires analyzed by SPSS and the results demonstrated that in this case study from the first year to the third year, the awareness of this group of nursing students has been raised gradually. These students enrolled in courses about the environment and natural resources and also were provided with educational materials about sustainability. In the first year, they were informed about climate change. In the following year, they learned about natural resources. Finally, in the third year, the new diseases that have been caused due to climate change were taught to them. Data on the attitudes of these

nursing students toward environmental sustainability have been collected by questionnaires. In the third year that their courses had been completed, the results showed that they were more likely to avoid unsustainable actions in their workplace [31].

Goodman and Richardson (2010), in their investigation, found that there has been a lack of focus on equipping nurses with the knowledge and skills needed to address global sustainability issues. Until recent years, higher education in nursing has not included topics on the environment and sustainability. Gradually sustainability programs and courses started in higher education for healthcare around the world after the United Nations (UN) encouraged education systems to include sustainability courses by promoting the “UN Decade on Education for Sustainable Development 2005–2014” [57]. However, as mentioned earlier Lister and coworkers in their case study demonstrated that in a developing country like South Africa, there is still a lack of sustainability education for healthcare students, however, they found a strong interest in environmentally friendly approaches among South African healthcare professionals (Lister *et al.*, 2022). Nevertheless, in some countries, green training in healthcare systems and nursing colleges has been included. According to the Richardson (2019) investigation, in the United Kingdom, undergraduate nursing students are experiencing some green topics and enrolling in courses on diseases caused due to climate change in their programs. In another example of the education system in the United Kingdom, the study of Clery and coworkers (2021) showed that in this country some medical schools require their students to enroll in courses about environmental sustainability to graduate [31,58].

An Italian hospital as a sample of healthcare systems in Italy has been studied by Pinzone and colleagues (2019). The hospital has implemented eco-friendly policies including training their employees about waste management and energy-saving topics from 2013. In this study, they evaluate the influences of environmentally friendly education on the attitude of the employees by running a survey of 260 participants among them. The result of the survey confirms that green education plans positively boost their tendency to participate in environmentally benign policies developed by the healthcare system and improve the level of job satisfaction [59].

In a very recent study that was conducted in Iran's healthcare facilities by Shirali *et al.* (2024), the level of “climate resilience and environmental sustainability” was evaluated in local healthcare systems. Their finding shows that in rural-urban health centers the awareness of environmental

sustainability is very low. They believe that it can be improved by training health workforces to inform them about the negative impacts of climate change. Since the healthcare systems are in the front line of defending and treatment of individuals injured by adverse effects of environmental disasters, it is crucial to empower employees in the health industry with the knowledge of global warming impacts [60].

According to previous studies, it is realized that green training for healthcare workers needs to be paid more attention in some developing countries. Healthcare systems all around the world should benefit from the experience of the pioneers in environmental sustainability education for their employees to positively improve green-related behaviors in healthcare sectors.

Although there is an increased effort by many healthcare professionals to support sustainability efforts in the workplace and in class, appropriate evidence of the programs that are more effective is lacking, as there are no studies measuring how sustainability interventions translate into improvements in health and the environment. For this reason, it is not possible to decide which ones to implement. For example, it is not clear the reach and impact that initiatives led by independent organizations (Table 3) are having in increased training, attitudes and awareness of sustainability among the general healthcare student and worker population. It is likely, however, that the most successful initiatives will be the ones that implement changes at the institutional level [35]. Because of the scarcity of information regarding the outcomes of implementing sustainability training in healthcare, some authors are suggesting the use of indicators to monitor the progress of integrating climate change into medical curricula, although even that appears to be difficult [14].

4.1. Study limitations

The main difficulty was in identifying appropriate publications in the literature, due to the absence of a clear definition of what sustainability in healthcare or sustainable healthcare are or includes, as it means different things depending on the orientation of the healthcare professional, the student, or the author writing the literature reports. This issue has already been discussed previously by other authors, leading Anâker and Elf, 2014 to a definition in which “.... The use of the concept of sustainability includes environmental considerations at all levels. The implementation of sustainability will contribute to a development that

maintains an environment that does not harm current and future generations' opportunities for good health" [61].

Because of the heterogeneous nature of the literature reviewed, in regards to the *type* of studies, a second limitation was the variable number of participants in the surveys, which ranged between a few dozen to several hundred people, as well as the length and content of the studies. For the studies that didn't involve a survey, the length of the study was not constant, with some short, whereas others spanned months of data collection to understand if there was any change in attitudes towards sustainability over time. Some studies were more complex and included educational seminars to educate their respective subjects on how to alter their actions to be more sustainable [30,46].

5. Conclusions

There is a clear increase in interest from healthcare workers in learning how to implement sustainability practices in their workplace. Most surveys show workers' concerns about climate change and willingness to engage in efforts to transition to more sustainable practice but would welcome greater support, guidance, and leadership from employers, for example in practical terms providing sustainable and eco-friendly products. A second aspect is the increase in educational initiatives to train current and future healthcare workers but given the difficulties in practical implementation—multiple barriers at the personal and industrial level-, and the lack of parameters to evaluate the effectiveness and translation of sustainability action proposed in such programs in actual practice, more specific studies—particularly field studies with surveys and quantitative analysis—are necessary to further implementation of sustainability objectives put forward by many national and international organizations.

Ethical Mission Statement

All authors have significant contributions to the body of research and literature. The authors agree with the author's responsibilities of the Health Professions Education journal and declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. All citations are real and authentic.

Conflict of interest

None.

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