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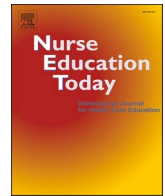
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Review

Climate change integration in nursing education: A scoping review

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ABSTRACT

Background: The environmental impacts of climate change such as extreme weather, affects human physical and mental health; therefore, including climate change and health is important in nursing education. Despite the recognition of the link between climate change and health, this important knowledge has not yet been systematically integrated into nursing curricula, highlighting the need for immediate action to prepare nurses for these emerging human health challenges.

Objectives: The objective of this review was to gain an overview of the existing literature exploring climate change in nursing curricula and answer following questions:

1. What teaching strategies are used to integrate climate change into the nursing curricula?
2. What are nursing students' perceptions of climate change education in the nursing curricula?

Design: Scoping review.

Methods: A protocol was created and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews Checklist (PRISMA-SrC). Five data bases were searched: CINAHL, Academic Search Premier, PubMed, Scopus and Cochraine, in addition to databases, grey literature was searched from different sources (reference lists, Google). A total of 1055 articles were derived from the search and 47 articles were included in this review. After selection results from selected studies on educational interventions and climate change education, and opinion pieces were charted, followed by a team review and consensus on the findings.

Conclusion: This review shows the importance of integrating the topic of climate change into nursing curricula. This integration of climate change-related content into nursing curricula is essential for preparing students, not just for their future roles in healthcare, but also their role in policy and climate justice. These results also reflect strong support from students for that integration. But while progress has been made, further research is essential to evaluate the impacts of these teaching strategies on nursing education.

1. Background

The World Health Organization WHO considers climate change to be the biggest threat to human health of this century (WHO, 2019). Climate change causes an increase in heat waves, extreme weather events, flooding, and wildfires. All these negatively affect human health, such as various heat-related diseases, water-borne diseases, vector-borne infections, accidents caused by extreme weather events, mental health problems and poor air quality (Anderko et al., 2017; CDC, 2021; Rocque

et al., 2021). An increase in heat waves has been linked to an increase in cardiovascular problems and mortality. The effects of floods go beyond structural damage, increasing the number of drowning deaths and increasing mental health problems such as depression. Forest fires are known to significantly affect respiratory health (Gasparrini et al., 2017; Heaviside et al., 2016; Curtis et al., 2017; IPCC, 2023). Knowledge of the connection between climate change and health is essential for health-care professionals, and for this reason it should be included in nursing education. The report of the Intergovernmental Panel on Climate

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Change (IPCC, 2018; IPCC, 2023) emphasizes the effects of climate change on human health, which also exacerbates already existing health challenges.

The United Nations Framework Convention on Climate Change ratified the Paris Agreement on 12 December 2015. During UN Climate Change Conference (COP 21) in Paris a special session was held to discuss the health impacts of climate change and the need to train health professionals to address climate impacts and emphasized the need for training related to the impacts of climate change (Paris Agreement, 2015). Integrating climate change into nursing education highlights the role of nurses in mitigating and adapting to the challenges caused by climate change (Gasparrini et al., 2015). The International Council of Nurses (ICN, 2018) has recognized the need for health care systems to be climate resilient, with nurses ready to face the challenges brought by climate change and strives to increase awareness of the connections between environmental factors and health.

Nurses play an important role in combating climate change and improving environmental sustainability. Nurses can also act as promoters of environmental stewardship, for example through waste management, recycling, and promoting the use of reusable nursing materials (Saber, 2020). Additionally, there have been various initiatives around the world where nurses have been involved in tree planting projects, such as Old Dominion University and Africa Air Rescue (AAR) Healthcare’s Trees for Health (T4H) initiative, further showing their commitment to environmental protection and public health (AAR Healthcare, 2022; Grinkewitz, 2022).

The effects of climate change on people’s health will challenge nurses in care delivery and therefore require educated nurses to respond. As trusted professionals, nurses can support climate change mitigation and adaptation. To respond to the problems caused by climate change, proactive measures need to be taken (Butterfield et al., 2021; Goodman, 2013; Goodman and East, 2014; Portela Dos Santos et al., 2023). Although the link between climate change and health is recognized, this knowledge has not been systematically integrated into nursing education. However, this information is necessary for preparation of nurses, the largest group of licensed health professionals globally (Lemery et al., 2020; Dupraz and Burnand, 2021).

The purpose of this review was to gain an overview of the existing literature exploring climate change in nursing curricula.

2. Method

Scoping review was chosen for this study because the topic covers a wide area and there was a concern that there could be valuable information in the grey literature. A scoping review can uncover the vast research has been done on the topic and how far it reaches. Arksey and O’Malley’s (2005) five-step method was followed in review. These steps were: Defining the research question, searching relevant publications, study selection, data charting and analysing and reporting results. PRISMA-SrC guidelines (Tricco et al., 2018) were also followed to ensure the quality and reliability of the review.

2.1. Step 1: Defining the research question

The Population, Concept and Context (PCC) model (Joanna Briggs Institute, 2015) was used to develop the research questions (See Table 1). This model directed the following research questions for the scoping review:

What teaching strategies are used to integrate climate change into the nursing curricula?

Table 1
The population, concept, and context (PCC).

P(opulation)	C(onsept)	C(ontext)
Nursing students	Climate change	Education, Curriculum

What are nursing students’ perceptions of climate change education in the nursing curricula?

2.2. Step 2: Searching relevant publications

Five databases were searched in December 2022. Manual searches of reference lists and grey literature were also conducted. Literature research was updated during 2023 to include most recent articles into review. The inclusion criteria were created to be able to answer the research questions. Articles were included if they were written in English and published after 2015, the year of the Paris Climate Agreement. Search of databases was conducted for study. Keywords derived from the preliminary literature were used in the search. These keywords were combined using Boolean Operators OR/AND functions to link terms such as “climate change,” “education,” and “nurse,” as described in Table 2 (Search strategies). To complete the search strategy, the help of the University library’s information specialist was used to make the search queues more efficient.

2.3. Step 3: Study identification

The selection process followed the PRISMA-SrC guidelines (Moher et al., 2009), as shown in Fig. 1 (PRISMA 2009 flow chart).

After conducting electronic database searches, researchers initially identified 1433 papers. In addition to the databases, 21 other papers were found. Once duplicates were removed, 1055 papers remained. Researchers initially screened title and abstract of the records and then full texts to determine inclusion in the review. Papers were considered relevant if their abstracts discussed climate change and included nursing education, researchers excluded 498 papers during the title and abstract review, leaving 179 papers for full-text review. Two independent authors performed study selection and disagreements were resolved by a third senior author. Following the inclusion and exclusion criteria, 47 papers were included in review (see Table 3).

2.4. Step 4: Data charting

After completing screening, the literature was charted and summarized in Table 4. Study characteristics by Author 1 (IT). This table presents characteristics of the studies and was reviewed and confirmed in its form and content by Author 2 (FC) All the selected papers (n = 47) were charted according to the method outlined by Arksey and O’Malley (2005). This process involved the extraction and summarization of key information from each paper, such as author, year, title, country, study design, data collection methods and data analysis, educational concepts, participants and key findings or recommendations.

2.5. Step 5: Analysing the results

After charting the data, an analysis was conducted of the data by Author 1 (IT). In the analysis the results of different studies were compared and analysed. Analysis focused on different educational

Table 2
Search strategies.

Databases	CINAHL (n = 258) Academic Search Premier (n = 356) PubMed (n = 238) Scopus (n = 202) Cochrane (n = 1)
Search string (consistent across databases)	(“climate change” OR “global warming” OR “environmental impact”) AND (nurs* OR nurse OR nursing OR nurses OR“ healthcare professional” OR“ health personnel”) AND (Educ* OR curric*)
Limiters	Date (2015–2023) Language (English)

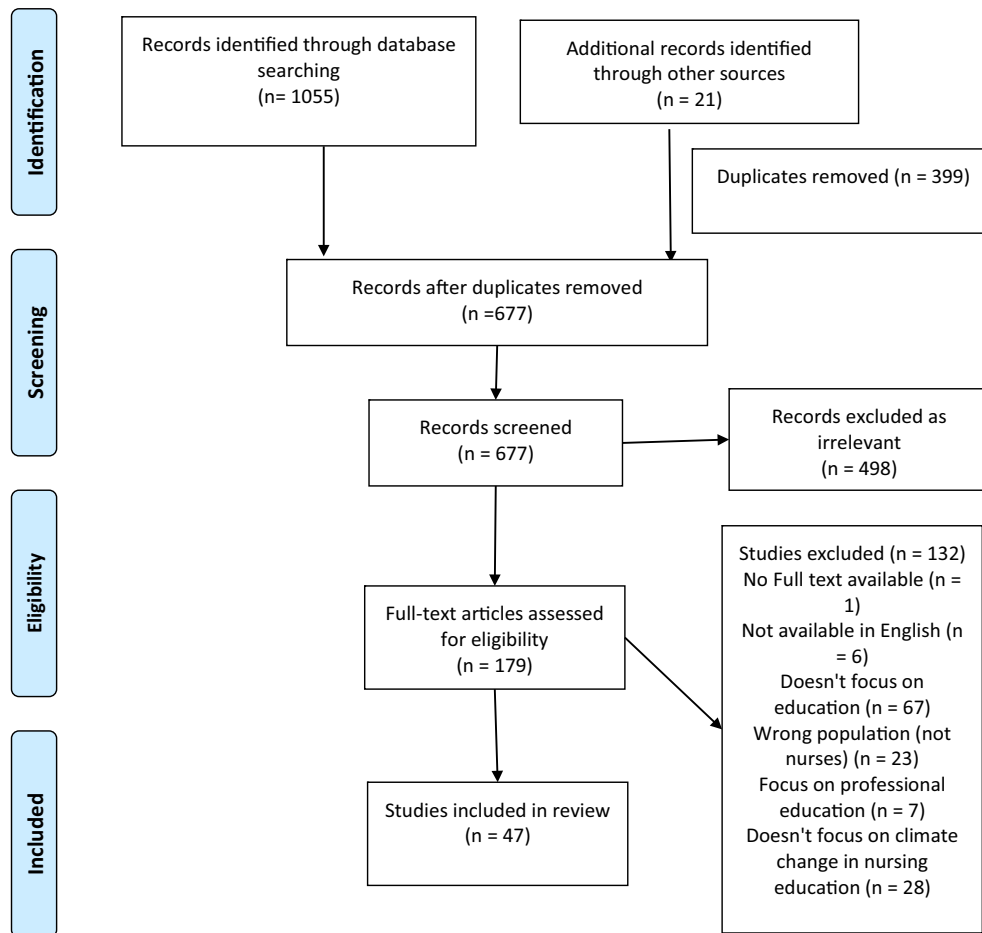


Fig. 1. PRISMA 2009 flow diagram.

Table 3
Literature review eligibility criteria.

Inclusion	Exclusion
<ul style="list-style-type: none"> • Focus on nursing education related to climate change • Nursing students (including AD; BSN; APN; NP; CNS; DNP; PHD students) • Full text available • Research article • Grey literature 	<ul style="list-style-type: none"> • Focus on professional education • Does not focus on climate change in nursing education • Non-English • Does not focus on education. • Non-nursing health students • Including studies on nursing students in conjunction with other health disciplines

interventions and importance of climate change in nursing education. Author 1 (IT) summarized the results and after that team reviewed them, and consensus was reached. The thematic synthesis approach of [Thomas and Harden \(2008\)](#) was applied under rigorous inquiry, which entailed inductive coding, forming of themes, and continuous refinement of the themes. This scoping review was aligned to the methodological guideline as recommended by [Arksey and O'Malley \(2005\)](#). A systematic evaluation of the included studies' quality was considered unnecessary, given that the scoping review is to offer a broad summary of existing evidence.

3. Results

3.1. Characteristics of studies

The included publications predominantly consisted of research articles ($n = 25$), followed by educational/curriculum development articles ($n = 8$), reviews ($n = 3$), position statements ($n = 2$), opinion pieces ($n = 2$), webinar and project reports ($n = 2$), a discussion paper ($n = 1$), a review protocol ($n = 1$), a policy brief ($n = 1$), a case study ($n = 1$), and one that was unspecified or unclear. These articles, representing a wide range of countries, were published between 2015 and 2022. As described in [Fig. 2](#) (articles per year), there was a slight decrease in publications between 2020 and 2021, followed by a subsequent increase.

The 47 articles included in this review underscore the global nature of the phenomenon in review (see [Fig. 3](#) on articles' geographic origin). The United States of America (USA) leads with contributions to 32 % of the articles, followed by the United Kingdom (UK) and Spain, each contributing 9 %. Additionally, articles originated from a diverse set of countries including Sweden, Australia, Germany, Canada, Saudi Arabia, the Philippines, Iraq, Switzerland, Egypt, the Palestinian Territory, Turkey, Brazil, Norway, India, the Netherlands, the Republic of Kazakhstan, and China.

3.2. Strategies of climate change integration to nursing education

Recent developments in nursing education shows increasing emphasis on integration of climate change and environmental topics into educational programs. This can be seen in various teaching methods

Table 4
Study characteristics.

Author(s), Year of publication, Country of origin	Study title	Study design, data collection methods and data analysis	Educational Concepts	Participants	Key findings or Recommendations
Alvarez-Garcia et al., 2019. Spain and UK	Effectiveness of the e-NurSus Children Intervention in the Training of Nursing Students	Quasi-experimental study of time series, Pre&Post intervention, three instruments were used: the Sustainability Attitudes in Nursing Survey, the Children's Environmental Health Knowledge Questionnaire, and the Children's Environmental Health Skills Questionnaire.	Students participated in a taught session entitled e-NurSus Children. As it included interaction with online digital materials using e-learning and CBL, a BOLD learning methodology was used	Nursing students	Nursing students understand the urgency of expanding their expertise to include children's environmental health, given their current limitations in addressing climate-related illnesses. The e-NurSus Children intervention offers a focused and interactive learning experience, seamlessly integrating into nursing curricula to enhance climate change education and competency in managing health issues tied to environmental factors.
Álvarez-Nieto et al., 2022a. Spain	Effectiveness of scenario-based learning and augmented reality for nursing students' attitudes and awareness towards climate change and sustainability.	Time-series analysis, questionnaires (1st year, 2nd year after intervention and 3rd year) SANS2 questionnaire	Scenario-based learning session about an asthmatic child exposed to pollutants at home, school, and city, whose health and care were compromised by the housing conditions and environment in which he lives. The case study was based on real circumstances of the effects of climate change and problems arising from excessive industrialization	3rd year nursing students	Scenario-based learning enriched with augmented reality enhances nursing students' awareness and commitment to climate change and sustainability. Despite their consciousness of unsustainable practices in their workspaces, there is a pressing need to embed sustainability principles more deeply into nursing practices.
Álvarez-Nieto et al., 2017. Spain	Curriculum nurse and strategies training on environmental sustainability and climate change	Narrative review	Study objectives: 1. To describe the dimensions that nursing education should include in terms of environmental sustainability, climate change and health care. 2. To determine pedagogical strategies that allow the integration of environmental sustainability in the competences of graduates in Nursing.		Educating nurses in environmental sustainability, climate change, and healthcare necessitates the integration of competencies across multiple levels. Individually, it requires a foundational understanding and application within professional and staff interactions. Socially, the nursing sector is imperative for advancing environmental health.
Álvarez-Nieto et al., 2022b. Spain, UK, Australia, Germany and Sweden	Nursing students' attitudes towards climate change and sustainability: A cross-sectional multisite study	A cross-sectional multicentre study. Data were collected through the Sustainability Attitudes in Nursing Survey (SANS_2) questionnaire	This study aimed to: 1) investigate nursing students' attitudes towards and awareness of climate change and sustainability issues and its inclusion in nurse education, 2) explore differences across a range of countries, and 3) compare attitudes in 2019 with those of a similar sample in 2014.	1st year undergraduate nursing students	Nursing students are increasingly supportive of incorporating sustainability and climate change education into their curriculum, recognizing its critical connection to health and advocating for robust environmental literacy. Given this positive shift in attitudes, it is imperative to act now and integrate these essential competencies into nursing education programs.
Amerson et al., 2022. USA	Nursing Faculty's Perceptions of Climate Change and Sustainability.	Cross-sectional, descriptive study (online survey consisting of demographic questions, the New Ecological Paradigm Scale, and the Sustainability Attitudes in Nursing Survey 2)	This study focused on perceptions of climate change and attitudes of sustainability of nursing faculty	Nursing faculty	The findings offer initial insights into the existing gaps and areas that require enhancement in the curriculum concerning climate change and sustainability.
Anåker et al., 2021. Sweden	Nursing students' perception of climate change and sustainability actions – A mismatched discourse: A qualitative, descriptive exploratory study	Qualitative, descriptive exploratory study, Individual in-depth interviews and one group interview were conducted for the study.	The study was designed as a qualitative descriptive interview, collecting students' personal accounts to comprehensively grasp their viewpoints on climate change and sustainability, and to explore their self-	Nursing students	Nursing students view themselves as crucial contributors to climate change mitigation and sustainability efforts, highlighting the necessity for nursing education to focus on climate-related health impacts and

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Table 4 (continued)

Author(s), Year of publication, Country of origin	Study title	Study design, data collection methods and data analysis	Educational Concepts	Participants	Key findings or Recommendations
Aronsson et al., 2020. UK	Student nurses exposed to sustainability education can challenge practice: A cohort study.	A cohort study method; data collection on two occasions following exposure to sustainability educational interventions that were designed to be relevant to the nursing undergraduate curriculum	perceived involvement as nursing students in the progression towards sustainable practices. Three educational interventions were spread across three academic years. The first-year students engaged in a case study examining a family facing health challenges attributed to climate change and resource scarcity. In the second year, sustainability education was woven into clinical skills practice, focusing on healthcare supply interruptions and the sustainable management of clinical waste—a session proven to significantly alter student attitudes and knowledge on sustainability and climate change in previous studies with over 600 participants. The third-year session presented a clinical scenario, connecting symptoms of an E. coli outbreak to environmental changes and water quality issues.	1 st year Undergraduate student nurses and midwives	integrate sustainability practices to prepare them for impactful roles in society. study indicates that sustainability sessions, integrated into nursing undergraduate curriculum and focused on aspects of clinical relevance can support nurses to implement change and challenge unsustainable practice
Aronsson et al., 2022a. England and Sweden	Sustainability in Clinical Practice: A Cross-National Comparative Study of Nursing Students in England and Sweden	Cross-national comparative survey design. Third-year undergraduate nursing students from universities in England and Sweden provided responses to open-ended queries featured in the Sustainability Attitudes in Nursing Survey. The data underwent analysis through the application of inductive content analysis.	Both universities have incorporated sustainability and climate change topics in the curriculum, including definitions and health effects. In England, students engaged with teaching and learning content integrated throughout their undergraduate curriculum, utilizing structured resources from the NurSusTOOLKIT (www.nursus.eu). Conversely, in Sweden, the curriculum primarily addressed climate change and sustainability topics in the first year through two specific courses—one centered on medicines management and environmental considerations, and the other on climate change and global issues.	Nursing and midwifery students in their final year of an undergraduate degree	Integrating climate change into nursing education is vital for empowering nursing students in England and Sweden to overcome their reported lack of confidence and actively participate in transforming healthcare practices towards sustainability. It ensures they are well-equipped with the necessary knowledge and skills, fostering a supportive learning environment, enhancing critical thinking, and preparing them to meet the required standards of proficiency for Registered Nurses. This approach not only addresses immediate educational needs but also contributes to long-term change in healthcare settings, promoting environmental sustainability and improved health outcomes.
Aronsson et al., 2022b. UK and Sweden	Awareness and attitudes towards sustainability and climate change among students and educators in nursing: A systematic integrative review protocol	Review protocol	This integrative review aimed to identify research on the awareness of and attitudes towards sustainability and climate change from the perspective of nursing students and educators.		Findings of this integrative review might inform curriculum development, potentially contributing to a future nursing workforce made up of responsible global citizens who look after the health of the planet, and the health of the population inhabiting it.
Australian Nursing and Midwifery Association, 2022, Australia	ANMF Policy brief: Climate change	Policy brief			Climate change needs to be understood as a public health issue and, as such, must be incorporated in undergraduate and postgraduate nursing and midwifery curricula. The

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Table 4 (continued)

Author(s), Year of publication, Country of origin	Study title	Study design, data collection methods and data analysis	Educational Concepts	Participants	Key findings or Recommendations
Barbosa Marques et al., 2016. Brazil	Research-action in the perspective of nursing in environmental education: from theory to practice	Descriptive study of the type case report that used the research-action technique. Data were produced by observations	Aim of the study is to report environmental education experiences held with children of an elementary school developed by undergraduate nursing students		existing and future nursing and midwifery workforce should be educated to understand and respond to health conditions related to climate change. Nursing's role in environmental education is pivotal, aligning with Public Health principles to address determinant factors in health and involving community actors in the health-disease process. The study demonstrates that a conscientizing methodology can effectively educate children about environmental issues, fostering reflection and understanding, and underscores the need for a paradigm shift from discussions to concrete actions for a broader community impact.
Barna et al., 2020. UK, Norway, India, Canada and Netherlands	Education for the Anthropocene: Planetary health, sustainable health care, and the health workforce.		This paper focuses on the climate crisis as an example of the relationship between environmental change, healthcare, and education		Planetary health is a rising field in healthcare, emphasizing the critical connection between climate change-induced disruptions in global ecosystems and human health. It actively seeks solutions that bolster both human wellbeing and environmental sustainability.
Cadet, 2022. USA	Integrating Climate Change Concepts into Advanced Practice Registered Nurses Curricula with the Application of the National Organization of Nurse Practitioner Faculties Competencies	A nonexperimental design	Climate change concepts were incorporated into a nursing curriculum for a family nurse practitioner program into a 14-week course. The teaching methods used to integrate climate change concepts into the APRNs curriculum include readings, classroom discussions, case studies, simulations, team-based learning, projects, and quizzes	20 family nurse practitioner students	Sustainable healthcare strives to provide exemplary medical services for all, with a particular focus on addressing the challenges posed by climate change. This includes preventative measures, efficient care practices, low-carbon treatments, and utilizing energy-efficient infrastructure to ensure the wellbeing of future generations. The integration of climate change concepts into nursing curricula, particularly for Advanced Practice Registered Nurses (APRNs), is a pressing yet unresolved issue in global nursing education. There is a critical need for more research to guide the effective implementation of these topics and to evaluate their impact on student learning outcomes.
Cruz et al., 2018b. Saudi-Arabia, USA, Philippines, Iraq, Egypt and Palestinian Territory	Factors Influencing Arab Nursing Students' Attitudes towards Climate Change and Environmental Sustainability and their Inclusion in Nursing Curricula	Descriptive-comparative study, Environmental Sustainability Attitudes in Nursing Survey-2 (SANS-2) questionnaire	Aim of this study was to assess the factors influencing the attitudes of Bachelor of Science in Nursing students towards climate change and environmental sustainability and the inclusion of these concepts in the nursing curricula of four Arab countries	Bachelor of Science in Nursing students	The findings of this study highlighted the significance of integrating climate change and environmental sustainability into nursing curricula within the Arab region. Incorporating practices of environmental sustainability into nursing education is crucial for equipping student nurses with

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Table 4 (continued)

Author(s), Year of publication, Country of origin	Study title	Study design, data collection methods and data analysis	Educational Concepts	Participants	Key findings or Recommendations
Cruz et al., 2018a. Saudi-Arabia, Philippines and Philippines	Predictors of Saudi nursing students' attitudes towards environment and sustainability in health care.	A secondary analysis of 280 questionnaire	Aim of this study was to investigate the predictors of student attitudes towards the environment and sustainable development in health care.	Bachelor of Science in Nursing students	critical thinking abilities and the skills necessary for providing adaptive healthcare, particularly in settings where resources are limited. Findings of this study highlights the imperative role of cultivating a deeper understanding and awareness among nursing students regarding climate change, environmental issues, and the necessity of sustainability in healthcare practices.
Eide and Odom-Maryon, 2019. USA	Environmental and Climate Change Initiatives in Nursing Education	Survey	Subset of nursing programs in the United States were surveyed to collect evidence for presence or lack of curricular content addressing climate change.	Faculty of Nursing programs in the Pacific Northwest and California	Climate change, as a complex public health issue, impacts various aspects of nursing practice, necessitating its inclusion across all levels of prelicensure nursing curricula. While there have been studies assessing public health nurses' knowledge and attitudes towards climate change, there is a notable gap in similar research within nursing academia, with existing surveys and reviews indicating a lack of adequate educational preparation in this field. Facing a global climate crisis, it is essential for nurse educators to equip students with knowledge on climate change and its impact on health. An interactive activity in a Community Health and Health Policy course introduces senior nursing students to these issues, emphasizing the role of nurses in policy advocacy and climate justice initiatives. Through group discussions and a mock summit format, students engage critically with the topic, demonstrating the necessity of integrating climate change education into nursing curricula to prepare the future workforce.
El Ghaziri and Morse, 2020. USA	Climate change in nursing curriculum: The time is now	Opinion piece			Climate change and global warming are complex issues that demand a deeper understanding than just basic knowledge. It's essential to integrate these topics, their health implications, and the role of nurses into the nursing curriculum to ensure healthcare professionals are equipped to address and counteract their health impacts.
Ergin et al., 2021. Turkey	A mixed method study on global warming, climate change and the role of public health nurses from the perspective of nursing students	Mixed method study that includes descriptive data and focus group discussion	This study aims to evaluate the knowledge and awareness of the nursing students taking the Public Health Nursing course about global warming, climate change, the impact on health and the role of the public health nurse	undergraduate senior nursing student	The results highlight the importance of enhancing the emphasis on climate change and its health-related consequences within nursing education curricula in Arab nations.
Felicilda-Reynaldo et al., 2018. USA, Saudi-Arabia, Iraq, Egypt, Palestinian Territory and Republic of Kazakhstan	Knowledge of and attitudes towards climate change and its effects on health among nursing students: A multi-Arab country study.	Cross-sectional study	Study explored the knowledge of and attitudes towards climate change and its effect on health among nursing students from four Arab countries.	baccalaureate nursing students	The webinar, initiated by a master's-level nursing program, aimed to educate
Gibbs et al., 2022. USA	An Interdisciplinary Collaboration for Environmental Education	Webinar report	The webinar aimed to promote gardening as a means to counteract the	Master's students preparing to become advanced practice	

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Table 4 (continued)

Author(s), Year of publication, Country of origin	Study title	Study design, data collection methods and data analysis	Educational Concepts	Participants	Key findings or Recommendations
			impacts of climate change, targeting master's students aspiring to be advanced practice registered nurses (APRNs), nurses, and the wider community. The focus was on illuminating the intricate connection between human health and the environment, and providing accessible gardening strategies to mitigate the health consequences of climate change. This initiative was a product of an interdisciplinary partnership involving two horticulturists and a garden educator from Sarah P. Duke Gardens, as well as a family NP student and a faculty member from the Duke University School of Nursing (SON).	registered nurses (APRNs)	nursing students and the broader community on the connections between human health, environmental health, and gardening practices in the context of climate change. It highlighted the critical role of nurse practitioners (NPs) in mitigating the health impacts of climate change and emphasized gardening as a practical and scalable intervention. The event served as a replicable educational model, advocating for the integration of climate change education into nursing curricula to better equip NPs for addressing the climate crisis in both clinical settings and the community.
Grose et al., 2015. UK	Integrating sustainability education into nursing using an interdisciplinary approach	Education/Curriculum development article	Scenario-based learning, containing two scenarios: 1) The sustainability and health scenario focused on a possible interruption to supply of healthcare items made from plastics, due to increasing oil prices. 2) Design students were asked to observe and film the procedures so that they could assess the problem and begin to create solutions.	Nursing and design students	This initiative highlights the effectiveness of a scenario-based, interprofessional approach to sustainability within undergraduate curricula, particularly emphasizing the role of education in addressing climate change. Universities are positioned as key players in fostering sustainability, and integrating real-world, practice-based scenarios relevant to students' disciplines enhances the teaching of sustainability in higher education. By encouraging collaboration across different disciplines, students gain a comprehensive understanding of sustainability issues, equipping them with diverse skills and expertise to tackle climate change and sustainability challenges in their professional futures.
Hanley and Jakubec, 2019. Canada	Beyond the Slogans: Understanding the Ecological Consciousness of Nurses to Advance Ecological Knowledge and Practice	Qualitative On-line survey, about nurses and nursing students knowledge and views on environmental health and nursing and the integration of this knowledge into their practice. Data was analysed using Thematic Data Analysis	In study participants answered following questions: <ul style="list-style-type: none"> • What factors influenced your initial eco-consciousness? • How has this consciousness affected you personally, and as a nurse? • How have you integrated this awareness into your practice? 	Canadian nurses and nursing student	Findings in this study highlights the need for curricular approaches in nursing education to actively integrate ecological health, placing a strong emphasis on the environment as a central element. By fostering a personal connection to the environment and instilling awareness and practice from the early stages of education, such as through initiatives like the European Union-sponsored NurSus sustainability curriculum, we can reestablish the vital link between nursing and the environment, preparing nurses to address climate change and ecological health in their future practice.
International Council of Nurses	Nurses, Climate change and health	Position statement			Raise awareness of the health implications of climate change <i>(continued on next page)</i>

Table 4 (continued)

Author(s), Year of publication, Country of origin	Study title	Study design, data collection methods and data analysis	Educational Concepts	Participants	Key findings or Recommendations
(ICN), 2018. Switzerland					and how to assess and address climate change risks to health by developing policy documents on the subject. Embed the concept of sustainability in nursing practice as well as climate change-related knowledge into nursing curricula and in post-registration continuing education.
Keating et al., 2022. USA	Integrating Climate Change in the Curriculum: Using Instructional Design Methods to Create an Educational Innovation for Nurse Practitioners in a Doctor of Nursing Practice Program	Education/Curriculum development article	Educational materials, that included asynchronous and synchronous learning activities	Doctor of Nursing Practice students	Nursing education should be restructured to ensure that nurses are equipped to offer top-tier care that incorporates the deep impacts of environmental factors and climate change on health. The inclusion of climate change and environmental epidemiology in the clinical applied epidemiology course signifies an important advancement, emphasizing that these vital topics should be consistently integrated across the DNP curriculum. This will cultivate critical thinking and promote advocacy and leadership roles in addressing the multifaceted health challenges that climate change presents.
Kurth, 2017. USA	Planetary Health and the Role of Nursing: A Call to Action.	Literature review	Purpose of the study was to discuss the drivers of planetary health, responses, and the role of nursing in making health systems more resilient in an era of increasing stresses. As health providers, scientists, educators, and leaders, nurses have an obligation to prepare for climate change and other impacts of ecosystem strain on human health		The formal and continuing education of nurses and midwives must keep pace with the changing conditions, evolving science, and higher levels of engagement from populations and patients in planetary health matters. Medical and public health curricula have made shifts to include climate change and health matters.
Leffers et al., 2017. USA	Mandate for the Nursing Profession to Address Climate Change Through Nursing Education	Discussion paper			This discussion paper addresses the critical need for the nursing profession to respond to the detrimental health impacts stemming from climate change. It delves into the urgent appeals for action, evaluates the current integration of climate change topics within nursing education, and outlines both the challenges faced and suggested recommendations for enhancing nursing education in relation to climate change and its effects on human health.
Linton et al., 2020. USA	Integrating environmental sustainability content into an RN-to-BSN program: A pilot study	Pilot study followed a pretest/posttest design	sustainability in nursing learning module, over a 4-week period, during which students created blog posts based on the learning materials and clinical practice observations	RN-to-Bachelor of Science in Nursing (BSN) student	initial findings highlight the crucial intersection of nursing education and climate change, serving as a catalyst for more in-depth investigations into the nursing profession's role in environmental sustainability.
Lopez-Medina et al., 2019. Spain, UK and Germany	Competencies on environmental health and pedagogical approaches in the nursing curriculum: A	Systematic literature review	The questions for the focus of this review are: What do nurses need to know about sustainability and climate	32 papers included in review	Integrating climate change and sustainability into nursing education is crucial as it empowers nurses with

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Table 4 (continued)

Author(s), Year of publication, Country of origin	Study title	Study design, data collection methods and data analysis	Educational Concepts	Participants	Key findings or Recommendations
	systematic review of the literature		change? What pedagogic approaches are used to embed sustainability in curricula in nursing or higher education?		essential skills and knowledge, particularly for caring for vulnerable populations like children and the elderly who are most affected by environmental changes. Covering key topics such as resource utilization, health promotion, and the environmental impact of healthcare within nursing curricula enhances the profession's capacity to respond effectively to these pressing global health challenges.
McDermott-Levy et al., 2019. USA	Integrating Climate Change Into Nursing Curricula	Education/Curriculum development article	Article identifies educational strategies in major content areas across undergraduate nursing curricula		Incorporating climate change into nursing education is essential to equip future nurses with the necessary skills for addressing its widespread impacts on public health across all areas of practice. Utilizing existing resources and models like the Ecological Model for Planetary Health ensures that nurses are prepared for climate mitigation, adaptation, and resilience, catering to the diverse needs of various populations
McElroy et al., 2021. USA	Environmental health nursing education: One school's journey.	Case study	Undergraduate Electives, Graduate courses	Undergraduate and graduate nursing students	While substantial progress has been made in the past twenty years in incorporating environmental health education into nursing, there is a critical need to further advance this field, with a specific emphasis on climate change. It is imperative to increase the number of nurses proficient in teaching and mentoring within environmental health, focusing particularly on climate change and sustainability in healthcare, to enhance overall environmental health outcomes.
National League for Nursing, 2022. USA	Vision statement: Climate change and health	Position statement			Nursing leadership in a climate-changing world requires optimal education of nurses across all levels of academic programs to ensure that nurses are well prepared to address adverse health consequences of climate change.
Neal-Boylan et al., 2019. USA	Integrating climate change topics into nursing curricula	Education/Curriculum development article	Unique differences exist for preprofessional, graduate, and professional development education regarding climate change and associated health consequences. Comprehensive curricular goals, objectives, and infusion across courses and programs are key outcomes		Nurses are essential in educating the public, mitigating impacts, and leading resilience efforts against climate change, particularly through raising awareness among health professionals, students, and vulnerable populations affected by climate-related health changes. To enhance this role, integrating climate health education into nursing curricula, especially in

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Table 4 (continued)

Author(s), Year of publication, Country of origin	Study title	Study design, data collection methods and data analysis	Educational Concepts	Participants	Key findings or Recommendations
Nicholas and Breakey, 2017. USA	Climate Change, Climate Justice, and Environmental Health: Implications for the Nursing Profession	Discussion paper			resource-limited settings, is crucial, utilizing tools like the Climate and Health Toolkit and engaging with non-nurse health professionals for comprehensive climate action and education. it is critical to integrate knowledge of environmental health concepts and offer content in baccalaureate and graduate education regarding global climate change and associated negative health outcomes and the policy and advocacy role of nursing worldwide.
Ogunseitan, 2022. USA	Broad spectrum integration of climate change in health sciences curricula	Two workshops for educators, pre workshop questionnaire	Thirty-one courses were presented for transformation with climate change information, among which there were 12 graduate-level courses, 19 graduate-level courses, including a course which simultaneously enrolls undergraduate and graduate students		Theoretical models for curriculum integration are crucial for embedding climate change education within health sciences, offering flexible solutions for packed curricula and ensuring comprehensive coverage of diverse climate-related topics. This approach, adaptable to various teaching formats, necessitates ongoing evaluation of its long-term effectiveness, and can be extended to address other pressing issues like diversity and inclusion through institutional support and faculty engagement incentives.
Quinn Griffin et al., 2022. USA and Canada	Incorporating climate change into Doctor of Nursing Practice curricula	Education/Curriculum development article	A recommendation is to develop advanced level nursing competencies that are observable and measurable that address climate change while incorporating climate change throughout the DNP curricular programs	Doctor of Nursing Practice students	This manuscript advocates for incorporating climate change content into Doctor of Nursing Practice (DNP) curricula, aligning with core nursing competencies and providing advanced learning objectives to increase awareness and integrate climate change topics within courses. The proposed curricular recommendations aim to bolster DNP students' knowledge, attitudes, and skills regarding climate change, equipping them to initiate transformative practices and policy changes across local, national, and global arenas.
Richardson et al., 2016. UK, Germany, Spain, Switzerland	Including sustainability issues in nurse education: A comparative study of first year student nurses' attitudes in four European countries	A comparative survey design using the Sustainability Attitudes in Nursing Survey (SANS_2) questionnaire. Descriptive and inferential statistical methods were used to establish psychometric quality and compare student nurses from the four countries	Aim of this study was to compare student nurses' attitudes towards including climate change and sustainability in the undergraduate nursing curriculum across four countries in Europe. An additional aim was to further assess the psychometric properties of the SANS questionnaire.	Nursing students	The results from this study highlight noticeable differences in sustainability awareness among nursing students from various European nations. The scale presented in the article has proven to be a dependable and valid tool for evaluating the attitudes of nursing students towards sustainability, warranting its application in future investigations to emphasize the importance of climate change in nursing education.

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Table 4 (continued)

Author(s), Year of publication, Country of origin	Study title	Study design, data collection methods and data analysis	Educational Concepts	Participants	Key findings or Recommendations
Richardson et al., 2017. UK	Developing awareness of sustainability in nursing and midwifery using a scenario-based approach: Evidence from a pre and post educational intervention study	Pretest/Post test intervention study using scenario-based learning as the educational intervention. The Sustainability Attitudes in Nursing Survey (SANS_2) was used as the outcome measure	Clinical skills session in a UK University School of Nursing and Midwifery	2nd year undergraduate nursing and midwifery students	Implementing a scenario-based learning method for nursing and midwifery students can positively alter their perspectives and understanding regarding climate change. Integrating this strategy within clinical skills training offers an innovative educational experience that is pertinent to clinical practice.
Richardson et al., 2019. UK, Germany, Spain and Switzerland	A cohort study of sustainability education in nursing.	Cohort study, Questionnaires were used to collect data on participant's attitudes towards sustainability and climate change, how useful the educational sessions were and the extent to which their clinical practice had changed.	Scenario-based learning sessions	Nurse and midwifery students	Embedding topics like climate change in nursing education requires innovative teaching methods, and a scenario-based learning approach using practical case studies can not only reshape attitudes but also promote interdisciplinary collaboration for a more holistic approach to sustainable healthcare solutions.
Ryan et al., 2020. USA	Medical, nursing, and physician assistant student knowledge and attitudes towards climate change, pollution, and resource conservation in health care	Cross-sectional survey of health professional students. Primary objective of the survey was descriptive, but researchers also assessed potential associations between 30 variables of interest and the personal characteristics of gender, age, geographic place of origin, school, and year in school	This study surveyed health professional students – medical, nursing, and physician assistant – at Yale University about their knowledge and attitudes regarding pollution from the health care sector itself, climate change, and responsibility for resource conservation within professional practice	Medical, nursing, and physician assistant students	Integrating education about the healthcare sector's role in pollution, climate change, and its impacts on human health into education for medical, nursing, and physician assistant students is crucial for enhancing professional responsibility and preparedness.
Shaman and Knowlton, 2017. USA	The Need for Climate and Health Education.	Opinion piece			Climate and health education should not be limited to health professional schools. Curriculum is needed for undergraduate programs in public health, earth and environmental science, and sustainable development, to name a few. Executive education programs are also needed to provide senior and mid-level executives, policymakers, and government officials short-course training on the health-related challenges and opportunities from climate change
Shea et al., 2020. USA	Assessment of Climate-Health Curricula at International Health Professions Schools	A survey of 160 institutional members of the Global Consortium on Climate and Health Education	The goal of this study was to assess the climate-health curricular offerings at health professions institutions by surveying the GCCHE membership	GCCHE member institutes	Climate change is increasingly impacting health, necessitating education for health professionals in public health, nursing, and medical services on prevention, mitigation, and response strategies. While the educational landscape on climate-health is diverse and evolving across different institutions, there are still significant gaps and challenges, and it is crucial to enhance awareness, financial support, resources, and expertise to integrate this critical content into health professions curricula and promote its uptake through

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Author(s), Year of publication, Country of origin	Study title	Study design, data collection methods and data analysis	Educational Concepts	Participants	Key findings or Recommendations
Simmonds et al., 2022. USA	Educating Nurse Practitioners About Climate Change, Health, and Climate Justice	Education/Curriculum development article	Article describes one nursing school's experience incorporating these concepts into nurse practitioner curricula.	Nurse practitioner students	guidance and information from online resources and networks. Integrating climate change content into advanced practice nursing education at master's and DNP levels has fostered faculty development and enriched student knowledge on the health consequences of climate change. Faculty have emerged as champions leading integration efforts, students show a keen interest in relating climate threats to clinical practice and policy engagement, and we've found that climate change and climate justice themes can be seamlessly incorporated into existing curricula, complementing ongoing initiatives to address justice, equity, diversity, and inclusion.
Tuna et al., 2022. Turkey	Determination of Nursing Students' Awareness of the Health Effects of Climate Change	Descriptive design survey	Aim of the study was to determine the extent to which nursing students perceive climate change and its effects on health and to determine the education and training needs of students on the effects of climate change	1st, 2nd, 3rd and 4th year nursing students	The study shows that while nursing students are generally aware of climate change and its health impacts, they feel unprepared and believe their education lacks sufficient content on the topic. The high level of concern and willingness to act positively towards climate change highlight the potential for integrating climate change into nursing curricula, suggesting a need for future research on effective incorporation methods and the development of comprehensive tools to assess health professionals' competencies in addressing climate change and its health impacts.
Wasco, 2019. USA	Strategies for Teaching Online RN-to-BSN Students the Health Impacts of Climate Change	Education/Curriculum development article	This article provides an introduction to the impacts of climate change on nursing care delivery and shares the pedagogy of an introductory course developed for an online, post-licensure RN-BSN program based at a university with deep roots in environmental sustainability	RN-to-Bachelor of Science in Nursing (BSN) student	The Climate Change and Human Health course aims to educate RN-BSN nursing students about the health impacts of climate change, fostering a sense of global responsibility. Nursing faculty from various institutions can utilize the active learning strategies and digital tools highlighted in this article to develop similar online courses, laying the groundwork for a healthier future through the integration of climate change topics in nursing education.
Williams and Downes, 2017. USA	Development of a Course on Complex Humanitarian Emergencies: Preparation for the Impact of Climate Change.	Education/Curriculum development article	Novel, 3-day (total 24 h) intensive, graduate-level course focused on introducing nursing students to complex humanitarian emergencies, including natural disasters. (including traditional lecture, case studies, table-top exercises, online modules, video conferences, a panel		As climate change amplifies the risk of natural disasters and Complex Humanitarian Emergencies (CHEs), healthcare responses are increasingly strained, necessitating fundamental skills and competencies in healthcare workers, particularly nurses who play versatile roles during such

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Table 4 (continued)

Author(s), Year of publication, Country of origin	Study title	Study design, data collection methods and data analysis	Educational Concepts	Participants	Key findings or Recommendations
			presentation, and group work)		crises. The educational course outlined in this article introduces nursing students to their critical functions in CHEs, ensuring they integrate this knowledge into their practice for better preparedness in handling humanitarian crises tied to climate change disasters.
Yang et al., 2019. USA	Mitigating a Nursing School's Impact on Climate Change: A Quality Improvement Project.	This quality improvement (QI) project report	This project included three people-, process-, and practice-based interventions. Sustainability Champion Workgroup	Faculty and staff members	Nurses and higher education institutions are key players in reducing human contribution to climate change through environmental sustainability initiatives, which necessitate supportive policies, active engagement, process improvements, and practice shifts. Overcoming barriers to sustainable behaviors and establishing incentives are crucial, with future Quality Improvement (QI) projects in these domains potentially uncovering more ways to tackle the multifaceted aspects of climate change mitigation within higher education settings.
Yang et al., 2018. China and Australia	Associations between knowledge of the causes and perceived impacts of climate change: A cross-sectional survey of medical, public health and nursing students in universities in China	Cross-sectional survey	This study aimed to measure the knowledge and perceptions of medical, public health, and nursing students about climate change and its impacts, and to identify associations between the knowledge and perceptions.	Medical, public health, and nursing students (China)	While medical, public health, and nursing students in China demonstrate a high awareness of the negative impacts of climate change, they exhibit a limited understanding of its causes and the complex pathways leading to its health consequences. A higher level of knowledge regarding the causes of climate change correlates with increased awareness of its negative impacts, but does not necessarily enhance recognition of its health consequences. To adequately prepare health professionals to address the consequences of climate change, there is a need for enhanced education and research into the underlying mechanisms of its health impacts.

and interventions (Fig. 4. Strategies of climate change integration to nursing education) that have been used to improve nursing students' knowledge of climate change. Piloted teaching methods ranged from online programs with interactive discussion forums (Wasco, 2019) to scenario-based learning (Álvarez-Nieto et al., 2022a; Grose et al., 2015; Richardson et al., 2019) and the inclusion of sustainable development subjects in the curricula (Aronsson et al., 2022a; Ogunseitan, 2022; Quinn Griffin et al., 2022). Innovative teaching methodologies such as Blended, On-Line and Digital (BOLD) learning, in which students read online material prior to the class (Alvarez-Garcia et al., 2019) and the use of case studies (Aronsson et al., 2020) were also used to educate students about climate change and health.

The studies revealed the various methods in integration of climate change and sustainability into nursing education. Methods ranged from complete curriculum redesign to exact courses on different educational

levels (Lopez-Medina et al., 2019; Eide and Odom-Maryon, 2019). Various teaching methods were used in piloted courses, such as online learning platforms, simulations, and case studies (Cadet, 2022) and this helped the effective learning and communication of climate change topics. The integration of climate change into nursing education through discussions, simulations, materials, and group learning (Cadet, 2022; Keating et al., 2022) was seen to serve different learning styles. Various standardized education materials show a trend towards more uniform and structured education content (Kurth, 2017; Leffers et al., 2017).

The primary aim of the educational methods and interventions were to develop nursing students' knowledge and attitudes towards climate change and environmental sustainability (Álvarez-Nieto et al., 2017; Álvarez-Nieto et al., 2022b; Cruz et al., 2018a). These findings were confirmed by studies that measured students' perceptions of climate change (Yang et al., 2018) and investigated factors influencing nurses'

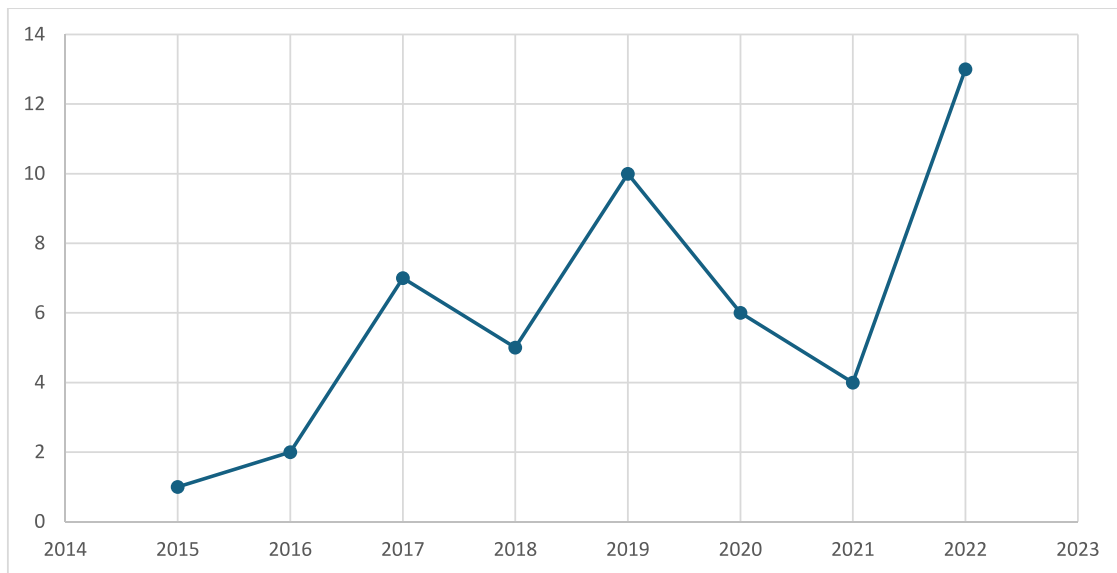


Fig. 2. Article(s) per year.

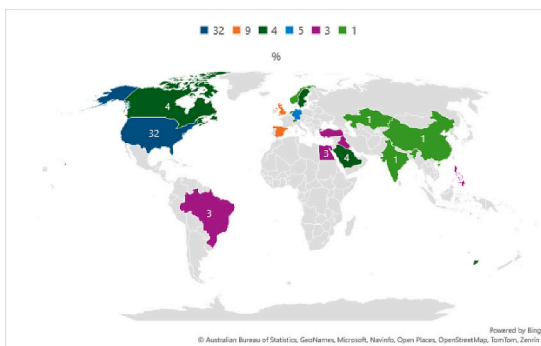


Fig. 3. Articles' geographic origin.

environmental awareness (Hanley and Jakubec, 2019). Innovative multidisciplinary teaching methods, including gardening as part of nursing, enlightened nursing students about connection between environment and human health (Gibbs et al., 2022). It was noted that, climate and sustainability contents in the curriculum should not only be

theoretical knowledge, but also include personal practices and role modelling, such as recycling and saving resources within one's home and workplace (Neal-Boylan et al., 2019; Ogunseit, 2022).

Data from studies showed that different teaching methods, such as scenario-based learning, change the way students related to climate change and sustainability as a nursing issue (Richardson et al., 2017, 2019; Álvarez-Nieto et al., 2022a). These different teaching strategies offered the students the opportunity to learn about climate change. Furthermore, some of the teaching strategies may have given the students experience in new ways of learning. The *E-NurSus* intervention and interprofessional approaches demonstrated the effective integration of these teaching methods into nursing curricula, which improved students' understanding and competence in managing climate change-related health issues (Alvarez-Garcia et al., 2019; Aronsson et al., 2020; El Ghaziri and Morse, 2020; Grose et al., 2015).

Including climate change and environmental sustainability as part of nursing education is crucial for nurses to respond to the health challenges caused by climate change (Aronsson et al., 2022a; Cadet, 2022; Ergin et al., 2021; Keating et al., 2022; National League for Nursing, 2022; Neal-Boylan et al., 2019; Nicholas and Breakey, 2017; Ogunseit, 2022; Richardson et al., 2016). An example of this is a Chinese

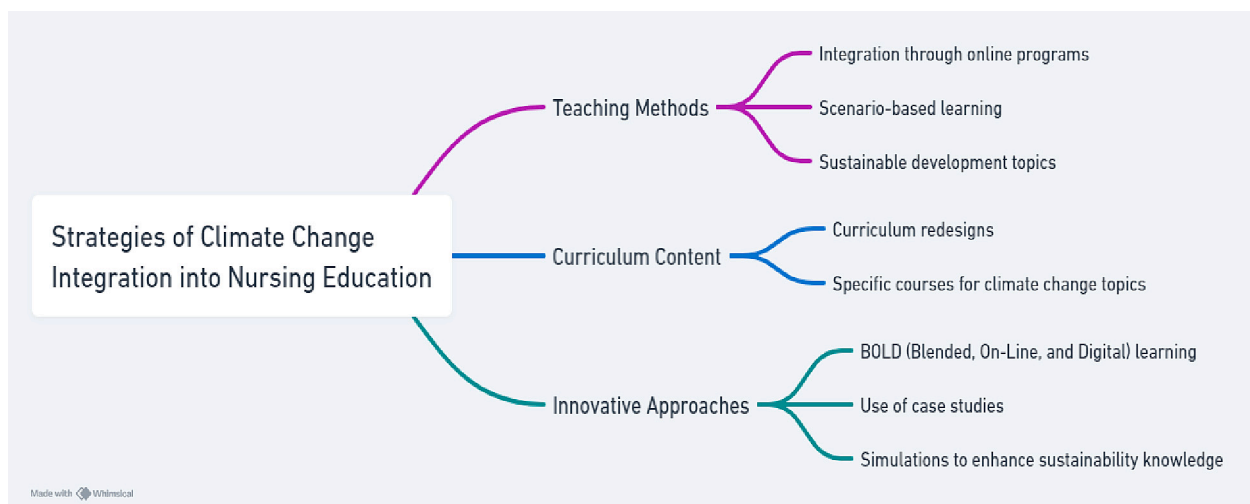


Fig. 4. Strategies of climate change integration to nursing education.

multidisciplinary (medical, public health and nursing students) study that showed that students were aware of the negative effects of climate change but had limited understanding of its causes and the complex pathways that lead to its health effects (Yang et al., 2018). The data also showed that integrating the topic as part of education would be globally important and integration should cover all teaching across the entire lifespan from paediatric nursing to geriatric nursing (Cruz et al., 2018a; Cruz et al., 2018b; Kurth, 2017; Leffers et al., 2017; Linton et al., 2020; Lopez-Medina et al., 2019). This also emphasized the need for a curriculum that promotes critical thinking and skills in future adaptive healthcare (Felicilda-Reynaldo et al., 2018; Hanley and Jakubec, 2019; Kurth, 2017; McDermott-Levy et al., 2019; McElroy et al., 2021).

Integrating climate change into Advanced Practice Nursing (APN) education at the master's and Doctor of Nursing Practice (DPN) levels promoted faculty's development and increased students' knowledge of the health effects of climate change (Simmonds et al., 2022). In addition, the Climate Change and Human Health course aimed at Registered Nurse to Bachelor of Science in Nursing (RN-BSN) students emphasized the importance of active learning strategies and digital tools in online courses (Wasco, 2019). Basic nursing education programs should include education related to the impact of climate change upon human health (Shaman and Knowlton, 2017). A comprehensive approach to climate change in nursing education would not only address immediate educational needs, but also promotes long-term changes in healthcare environments, promoting environmental sustainability.

3.3. Students' perspective of climate change in their education

Nursing students are increasingly recognizing their role in addressing climate change. They see themselves as contributors to sustainability efforts (Anäker et al., 2021). The field of planetary health highlights the connection between climate change and human health and actively seeks solutions that strengthen both human wellbeing and environmental sustainability (Barna et al., 2020). Educational programming such as webinars initiated by nursing programs (Gibbs et al., 2022) and the role of nurse practitioners in mitigating health impacts of climate change (Gibbs et al., 2022; Williams and Downes, 2017) highlight the necessity of focusing on climate change in nursing education. Nursing's role in environmental education aligns with public health principles to address determinants of health and involves community actors in the health-disease process (Barbosa Marques et al., 2016). The findings of these studies highlight the significant role of climate change education in preparing a nursing professional capable of addressing the health of the planet and its inhabitants (Aronsson et al., 2022b; Cruz et al., 2018a; Cruz et al., 2018b; Leffers et al., 2017; Linton et al., 2020). Climate change is increasingly seen as a public health issue that must be integrated into undergraduate and postgraduate nursing and midwifery curricula (Australian Nursing and Midwifery Association, 2022).

Students support the integration of sustainable development and climate change in the curriculum, they are recognizing the connection between climate change and health (Álvarez-Nieto et al., 2022b). The positive shift in attitudes highlights the potential for integrating climate change into nursing curricula (Tuna et al., 2022). Students view themselves as key contributors to climate change mitigation and emphasize the necessity for nursing education to prepare them for impactful roles in society (Anäker et al., 2021). The integration of these concepts is viewed as essential for preparing nurses to address the effects of climate change on public health (Wasco, 2019). Initiatives such as the webinar initiated by a master's-level nursing program educate nursing students and the broader community about connections between human health, environmental health, and gardening practices in the context of climate change is an example of innovative educational programming in nursing (Gibbs et al., 2022).

Integration of climate change and sustainability topics into nursing education is essential to prepare nurses to effectively respond to global health challenges posed by climate change. This integration can be done

by various teaching methods, curriculum content, and nurturing proactive attitudes among students towards climate change and sustainability (Amerson et al., 2022; Aronsson et al., 2022b; Barna et al., 2020; Cruz et al., 2018a; Cruz et al., 2018b; Gibbs et al., 2022; Leffers et al., 2017; Linton et al., 2020; Tuna et al., 2022; Wasco, 2019; Williams and Downes, 2017). Through this approach, nursing education not only addresses immediate educational needs but also contributes to long-term change in healthcare practices, promoting environmental sustainability and improved health outcomes.

3.4. Summary of results

In synthesizing climate change-related strategies and interventions in nursing education, the review identified versatile approaches that encompass teaching methods, curriculum content, and innovative teaching methods (see Table 5. Summary of results). The integration of climate change topics is being achieved through online programs, scenario-based learning, and a focus on sustainable development (Wasco, 2019; Álvarez-Nieto et al., 2022a). Additionally, curriculum redesigns are helping effective communication on these critical issues (Lopez-Medina et al., 2019; Eide and Odom-Maryon, 2019), while the incorporation of BOLD learning, alongside case studies and simulations, is enhancing both knowledge and attitudes towards sustainability (Cadet, 2022; Keating et al., 2022).

In addition, the review highlights students' views on their role in sustainable development efforts and climate change mitigation. Students are increasingly recognizing their influence and responsibility in this area, which is evidenced by their proactive attitude and the educational emphasis on the connection between health and the environment (Anäker et al., 2021; Álvarez-Nieto et al., 2022b). Detailed findings of these strategic approaches and student perspectives are summarized in Table 5, which presents focus areas, descriptions, and evidence supporting the integration of climate change into nursing education.

3.5. Limitations

This study's focus on primarily English-language literature which might introduce a geographic bias by overlooking significant research in other languages. The diverse methodologies used in the studies we included also made direct comparisons and comprehensive synthesis challenging. Future research should aim to include a wider range of languages and geographic areas and update reviews as new information becomes available. Although Arksey and O'Malley (2005) recommend including stakeholders and consumers for deeper insights, time and resource constraints prevented us from doing so in our review process.

4. Discussion

The results of this scoping review highlight the implementation of innovative strategies to educate nursing students of climate-related health issues. These methods promote critical thinking and problem-solving skills and prepare students for the multifaceted challenges of climate change in health care. Furthermore, this was shown to expand nursing practices, highlighting the need for a holistic educational approach across all specialties, enabling nurses to provide care for their patients amid climate-induced health challenges. The review highlights nursing students' growing awareness of their role in mitigating climate change and promoting sustainable healthcare practices, which reflects a broader shift towards environmental protection and public health in nursing. Attention should also be paid to the fact that educational institutions must commit to changing nursing education to address current and relevant content. This is central when educating nurses for future environmental challenges.

Table 5
Summary of results.

Theme	Focus Area	Description	Sources
Strategies of climate change integration to nursing education	Teaching Methods	Integration of climate change through online programs, scenario-based learning, and sustainable development topics.	Wasco, 2019; Álvarez-Nieto et al., 2022a; Grose et al., 2015; Richardson et al., 2019; Aronsson et al., 2022a; Ogunseitán, 2022; Quinn Griffin et al., 2022; Alvarez-García et al., 2019; Aronsson et al., 2020
Strategies of climate change integration to nursing education	Curriculum Content	Curriculum redesigns and specific courses aimed at effective communication of climate change topics.	Lopez-Medina et al., 2019; Eide and Odom-Maryon, 2019; Cadet, 2022; Keating et al., 2022; Kurth, 2017; Leffers et al., 2017
Strategies of climate change integration to nursing education	Innovative Approaches	Use of BOLD learning, case studies, and simulations to enhance knowledge and attitudes towards sustainability.	Cadet, 2022; Keating et al., 2022; Gibbs et al., 2022; Neal-Boylan et al., 2019; Ogunseitán, 2022; Alvarez-García et al., 2019; Aronsson et al., 2020; El Ghaziri and Morse, 2020; Grose et al., 2015
Students' perspective of climate change in their education	Role Recognition	Students recognize their role in sustainability and climate change mitigation efforts.	Anáker et al., 2021; Barna et al., 2020; Gibbs et al., 2022; Williams and Downes, 2017; Barbosa Marques et al., 2016; Aronsson et al., 2022b; Cruz et al., 2018a; Cruz et al., 2018b; Leffers et al., 2017; Linton et al., 2020; Australian Nursing and Midwifery Association, 2022
Students' perspective of climate change in their education	Educational Impact	Webinars and nurse practitioner roles in climate change highlight the importance of focused education.	Gibbs et al., 2022; Williams and Downes, 2017; Barbosa Marques et al., 2016
Students' perspective of climate change in their education	Curriculum Support	Support for integrating sustainable development and climate change in the curriculum, recognizing health connections.	Álvarez-Nieto et al., 2022b; Tuna et al., 2022; Australian Nursing and Midwifery Association, 2022; Álvarez-Nieto et al., 2017; Cruz et al., 2018a; Yang et al., 2018; Hanley and Jakubec, 2019
Students' perspective of climate change in their education	Proactive Attitudes	Students emphasize the need for education to prepare them for impactful roles in addressing climate change.	Amerson et al., 2022; Aronsson et al., 2022b; Cruz et al., 2018a; Cruz et al., 2018b; Leffers et al., 2017; Linton et al., 2020; Wasco, 2019; Shaman and Knowlton, 2017; Simmonds et al., 2022

4.1. Educational strategies for climate change integration

The progress of nursing education in recent years demonstrates efforts to address the challenges caused by climate change, recognizing its effects to human health. This commitment is shown by the adoption of diverse and innovative educational strategies aimed at enriching nursing students' understanding and responsiveness to climate change-related health issues. Notably, the use of scenario-based learning, interactive online forums, and case studies has appeared as a cornerstone in this pedagogical shift, helping a deeper engagement with the complex dynamics between climate change and health outcomes (Wasco, 2019; Álvarez-Nieto et al., 2022a; Richardson et al., 2019).

These educational interventions are not merely about information dissemination; they represent a strategic approach to fostering critical thinking, problem-solving, and adaptive skills among future nursing professionals. The integration of multidisciplinary methods, such as gardening, into the nursing curriculum underscores a holistic view of health that transcends traditional boundaries, linking the well-being of the natural environment directly with human health (Gibbs et al., 2022). Similarly, the adoption of BOLD learning exemplifies a move towards more flexible, accessible, and engaging educational experiences, allowing students to explore the practical implications of their theoretical knowledge in real-world contexts (Alvarez-García et al., 2019). Such innovative methodologies not only enhance the learning experience but also prepare students to navigate the complex and evolving landscape of environmental health challenges (Aronsson et al., 2020; Kurth, 2017; Leffers et al., 2017).

4.2. Implications for nursing practice and education

The importance of integrating climate change into nursing education extends beyond curricular innovation; it reflects a broader shift towards preparing nurses to play a pivotal role in the global response to climate change. As the effects of climate change increasingly permeate all aspects of healthcare, the need for a holistic educational approach that extends across nursing specialties becomes important. From paediatrics to geriatrics, nurses must be equipped with the knowledge and skills to address the diverse health challenges caused by climate change, ensuring a comprehensive approach to care (Cruz et al., 2018a; Cruz et al., 2018b; Kurth, 2017; Leffers et al., 2017). In the realm of nursing practice, it is essential to equip the nursing workforce with the knowledge of nurses' carbon footprints and to provide education on the requisite sustainable and mitigating measures aimed at offsetting carbon dioxide emissions (Tiitta et al., 2021; Cubelo, 2023).

The growing awareness among nursing students of their role in addressing climate change reflects a shift in perspective, aligning with the core principles of public health and community engagement. This awareness is crucial, as nurses are often at the forefront of community health initiatives, where they can influence public attitudes and behaviors towards sustainability and environmental stewardship (Anáker et al., 2021; Barbosa Marques et al., 2016). Furthermore, the integration of climate change education into nursing curricula not only prepares nurses to mitigate and adapt the direct effects of climate change on health but also empowers them to contribute to broader discussions and policy-making efforts aimed at promoting sustainable healthcare practices (Ergin et al., 2021; Neal-Boylan et al., 2019).

In response to these evolving educational and professional demands, nursing education programs are encouraged to continue exploring and implementing innovative strategies for integrating climate change and sustainable development into their curricula. This endeavour should include both theoretical knowledge and practical application so that students can change what they have learned into meaningful action in their communities and professional settings. By promoting a proactive and committed attitude towards climate change and sustainability, nursing education can play a critical role in equipping the next generation of nurses with the competencies needed to navigate and respond to

the complex health challenges of the 21st century (Neal-Boylan et al., 2019; Ogunseitan, 2022).

5. Conclusion

This review studied how climate change is integrated into nursing education and the strategies used to educate nursing students. The results of this review showed diverse strategies of integrating climate change into nursing curricula. In consideration of the present and future demands of nursing practice, it is important to educate nursing students across these areas of climate change. Integrating climate change education into the nursing curricula would, therefore, mean not only understanding the deep nature of the subject but also prepare nursing students for practice amidst challenges that characterize professional nursing. The role of nurses should also be emphasized in policy promotion and climate justice initiatives. As the environmental changes from climate change evolve, nurse scholars will need to continue research on effective methods of teaching aimed at integrating climate change and its impact on health into nursing education.

Integrating climate change into the nursing curriculum heralds an important shift of preparing healthcare professionals to take on the challenge for the biggest threats to human health in this century. The use of advanced teaching methods has shown considerable promise in deepening students' understanding of and agility in responding to the health impacts of climate change. Additionally, the marked shift in nursing students' attitudes towards climate change reflects a growing recognition of their role in advocating for sustainable health care practices.

While significant progress has been made, the opportunity for further research gives an interesting opportunity for innovation in nursing education. The long-term effectiveness of these educational interventions in influencing nursing practice and patient outcomes in the context of climate change is an area ripe for exploration. In addition, the successful teaching practices lack scalability and generalizability for possible replication across educational and healthcare settings. There is also the need for wholistic studies that would assess the integration of the content on climate change in different specializations of nursing with the aim of seeing a wholistic approach to education. Addressing these research gaps is necessary for refining and optimizing the integration of climate change into nursing curricula. Doing so will continue to further develop and integrate education within nursing into the changing contour of global health, so that future professionals will be uniquely equipped to meet and integrate with the challenges and opportunities that climate change offers public health.

CRedit authorship contribution statement

Iira Tiitta: Writing – review & editing, Writing – original draft, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **Floro Cubelo:** Writing – review & editing, Methodology, Data curation, Conceptualization. **Ruth McDermott-Levy:** Writing – review & editing, Supervision, Methodology, Data curation, Conceptualization. **Jouni J.K. Jaakkola:** Supervision, Methodology, Conceptualization. **Lauri Kuosmanen:** Supervision, Methodology, Conceptualization, Writing – review & editing.

Declaration of competing interest

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