

Nurses as agents for achieving environmentally sustainable health systems: A bibliometric analysis

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Abstract

Aim: To analyse the current scientific knowledge and research lines focused on environmentally sustainable health systems, including the role of nurses.

Background: There seem to be differences between creating interventions focused on environmentally sustainable health systems, including nurses, and the scarcity of research on this topic, framed on the Sustainable Development Goals.

Methods: A bibliometric analysis was carried out, via three databases (Web of Science, Scopus and Pubmed), and the guideline recommendations were followed to select bibliometric data.

Results: The search resulted in 159 publications, significantly increasing the trends from 2017 to 2021 ($p = .028$). The most relevant countries in this area were the United States, the United Kingdom and Sweden. Also, the top articles were from relevant journals, indexed in Journal Citation Report, and the first and the second quartiles linked to the nursing field and citations ($p < .001$).

Conclusion: Education is key to achieving environmentally sustainable health systems via institutions and policies.

Implications for Nursing Management: There is a lack of experimental data and policies on achieving or maintaining environmentally sustainable health care systems, indicating that nurses have an important role and should be consulted and included in decision-making policies regarding sustainability in the health care systems.

KEYWORDS

bibliometrics, environment, environmental research, global health, health research policy, nursing

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1 | INTRODUCTION

The environment is a determining factor in the well-being and health of the population, causing a negative impact when it is toxic or unbalanced (Kiang & Behne, 2021). Air and soil pollution, imminent climate change, the destruction of healthy ecosystems and the creation of ideal ecosystems for new microorganisms, such as the SARS-COVID-2 virus, among other factors, are reducing the quality of life and increasing mortality (Fields et al., 2021). From Florence Nightingale to the present, the environment makes it possible to improve the patient's disease process (Kiang & Behne, 2021). Still, if it is damaged or contaminated, it can even harm it in the short- and long-term health (Fields et al., 2021).

Health systems are one of the more significant industries that consume a tremendous amount of water, food, plastic materials and energy (Fields et al., 2021). World Health Organization indicated in 2009 that the health sector might have one of the highest footprints linked to energy and material consumption (World Health Organization, 2009). Sustainable awareness and climate-friendly programmes can provide a high quality of care and reduce the production of waste, plastic and emissions (Kiang & Behne, 2021). The World Health Organization has promoted such programmes and interventions since the beginning of 2010 (General Assembly, 2011), but it was not until 2017 that a definition of environmentally sustainable health systems was given. Environmentally sustainable health systems are 'health system that improves, maintains or restores health, while minimizing negative impacts on the environment and leveraging opportunities to restore and improve it, to the benefit of the health and well-being of current and future generations' (World Health Organization, 2017). To achieve such a definition, the pillar is the integration of health care workers, especially nurses, since they are the primary health care workforce (Álvarez-Nieto et al., 2022). Diverse authors have highlighted the vital role of nursing in climate change, their relevance in the Sustainable Development Goals, especially Goal 3, and the importance of nursing education in the environmental awareness framed in Goal 4 (Anåker et al., 2015).

The education in sustainability and its awareness among nurses have been described as pillars to mitigate the negative impact of pollution on people's health (Leffers et al., 2017), being entangled in all 17 Sustainable Development Goals (Anåker & Elf, 2014; Kearns & Kearns, 2021; Kitt-Lewis et al., 2020). Therefore, nurses are engines of change in the current health system regarding environmental sustainability through research, and projects are integrated to achieve it (Lilienfeld et al., 2018; Richardson et al., 2016). Recent research indicated a scarcity of research focused on nurses and environmentally sustainable health systems (Osingada & Porta, 2020). Additionally, this pandemic has increased hospital waste and disposal and unsustainable options, limiting the sustainable policies instituted (Sarkodie & Owusu, 2021). There seem to be differences between creating interventions focused on environmentally sustainable health systems, including nurses (Álvarez-Nieto et al., 2022; Osingada & Porta, 2020) and the scarcity of research on this topic (Sarkodie & Owusu, 2021).

Based on these discrepancies, it is necessary and appropriate to investigate how this revolution toward environmental sustainability is going and what nurses' role as agents is to create environmentally sustainable health systems. The objective of this research was to analyse the current scientific knowledge, and research lines focused on environmentally sustainable health systems, including the role of nurses during this last decade. Also, a secondary objective was to determine the nursing education and interventions to improve the environmental awareness among them.

2 | METHODOLOGY

2.1 | Research structure

Bibliometric analysis has been used in nursing to analyse meta-approaches and data research (Kokol, 2021). Nonetheless, only one bibliometric analysis includes some ideas about the sustainability in the health sector and the role of nurses (White et al., 2014). Therefore, the current research was structured to cover this topic following the workflow described by Aria and Cuccurullo (2017): first, the research design, which included the research questions (research questions according to Zupic & Čater, 2015); second, the selection of the bibliometric and visualization section (SPSS program and Vosviewer); and third, the compilation of the bibliometric data (via three major databases in health: Scopus, Web of Sciences and PubMed), analysis (bibliometric analysis and use of programmes), visualization and interpretation.

2.2 | Data gathering

The research questions proposed were as follows:

Research Question 1. Which are the publication trend and differences from the definitions of the World Health Organization?

Research Question 2. Which countries and journals contribute to this field, and what is their relationship?

Research Question 3. Which are the top publications and authors focused on interventions to obtain environmentally sustainable health systems and the inclusion of nurses?

Research Question 4. How did the research focus and major topics evolve in the timeframe?

Research Question 5. What influence of nurses have as agents and based on their workforce in the sustainability of health care systems?

Based on these research questions, the research strategy followed the population, intervention, comparison and outcome structure, which led to selecting the keywords and medical subject heading. The research strategy was formed by search strings: 'Sustainability', 'Nursing' and 'Environment' and a time limit of 10 years.

The review's inclusion criteria were articles indexed in the databases that contained some of the keywords from the thematic area of nursing. The exclusion criteria were other thematic areas and documents focused on different systems and health care workers and not framed in the World Health Organization's definition.

An initial search carried out in September 2021 using 'nurse' and 'sustainability' identified 1112 from Scopus and Web of Science databases. The results were reduced after the double peer revision from researchers, leaving 87 articles that would provide information on the topic. Based on the scarcity, the final research implemented in January 2022 was TITLE-ABS-KEY (nurs* AND environment* AND sustainable) in Scopus; TS = (nurs* AND environment* AND sustainable) in Web of Sciences and ((nurs*[Other Term]) AND (sustainable[Other Term])) AND (environment[MeSH Terms]) in PubMed.

After applying the time limit, 852 documents were obtained in Scopus, 677 papers in Web of Science, and 19 in PubMed, exported in an excel and bibliographic format (.csv and .enw) to be reviewed in the Endnote program (Clarivate Analytics, London, UK). The documents' details included author(s), affiliation, type of publication, title, abstract, keywords, year of publication, language and the number of citations. Further searches were implemented in other databases (Google Scholar and Dialnet) using the exact search string. Finally, grey literature relevant to the topic (conference papers) was included (Figure 1).

The selection of the documents for the quantitative analysis followed the PRISMA recommendations (Page et al., 2021). Two researchers screened the documents' titles, abstracts and keywords. During the analysis, 468 documents were eliminated since they focused on unrelated topics, such as fishing, biodegradation of waste or microplastic in the oceans. Also, 450 documents were not included

since they focused on environmentally sustainable systems. Finally, 159 papers related to the nurses and sustainability in the health system environment (Figure 1).

2.3 | Trend and association analysis

After obtaining all the data structured in the csv. format using the Excel version 17 (Microsoft Corporation, Redmond, Washington, USA), SPSS program version 28 (IBM Corporation, Armonk, NY, USA) and VOSviewer version 1.6.15 (Ness Jan van Eck, Netherlands) were used to determine significant differences, citation analysis and mapping and networking.

The data analysis was qualitative (mapping the items and checklist of the publications) and quantitative (statistical analysis). The qualitative analysis of the maps to identify the thematic and semantic structure of the scientific domain, visualizing its relationships with other keywords, completed with a manual and critical selection for the final filtering of the keywords, eliminating those that had to be with different themes such as stressful work environments or burnout. The checklist implemented was the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) and Enhancing the Quality and Transparency Of health Research (EQUATOR).

The quantitative analysis included metrics (Journal Citation Report, quartile and Journal Citation Indicator of the year 2020 and the year of publication) and details of the documents, such as the count of cites according to PlumX Metrics. The research results were analysed using descriptive analysis, such as the frequency of

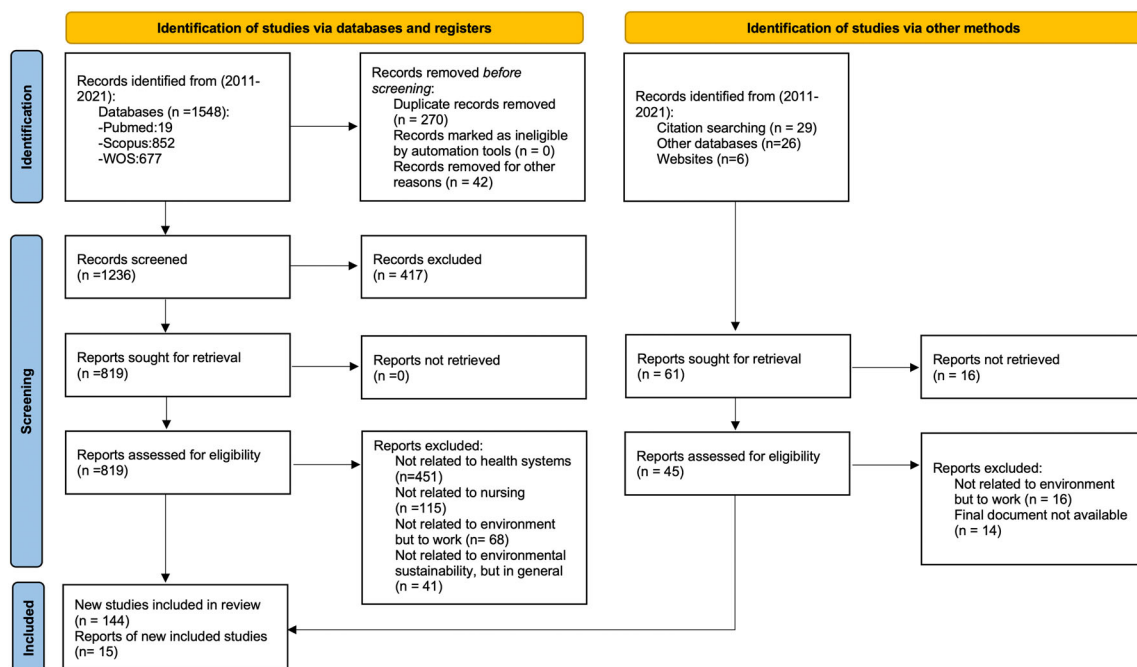


FIGURE 1 PRISMA 2020 flow diagram for systematic reviews. WOS, Web of Science

publications per country. The nonparametric tests (Kolmogorov–Smirnov $p < 0.001$) were used according to the variable, such as the Mann–Whitney test or Spearman's correlation.

2.4 | Ethical considerations

This research is framed on PhD research called “The Nursing Responsibility in the Environmental Sustainability” and framed on the Biomedicine Programme, receiving the ethical approval from the regional hospital (no. 267, ref. 3605). This research did not use patient data, with the information being available on databases. Nonetheless, the research respects the principles of Bioethics of the Oviedo Convention, the Helsinki Declaration and the current Spanish Data Protection Laws (5/12/2018).

3 | RESULTS

Table 1 shows the frequency of academic publications related to the environmentally sustainable health sector, including the role of nurses. The trend of publications indicated that the change occurred in 2017, being the most prolific researchers in 2019 and 2020. Additionally, the median of the year of publication was set in 2018, which matched the more substantial number of publications. From 2011 to 2021, the most published documents were articles (originals 81.10% and reviews 5.69%) being no significant differences according to the year of publication ($p > .05$). These documents were mainly from the United States (32.08%), followed by the United Kingdom (10.69%). They were most of them published in indexed journals (Table 1), being independent of the year of publication ($p > .05$). This trend of publication seemed to be associated with the number of citations ($p < .001$), being more relevant than the difference between the 2017–2021 (value = 44.49; $p = .028$) and the Journal Citation Report of the year of publication ($p = .046$).

The countries with a higher number of publications and higher number of citations were the United Kingdom (number of publications = 10.7% and 8.25 ± 14.29 cites; IC at 95% 0.64–15.68), the United States (number of publications = 32.1%; 5.92 ± 6.98 ; IC at 95% 3.95–7.89), Australia (number of publications = 8.8%; 3.78 ± 3.31 ; IC at 95% 1.86–5.69), Spain (number of publications = 6.9%; 6.0 ± 9.49 ; IC at 95% 0.38–12.38) and Sweden (number of publications = 5.0%; 11.25 ± 17.87 ; IC at 95% –3.69–26.19). The co-currency of countries indicated that there were four clusters formed by nine countries (Figure 2), with the first (red) constituted by the United States (48 documents and eight links) and Sweden (nine documents and eight links). The second (green) was constituted by Australia (20 documents and eight links) and Taiwan (three documents and three links). Meanwhile, the third was formed by the United Kingdom (23 documents and seven links) and Spain (16 documents and seven links), and the fourth was formed only by China. The comparison between the countries and associations between these was related to the number of cites ($p = .006$), with the differences being more significant between the countries with fewer publications, such as France (2.5%), compared with the United States (value = 36.34; $p = .001$), which was also associated with the Journal Citation Indicator in 2020 ($p = .021$).

According to the cites, the relevance of these countries in this topic is also reflected by the top 10 articles (Appendix S1). Appendix S1 shows how the most relevant investigations (7/10) were published in the top countries (Figure 2), which were also co-writing the results (3/10). Most of the studies were reviews (6/10), from systematics and scoping to scientometrics, followed by original studies, qualitative (2/10) and observational (2/10). The quality of the studies based on the checklists indicated that the qualitative analysis had higher methodological quality than the observational studies (Anãker et al., 2015, had 93.75% while Richardson et al., 2014, had 34.38%). The data (Table 2) indicated that the most relevant articles were published in 2013 or 2014, being their thematic area focused on education, Sustainable Development Goals and care. Only one of the top 10 articles

TABLE 1 The trend of publication on this topic and differences regarding the type of publication, the affiliation of the author, indexed in Journal Citation Report and Quartile (Research Question 1)

Year of publication	Frequency	Type of documents	Country	Indexed at Journal Citation Report	Quartile
2011	1.3%	Articles	The United States of America (USA)	Indexed	Quartile (Q1–Q4)
2013	1.3%	86.8%	32.1%	61.0%	61.6%
2014	3.8%	$p = .91$	$p = .28$	$p = .17$	$p = .28$
2015	5.0%				
2016	8.8%				
2017	13.1%				
2018	8.8%				
2019	15.6%				
2020	24.4%				
2021	18.1%				

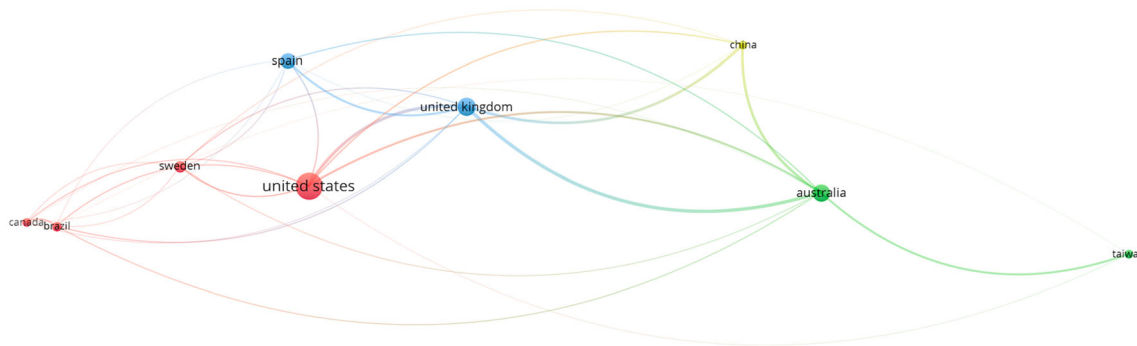


FIGURE 2 Co-currency of countries based on bibliographic coupling with a maximum of 25 documents and a minimum of five (Research Question 2)

TABLE 2 Top 10 authors published in the topic, with h-index, citations and total publication

Author	Publications on the topic	h-index	Total citations	Total publications	First publication	Affiliation	Author ID
Rosa W.E.	11	12	511	123	2014	United States	56194379200
Grose J.	4	11	394	30	2012	United Kingdom	55226482400
Richardson J.	3	46	7094	200	1993	United Kingdom	35500478000
Beck D.M.	3	5	80	19	1998	Canada	15761985500
Cunha I.C.K.O.	3	9	323	79	1995	Brazil	7003935865
Elf M.	3	16	699	59	2001	Sweden	23008276300
Dossey B.M.	3	11	358	68	1993	United States	7004496398
Anåker A.	2	7	173	12	2004	Sweden	56056321800
Furukawa P.d.O.	2	3	37	6	2010	Brazil	36463381900
Marck P.B.	2	16	738	62	1993	Canada	6701740195

was in sync with the definition of an environmentally sustainable care system (Dossey et al., 2019). However, other authors indicated the relevance of sustainability in health systems, including hospitals or primary care.

The top five articles regarding the cites (Table 2) were carried out in Sweden, International collaborations (the United Kingdom, Brazil, Belgium, Ghana and Australia), the United Kingdom, and the United States. These results were published from 2013 to 2019, most of which were among the top 10 from 2014. Moreover, this table also indicated how the top articles were from relevant journals, indexed in Journal Citation Report, and the first and the second quartiles linked to the nursing field and linked to the number of cites ($p < .001$).

A further analysis was carried out based on the dominant authors on this topic (Research Question 4). The top five authors (Table 2) who focused on this subject during the last decade were also from the leading countries and collaborated among them (Figure 3). The mean of the h-index of the top 10 authors was 13.6 ± 12.1 , the mean of citation 1040.7, and a mean of 65.8 documents. The principal authors were from the United States (Rosa W.E. and Dossey B.M.), the United Kingdom (Grose J. and Richardson J.) and Sweden (Elf M. and Anåker A.), followed by Brazil (Cunha I.C.K.O. and Furukawa P.d.O.) and Canada (Beck D.M. and Marck P.B.).

Rosa W.E. tops this field with 11 documents during the last decade, with 123 publications mainly in the area of *Dental Practice*; *Delivery of Health Care* and *Environmental Sustainability*, followed by Grose J., who also published in the same area as Rosa W.E.

Nonetheless, the author with the h-index is Richardson J. (h-index of 46), Elf M. with an h-index of 16, Marck P. B with an h-index of 16 and the fourth Rosa W. E. with an h-index of 12 (Table 2). The top published on this topic started to publish in 2012 and 2014, also connected among the authors (Figure 3).

The connection of the authors, based on co-citations, indicated that the top authors were cited between them (Figure 3). The co-citation of the authors pointed out that there were clusters among the authors, with the first (red) constituted by 14 authors, led by Richardson J. (citations = 38, links = 25), Grose J. (citations = 26, links = 25), Anåker A., (citations = 24, links = 24) and Elf M. (citations = 23, links = 24). The second cluster (green) is formed by 11 authors, led by Rosa W.E. (citations = 34, links = 21) and Dossey B.M. (citations = 34, links = 19). The last cluster is formed by three authors, led by Haines A. (citations = 19, links = 26), whose h-index is 85, but mainly published on *Climate Change*; *Rockefeller Foundation*; *Malnutrition*, including Gonzalez-Garcia S. from Spain (12 citations and h-index of 41). These results indicated that most connections were

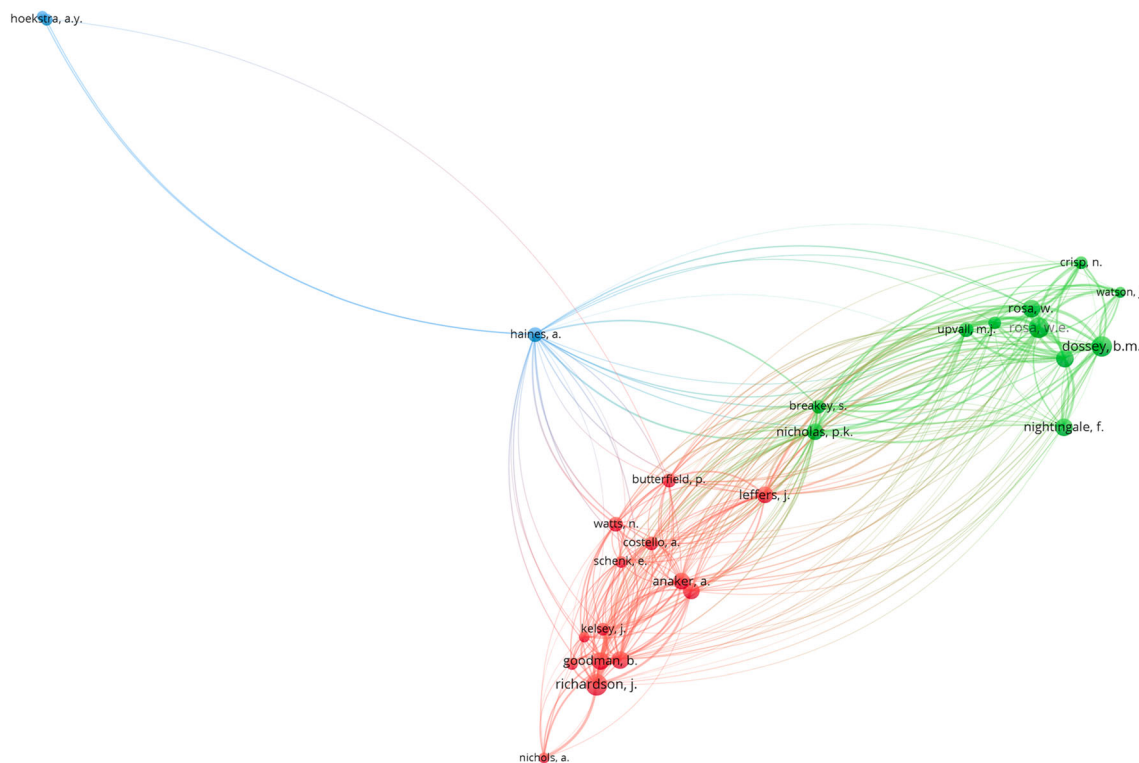


FIGURE 3 Connections between authors based on co-citation with 25 documents and a minimum of 10 (Research Question 4)

established between researchers from United States, United Kingdom, Sweden and Spain (Research Question 4).

Finally, the keyword analysis was carried out to determine the current lines of research on this topic (Research Question 5). Four clusters were identified that include 80 keywords represented by red (first with 28 keywords, 1108 links and 271 occurrences), green (second with 24 keywords, 875 links and 182 occurrences), blue (third with 17 keywords, 687 links and 261 occurrences) and yellow (11 keywords, 476 links and 110 occurrences) (Figure 4). The first cluster was led by the keywords ‘organization and management’ (65 links and 20 occurrences) and ‘nursing education’ (59 links and 23 occurrences). This cluster represented one of the main topics based on sustainable education, including the training, curricula and competencies. The second, including the terms ‘nurses’ (71 links and 26 occurrences) and ‘waste management’ (45 links and nine occurrences), highlighted the subtopic of the nursing profession and nursing discipline in environmental sustainability. The cluster focused on primary health care responsible for preventing this impact through health promotion and prevention of diseases related to environmental environments and pollutants. The third cluster had significant terms ‘sustainable development’ (73 links and 52 occurrences) and ‘United Nations’ (40 links and 25 occurrences). This cluster is based on environmental sustainability through protection and prevention of its impact, for example, through the waste that is generated or the essential elements of nature in the environmental sustainability of Florence Nightingale. The last cluster, whose leading keywords were ‘environmental protection’ (61 links and 17 occurrences), ‘education’

(51 links and 12 occurrences) and ‘organization’ (46 links and 10 occurrences), focused on health policy to maintain the environment. This cluster highlighted the relevance of education and policies to preserving the ecosystem and achieving environmental health.

4 | DISCUSSION

This study aimed to determine the current scientific knowledge and research lines focused on environmentally sustainable health systems, including the role of nurses during this last decade, and to choose the nursing education and interventions to improve the environmental awareness among nurses.

The trend of publication, major countries and connections between them, the most relevant authors and what are the topics more analysed by the authors indicated associations between countries, the importance United Nations’ recommendations (General Assembly, 2011) and the most relevant topics.

First, the trend analysis indicated that the period with a higher number of publications is from 2017 to 2021, despite a slight decrease during 2021. This trend matched the inclusion of nursing in the sustainability (Benton & Shaffer, 2016) and environmentally sustainable health systems’ definition (World Health Organization, 2017). This tendency also matches previous bibliometric analyses that indicated how nursing had grown exponentially during the last decade (Kokol, 2021). There are more reviews on this topic (Lilienfeld et al., 2018). Nonetheless, the Covid-19 has impacted this research

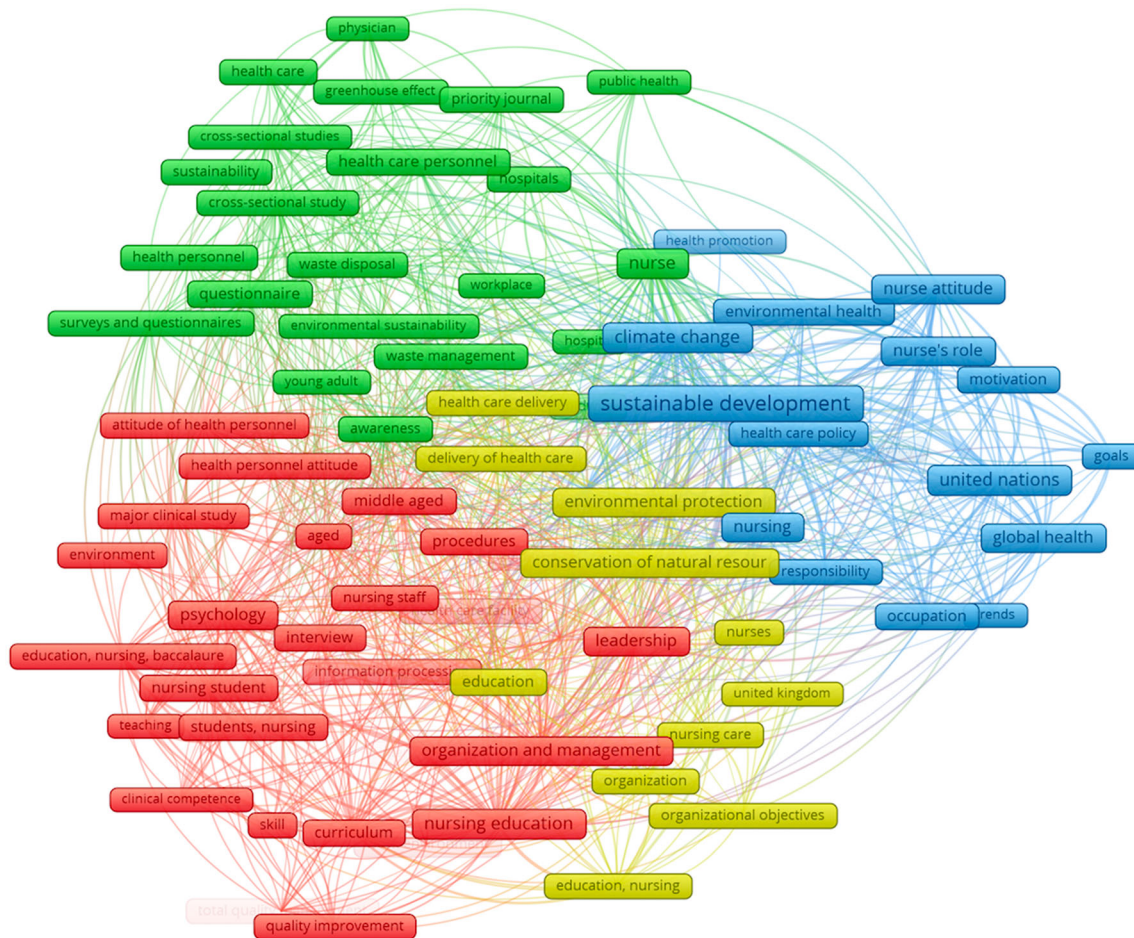


FIGURE 4 Co-occurrence of most common index terms per document with a minimum of five connections. Note: Words unrelated to the topic were eliminated (human/s, article, gender, adult and human experiments) (Research Question 5).

since there was a decrease from 2020 to 2021, which could be explained by the findings of Osingada and Porta (2020). Their results stated how the pandemic had impacted this field and even reduced the number of available publications.

Besides, most of the publications were from Northern countries, interconnected among themselves. These results are consistent since these major countries are the geographical base of diverse international organizations, such as the United Nations.

Analysis of the top 10 publications, mainly carried out in such countries and by the 10 top authors like Anåker or Richardson, focused on the role of nursing in diverse areas but was highly repetitive about the relevance of the education and their role in Sustainable Development Goals. Also, it reflected the lack of original studies framed on the definition (World Health Organization, 2017) and the role of nurses in obtaining it, which is understandable since the definition is recent. The articles introduce the idea of environmentally sustainable health systems and the role of nursing in improving awareness. However, empirical data were missing on how to achieve such awareness and environmentally sustainable health systems. One example of this lack of empirical data and the reviewing of the nursing role is the article published by Dossey et al. (2019). This publication

(Dossey et al., 2019) highlighted education in sustainability as critical, especially for Goal 3, but the authors do not present a unified action to achieve it.

In this sense, Yakusheva et al. (2022) highlighted the need for value-informed decision-making to achieve environmentally sustainable health care systems. Only one of the articles, even published after 2017 (Dossey et al., 2019), presented the idea, achieving it through education (Lilienfeld et al., 2018; Rosa et al., 2019). Most of the top ten articles indicated the high relevance of education nurses as agents to integrate, framed the Sustainable Development Goals, and create environmentally sustainable health systems.

Moreover, from the analysis of the keywords, it can be concluded that the role of nursing in this topic is diverse but that it focuses on education, organization and management, policies to maintain or create an environmentally sustainable system. Also, the analysis indicated that the organizations, mainly United Nations, and their reports or recommendations, mainly the Sustainable Development Goals, are essential to nurses as guides to incorporate actions and measures to be effective agents, which were also patent in different works of the top 10 publications (Benton & Shaffer, 2016; Kurth, 2017; Pettigrew et al., 2015).

4.1 | Limitations

The study's main limitation is the selection of the keywords, which was tried to be mitigated by including three databases and a follow-up of the PRISMA declaration carried out via a double peer screening. Additionally, the analysis was focused on the quantitative analysis, reducing the qualitative results to the top 10 articles.

5 | CONCLUSION

The bibliometric analysis indicated that research in environmentally sustainable health care systems is currently more theoretical. The research literature told how nurses are pivotal to the environment. Still, there is a lack of publications that analyse on this topic.

Nursing education is key to achieving it, being relevant in organizations, management and policies integrating high quality education so nurses can be active and positive agents in creating and maintaining environmentally sustainable health care systems.

6 | IMPLICATIONS FOR NURSING MANAGEMENT

The current research presents a bibliometric analysis that explores the role of nursing in environmentally sustainable health care systems relevant to Sustainable Development Goals, highlighting the importance of education and policies that include nurses. Global collaborations were identified in the current research, highlighting the role and connections between the major authors' countries and how these countries have relevance in major institutions. However, there is a lack of experimental data and policies on achieving or maintaining environmentally sustainable health care systems, indicating that nurses have an important role and should be consulted and included in decision-making policies regarding sustainability in the health care systems. Additionally, to adequate management and policies, nursing education continues to be vital in achieving sustainability and, therefore, the Sustainable Development Goals. Therefore, continuous training should be included for nurses.

The findings are exciting since this is the first bibliometrics analysis to identify the role of nursing in achieving environmentally sustainable health care systems. The findings indicated that there is a need for further original publications on this topic and this would happen during the decade of Agenda 2030, and education is key and should be included in the diverse institutions and policies created.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ETHICS STATEMENT

This research is framed on PhD research called 'The Nursing Responsibility in the Environmental Sustainability' and framed on the Biomedicine Programme of IMIBIC and University of Cordoba, receiving the ethical approval from the regional hospital (no. 267, ref. 3605). This research did not use patient data, with the information being available on databases.

DATA AVAILABILITY STATEMENT

Authors do not wish to share the data.

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SUPPORTING INFORMATION

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