Volume: 9 Issues: 63 [June, 2024] pp. 119 - 135
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.jised.com
DOI: 10.55573/JISED.096308

UTILISATION OF ARTIFICIAL INTELLIGENCE IN NURSING CARE - GAP FROM AN ISLAMIC PERSPECTIVE: A BIBLIOMETRIC REVIEW

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Article history

Received date	:	8-2-2024
Revised date	:	9-2-2024
Accepted date	:	6-5-2024
Published date	:	25-6-2024

To cite this document:
Wan Mamat, W. H., Mahat, N. A., Zainudin, A. A., Salah, M., Mohamad Shariff, N., Syed Elias, S., & Isa, S. N. I. (2024). Utilisation of artificial intelligence in nursing care - gap from an Islamic perspective: A bibliometric review. *Journal of Islamic, Social, Economics and Development (JISED)*, 9 (63), 119 – 135.

Abstract*: The integration of artificial intelligence (AI) into nursing care within healthcare settings is on the rise, promising significant benefits for patients. AI technologies hold the potential to improve nursing care for various medical disorders, thereby improving the overall quality of services. The objective of this study is to investigate the current trends and analyse their evidence on this topic. This study utilised the Scopus database to identify and compile comprehensive information from English-language articles on AI in nursing care. Through bibliometric indicators, the study conducted a quali-quantitative analysis to examine the growth rate of publications and subject areas and identified the most active countries, institutions, journals, and authors. Visual cooperation network maps for countries, organisations, authors, citations, keywords, and other pertinent aspects were generated and analysed using VOSviewer and the Bibliometrix R-package. The search identified 223 non-duplicated articles. Fewer publications were noted between 1985 and 2015, which increased notably in subsequent years, excluding 2019. The United States emerged as the most dominant country, with the Journal of Nursing Management and the Journal of Robotic and Mechatronics*

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being the top productive journals. This bibliometric analysis not only offers a comprehensive overview to assist researchers in understanding important articles, journals, and potential collaborators in the field of AI related to nursing care but also analyses the historical evolution, and identifies hot spots, and predicts future trends in the research topic.

Keywords: *Artificial Intelligence, Nursing Care, Islamic, Bibliometric*

Introduction

Artificial intelligence (AI) is often associated with algorithms, a term derived from the name of the ninth-century Muslim mathematician, Mohammed Ibn Musa al-Kharizmi (d. 850), denoting specific instruction for solving a problem or calculations (Sheikh et al., 2023). From a Western perspective, significant efforts in AI development are often attributed to Alan Mathison Turing, a British logician and computer pioneer in the mid-20th century, who invented a machine that can learn from experience and alter its mechanisms of instruction (Copeland, 2024). Another definition describes AI as the ability of a digital computer or robot under computer control to perform tasks typically associated with human intelligent entities, such as reasoning, meaning discovery, generalisation, and learning from past experiences (Copeland, 2024). Thus, AI is a technology that enables machines to imitate various complex human skills (Sheikh et al., 2023).

Literature Review

Integrating AI in nursing care has become increasingly prevalent in healthcare settings, offering benefits such as revolutionising healthcare delivery and improving patient outcomes. AI analyses patient data, including vital signs and health records, to formulate personalised care plans and monitor patients in real time, enabling timely interventions and improving patient outcomes (Rajkomar et al., 2018). Consequently, AI can enhance patient care by improving diagnosis, treatment, and healthcare delivery systems. Any technology or intervention, including AI, in nursing care should prioritise enhancing human well-being and alleviating suffering, aligning with the Islamic principles of seeking the betterment of society and fulfilling the obligation of caring for one another's well-being (Maarof & Balogun, 2019). Understanding the Islamic view on AI in nursing care provides a valuable perspective on ethical considerations and implementation guidelines. Therefore, it is crucial to have a comprehensive and organised database for references to navigate the intersection of AI in nursing care and Islamic views.

In Islamic tradition, the preservation and promotion of human life are highly valued. When implementing AI in nursing care, it is crucial to identify and address biases or prejudices embedded in the technology. Islamic ethics emphasise the need for equitable and non-discriminatory healthcare delivery, ensuring that AI systems do not perpetuate disparities or injustices (Karim & Ismail, 2018). Islamic views on AI in nursing care are guided by the principles and teachings of Islam. While AI can provide valuable support, it should not replace the human touch and compassionate care that are integral to nursing. The Islamic perspective calls for AI to be viewed as a complementary tool that enhances the capabilities of healthcare professionals (Salleh & Ahmad, 2018). Islamic teachings provide a framework for the responsible and ethical integration of AI in nursing care, aligning with the values of Islam. Therefore, a comprehensive understanding of the Islamic view on AI in nursing care, addressing ethical considerations and guidelines for its implementation, is urgently required.

While initial research has highlighted the promising potential of health technologies driven by artificial intelligence to improve nursing practice (Buchanan et al., 2020), a more recent study

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by Seibert et al. (2021) has revealed significant shortcomings in the practical application of artificial intelligence within nursing care settings. Currently, there exists a gap in knowledge regarding the Islamic perspective on AI in nursing care, particularly concerning ethical considerations and guidelines for its responsible implementation. As AI technologies continue to advance, there is an urgent need to address this gap and develop a comprehensive understanding of how Islamic teachings intersect with the integration of AI in nursing practice.

A recent study by Shi et al. (2023) used a bibliometric method to investigate AI related to the nursing field by identifying key trending subjects in nursing areas, which included nurse scheduling and nursing diagnosis, decision support for nursing, prediction of disease risk factors, management of nursing big data, expert systems, support vector machines, decision trees, deep learning, natural language processing, and nursing education. None of the key trending topics mentioned are specific to nursing care despite the relevance of some of the issues. Identification of relevant and good information related to the issues is required to provide comprehensive and exhaustive evidence for future reference. The study aims to conduct evidence synthesis, offering directions for potential future research and serving as a reference for researchers, academicians, healthcare providers, and students. The specific objectives include:

1. Searching and retrieving current and reliable information related to AI in nursing care.
2. Identifying key research themes/streams and research gaps in using AI in nursing care.

Methods

This bibliometric study comprises three stages: 1) Search strategy and screening, 2) Bibliometric analysis, and 3) Content Analysis, as illustrated in Figure 1.

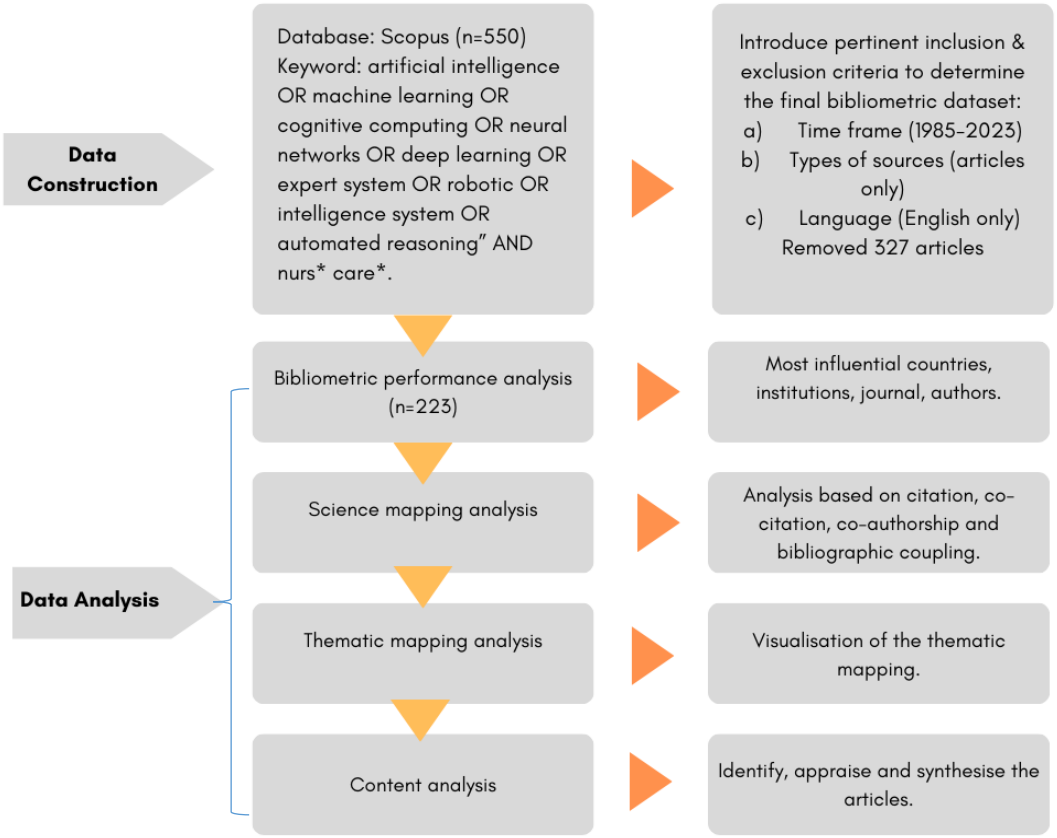

Figure 1: Study flow chart

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Search strategy and screening

The Scopus database was utilised to search for existing and highly cited publications on AI in nursing care. Scopus is a recognised and reliable source of bibliometric data and is the largest curated abstract and citation database that offers extensive global and regional coverage of scientific journals, including those in the nursing field (Baas et al., 2020). Multiple keywords were used in the search strategy to ensure comprehensive coverage in identifying relevant studies related to AI in nursing care. The search strategy involved combining keywords with Boolean operators and truncation as follows: "artificial intelligence" OR "machine learning" OR "cognitive computing" OR "neural networks" OR "deep learning" OR "expert system" OR robotic OR "intelligence system" OR "automated reasoning" AND "nurs* care*". The step produced 550 documents as the primary sample. Next, the search was limited to 2023 journal articles because it is the final output of most studies and articles in English, as the authors are not proficient in other languages for subsequent content analysis. Finally, 223 articles were included for bibliometric analysis.

Bibliometric analysis

Bibliometric analysis is the "quantitative study of literature and measurable methods used to identify the developmental trends within a certain field to obtain quantifiable, reproducible, and objective data" (Guo et al., 2020, p. 3). Bibliometric performance and science mapping analyses using VOSviewer, Bibliometrix R-package, and Microsoft Excel were employed in this study. VOSviewer and Bibliometrix R-package provide the necessary functions to conduct the analyses as both help construct, visualise, and examine the various bibliometric networks, while Microsoft Excel was used to keep the raw data before being imported into Vosviewer and Bibliometrix R-package. Bibliometric performance analysis encompasses a range of quantitative methods to describe and summarise publication characteristics, such as authors, institutions, countries, and journals in research areas (Donthu et al., 2021), through basic statistical measures, such as counts, percentages, averages, and distributions. Science mapping focuses on the relationships and connections between various elements within a set of publications, such as citation analysis, co-citation analysis, bibliographic coupling, co-word analysis, and co-authorship analysis (Donthu et al., 2021) that often involve the creation of network maps to visually represent the connections.

The growth rate of publications was also calculated. The growth rate over time was computed by raising the rate of the number of publications in 2023 over the number of publications in 1985 to the power of 1/38, as shown below. The publication trends of the number of publications each year were also reported.

$$\text{Growth rate} = [(\text{number of publications in the last year} \div \text{number of publications in the first year})^{1/(\text{last year - first year})} - 1] \times 100$$

Content analysis

Content analysis was applied to identify, appraise, and synthesise the bibliographic dataset. The focus was on studies related to the utilisation of AI in nursing care, including its benefits, challenges, and ethical perspectives. The integration of the quantitative and qualitative content analysis aims to enhance the paper's credibility through these triangulations.

Results

A total of 223 articles were included in the final dataset. It is noteworthy that only three articles were retrieved in the initial phase of the search strategy when the keyword 'Islam*' was

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included. Unfortunately, these articles fail to adequately address or incorporate an Islamic perspective in their content. Thus, the authors opted to review the articles retrieved without the keyword 'Islam*'. The finding signifies the limited studies integrating Islamic perspectives of AI in nursing care, highlighting a significant gap in the field.

Growth rate of publication

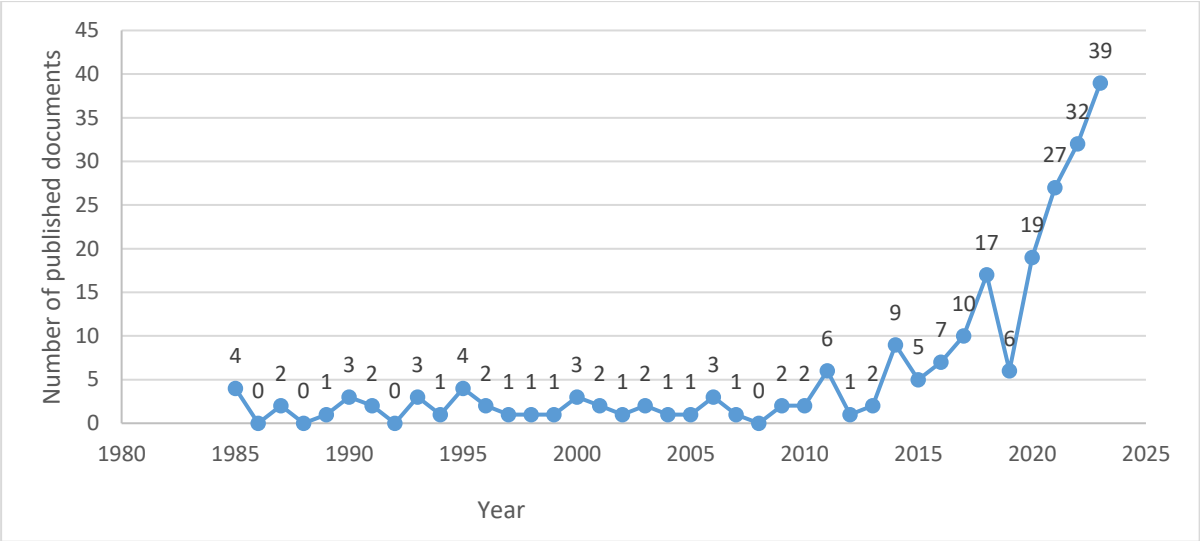

Figure 2: The distribution of bibliographic records per year

Figure 2 depicts the annual trend of publications concerning AI in the context of nursing care. An average growth rate of 5.52% in AI-related nursing care articles is observed from 1985 to 2023, indicating a gradual advancement in research within the field. A growth rate of 1.57% is noted from 1985 to 2011, with a slight increase to 2% from 2012 to 2014. Throughout these 29 years, the number of publications vary within the 0–6 range, underscoring sluggish overall progress. Notably, a sharp increase in publications between 2015 and 2018 is observed, constituting 50.4% of the total growth. The highest growth rate is observed between 2019 and 2023, peaking at 59.7%. Meanwhile, the most significant number of articles (n = 39) is noted in 2023.

Most influential countries and institutions

Figure 3 shows the ten leading countries in AI related to nursing care research based on the number of publications. Meanwhile, Figure 4 presents the most influential countries based on the total number of citations. Remarkably, the United States of America (USA), Japan, and China maintain their positions in the top three countries for both categories. The USA stands out with nearly twice the number of published articles compared to Japan and more than two-thirds of the articles in China. However, a closer examination using the average citation scores as the underlying indicator for country classification could reshape their ranking, offering deeper insights into the impact of their publications. Finland and Norway emerged as the leading countries in this respect. The average citation score is calculated as the ratio of a country's total citations to its total number of publications.

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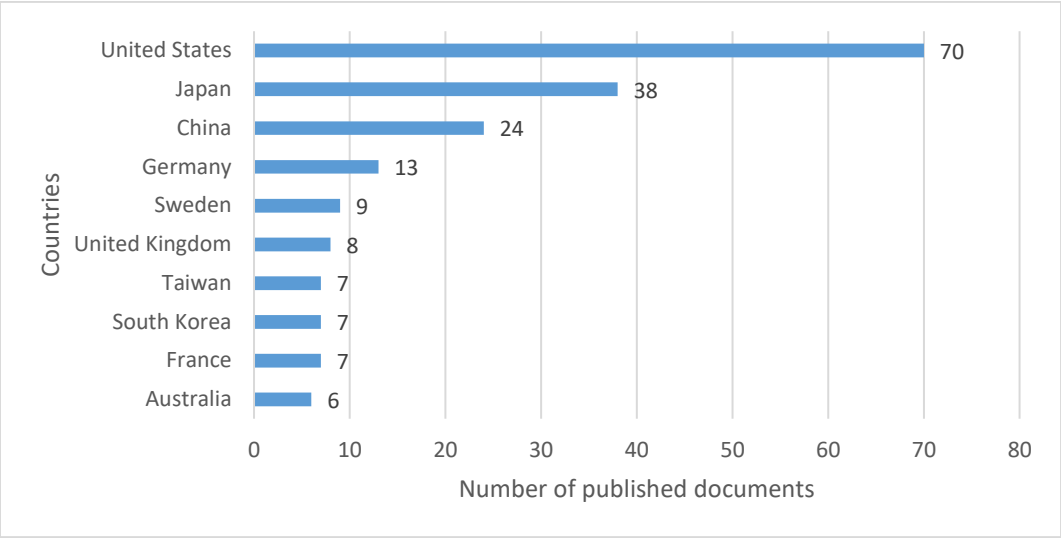

Figure 3: The distribution of the bibliometric records by top 10 countries from the number of publications

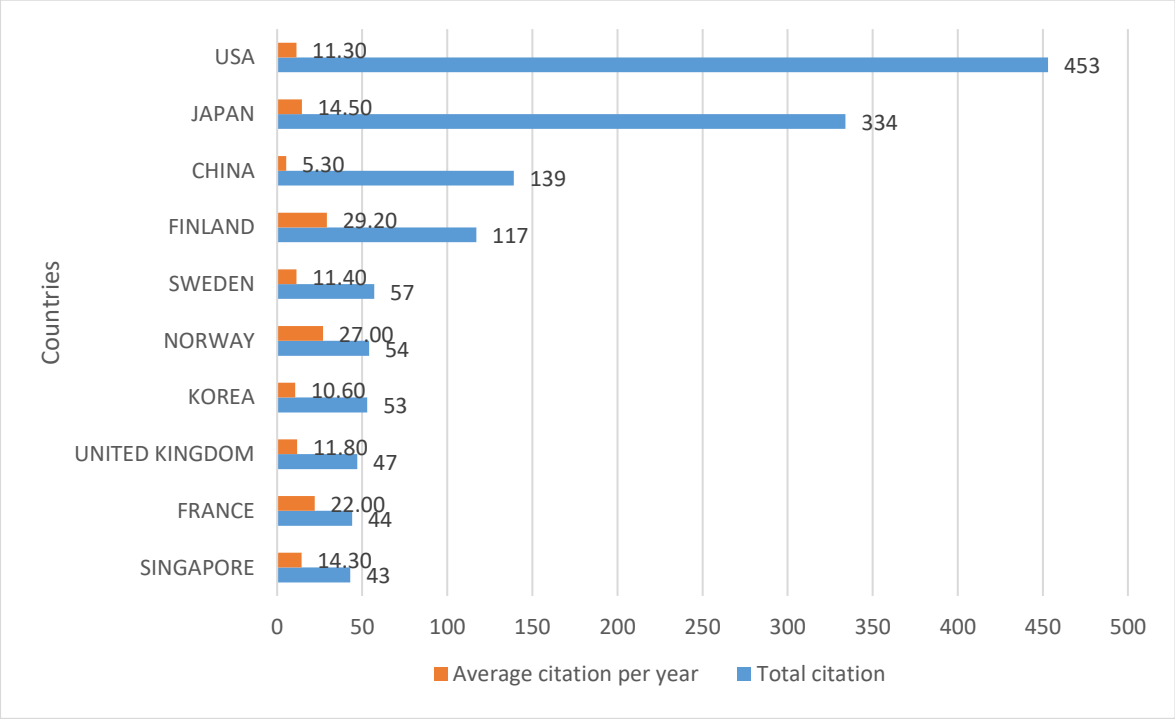

Figure 4: Most impactful countries by citation index.

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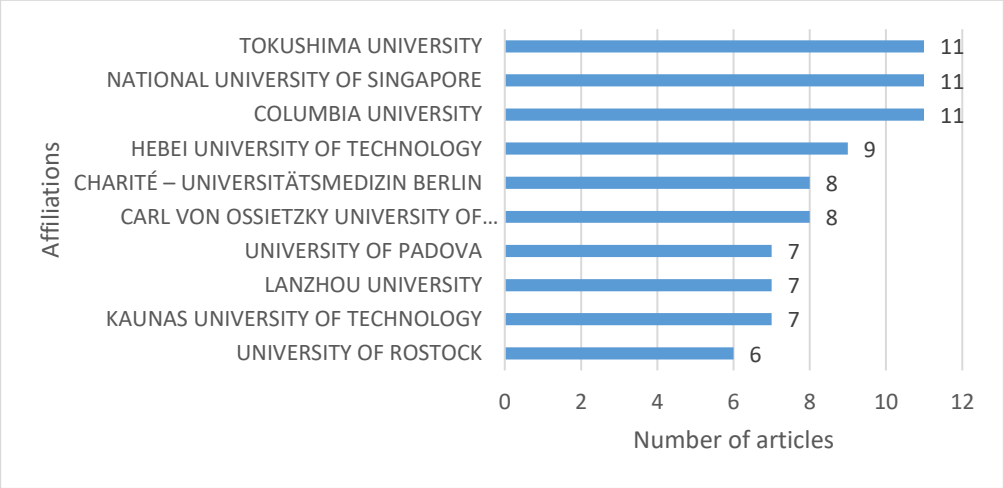

Figure 5: The distribution of the bibliometric records by top 10 institutions from the number of publications

Figure 5 displays the top ten most influential institutions in AI related to nursing care. Tokushima University, the National University of Singapore, and Columbia University share the same number of published articles. Notably, four of the ten most influential institutions for both the citation and average citation perspectives are from Japan, Singapore, the USA, and China.

Most influential journals and authors

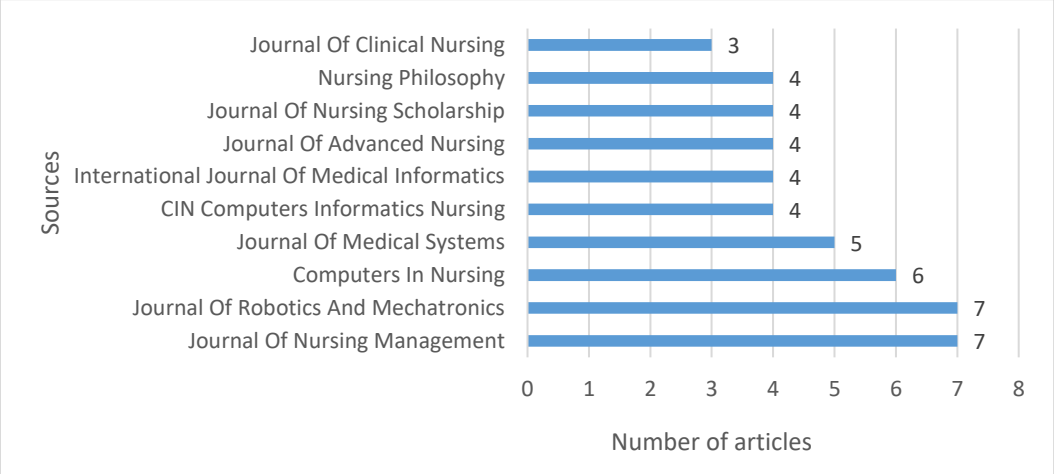

Figure 6: The distribution of the bibliometric records by top 10 journals from the number of publications

Overall, the articles were published in 155 different journals, and all the top 10 journals published fewer than 10 articles. The Journal of Nursing Management and the Journal of Robotics and Mechatronics published the most articles in this field, followed by Computers in Nursing and the Journal of Medical Systems.

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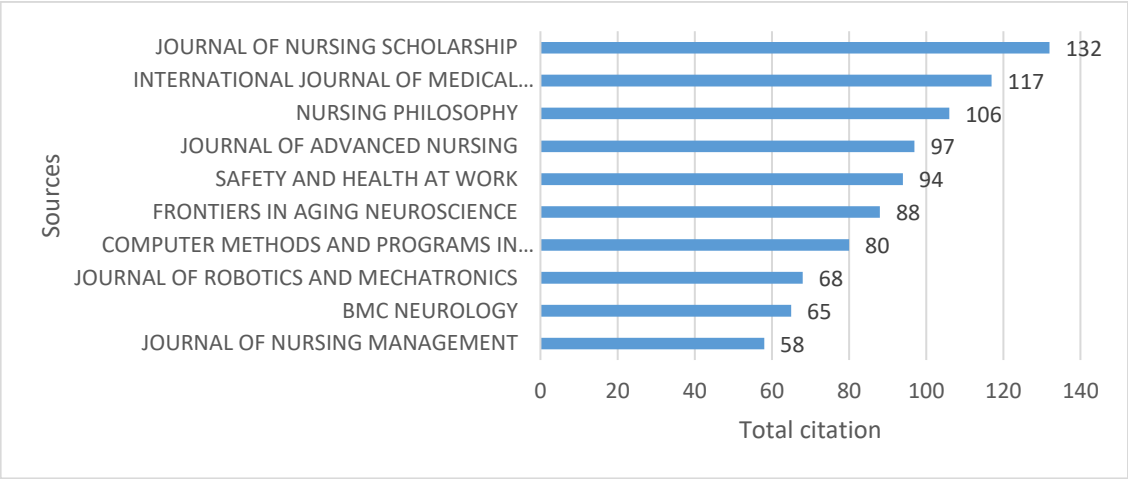

Figure 7: Most relevant journal based on number of average citations score

Figure 7 shows that the Journal of Nursing Scholarship is the most impactful source, followed by the International Journal of Medical Informatics and Nursing Philosophy. It is evident that half of the ten most influential journals are also included in the top 10 journals based on the number of publications.

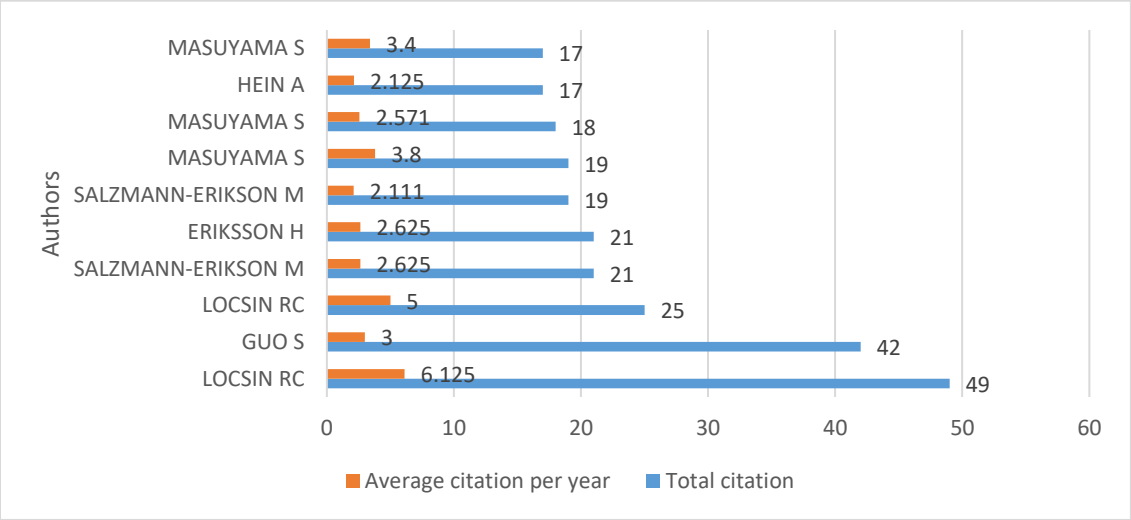

Figure 8: Most impactful authors by citation index

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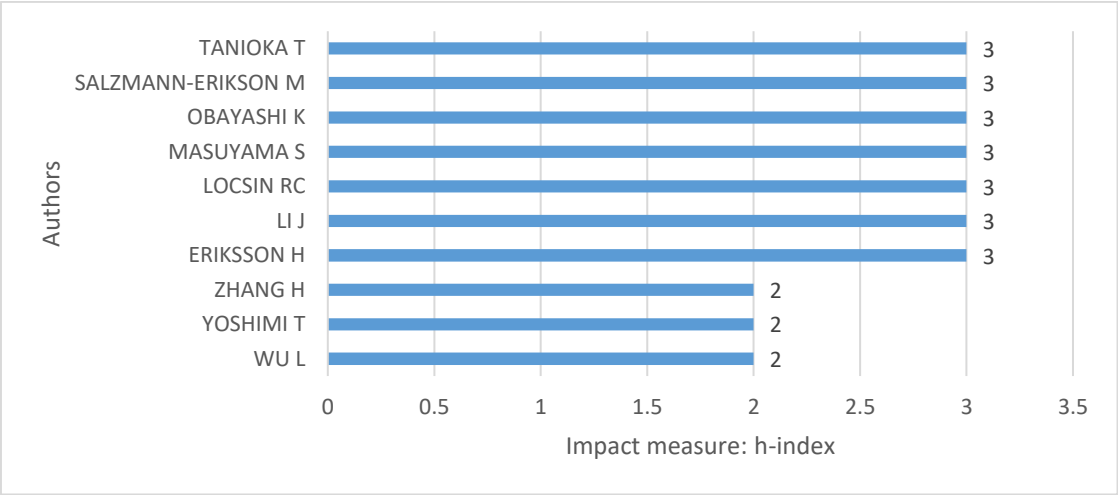

Figure 9: Most impactful authors by H-index.

Figures 8 and 9 show the top ten most influential authors in the literature related to AI in nursing care. Locsin is the most impactful author across all categories, which includes total citations, average citations, and h-index. Three of the top ten authors are, in fact, the same individuals, as they have each published at least two articles and are highly cited.

Science mapping analysis

Citation analysis

Through citation analysis, "one can analyse the most influential publications in a research field to gain an understanding of the intellectual dynamics of that field … because the impact of a publication is determined by the number of citations that it receives" (Donthu et al., 2021, p. 288). The result indicates that of 223 articles, 156 meet the threshold, in which the minimum citation was set at 2. However, among these 156 items, some lack interconnectedness. The largest set of connected items comprised only four items (see Figure 10). Further details about the four articles are presented in Table 1.

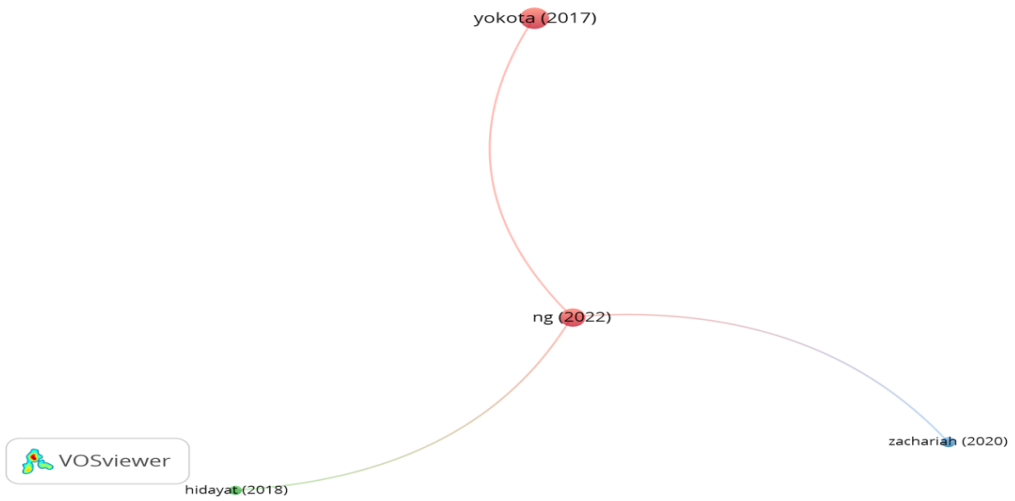

Figure 10: Citation analysis of documents.

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Table 1: The most influence publications

No.	Author (s) & Year	Title & Journal	Citation
1	Yokota et al. (2017)	Establishing a classification system for high fall-risk among inpatients using support vector machine. *Computers Informatics Nursing.*	19
2	Ng et al. (2022)	The role of AI in enhancing clinical nursing care: A scoping review. *Journal of Nursing Management.*	15
3	Zachariah et al. (2020)	Novel strategies for predicting healthcare-associated infections at admission: Implications for nursing care. *Nursing Research.*	5
4	Hidayat et al. (2018)	Analysis of nursing diagnosis using expert system in paediatric patients. *International Journal of Civil Engineering and Technology*	4

Publications with a higher number of citations are generally deemed more influential and relevant. The effective review of top influential publications helps researchers establish a consistent understanding of the emergence, development, direction, and scope of research coverage within any scientific discipline. The results show that the highest citation is 19, while the lowest is 4. This pattern may suggest that this area is relatively limited and not extensively explored or connected to other studies. The major research objectives of these four articles are to (1) develop a model to determine whether an inpatient will suffer a fall on a given day based on the previous day's status using fall report data from hospital information systems (Yokota et al., 2017); (2) present an overview of how AI has been used to improve nursing care (Ng et al., 2022); (3) apply supervised machine learning methods to predict urinary tract infections during inpatient hospitalisation at the time of admission; and (4) explain the use of computer expert systems in the analysis of nursing diagnoses in paediatric patients (Zachariah et al., 2020).

Co-citation analysis

The co-citation of sources considers representative journals as the primary unit of analysis. Its major objective is to examine the journal interrelatedness so as to assess the importation and exportation of citations across all given pairs of journals (Hsiao & Yang, 2011). In other words, it is set to identify the most co-cited journals and their links (Du & Chen, 2022). The rule of thumb in this respect is that the closer the journals' positions are to each other, the more significant their relatedness or their co-citation links are (Van Eck & Waltman, 2022). Moreover, the lines that connect journals provide an additional indicator of the strength of the co-citation links. The result indicates that of 3788 sources, only 7 meet the threshold, in which the minimum citation is set at 20 by default. A total of 3 clusters of journal sources that meet the threshold of 20 citations at least tend to cite (share) related or common references; hence, their co-citation links are relatively strong (Figure 11).

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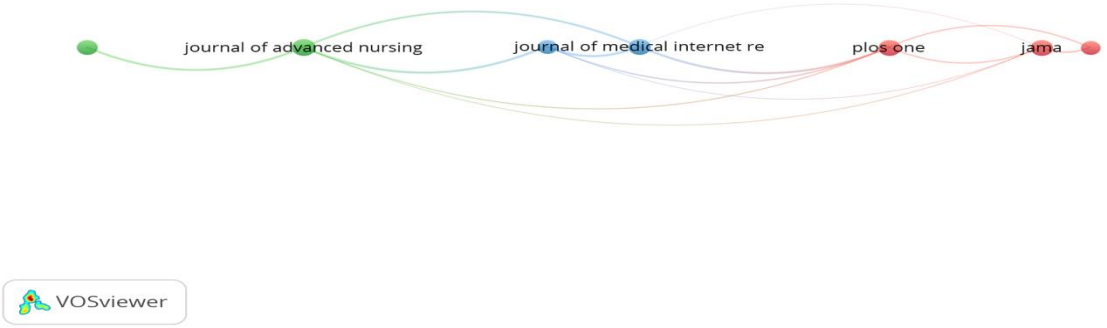

Figure 11: Co-citation of sources

Co-authorship analysis

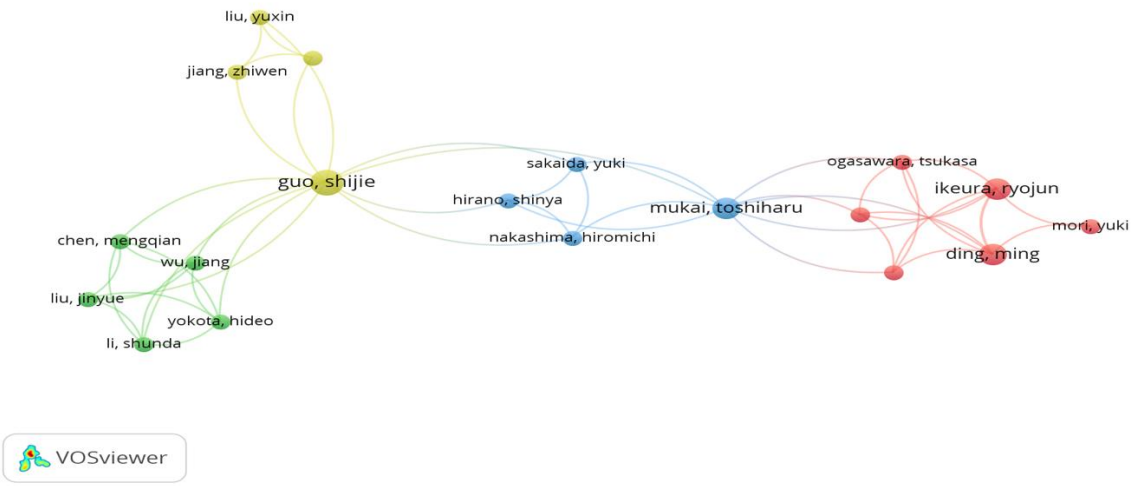

Figure 12: Social network of research collaboration

The co-authorship analysis provides a systematic documentation of the social and professional networks of authors (Newman, 2004). It helps explore their features and derive the level of cohesiveness of research collaboration within the knowledge community on that particular topic (Kumar, 2015). Moreover, it is a relatively reliable proxy to identify the most productive or impactful groups of authors within a given network. In the context of this review, the threshold of the author's inclusion is set to one publication only in order to comprehensively examine the authors' network in AI related to nursing care. The results of this analysis revealed 19 authors distributed across 4 clusters. Despite the relatively small number of authors in each cluster, the findings indicate ongoing collaboration and networking within this field (Figure 12).

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Bibliographic coupling

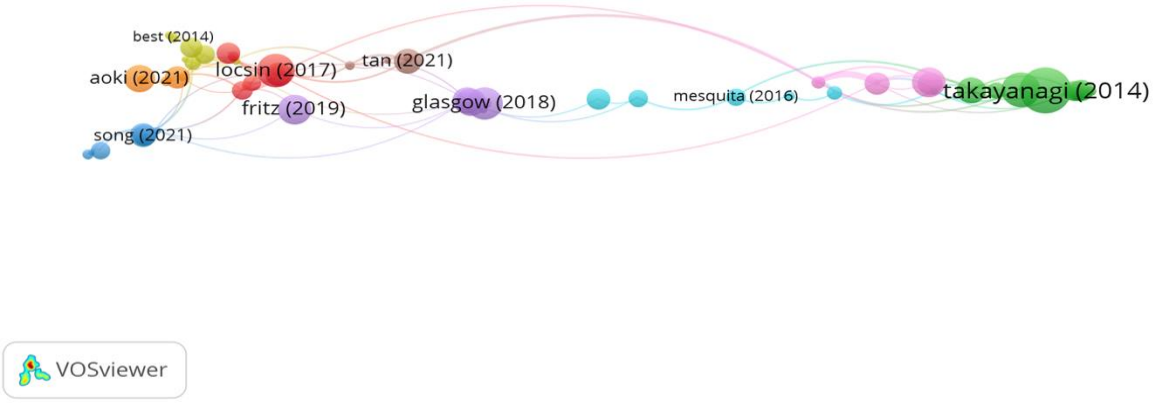

Figure 13: Bibliographic coupling network.

Bibliographic coupling (BC) measures the relatedness of publications based on the number of references they share (Martinho, 2022). This metric provides an indicator that those publications are most likely investigating a related topic (Ferreira, 2018). Generalising this principle across a collection of publications may produce consistent research clusters that may shape the thematic or conceptual structure of that particular topic. In this review, "document" as a unit of analysis and "fractional count" as a method of analysis were selected. The idea of the fractional count method of analysis is to minimise the influence of publications with many authors (Van Eck & Waltman, 2022). The minimum number of citations for a document was set to 2. A total of 156 of 223 articles meet the criteria. The result shows that nine clusters were produced in the theme based on bibliographic coupling (Figure 13).

Title and abstract map

The textual data emanating from publication titles and abstracts help create keyword co-occurrence maps. In this context, the keywords network in this respect may support researchers in their way to identify the relevant variables to their research interest. In this analysis, the minimum occurrence of the term was set to the default value, i.e., 10 times, and the complete count method of analysis was selected. The results generated 149 of 6008 terms, meeting the threshold based on the set parameter. The cluster of keywords displayed in the network map may improve the authors' perception of possible keyword combinations to develop appropriate research topics (Figure 14).

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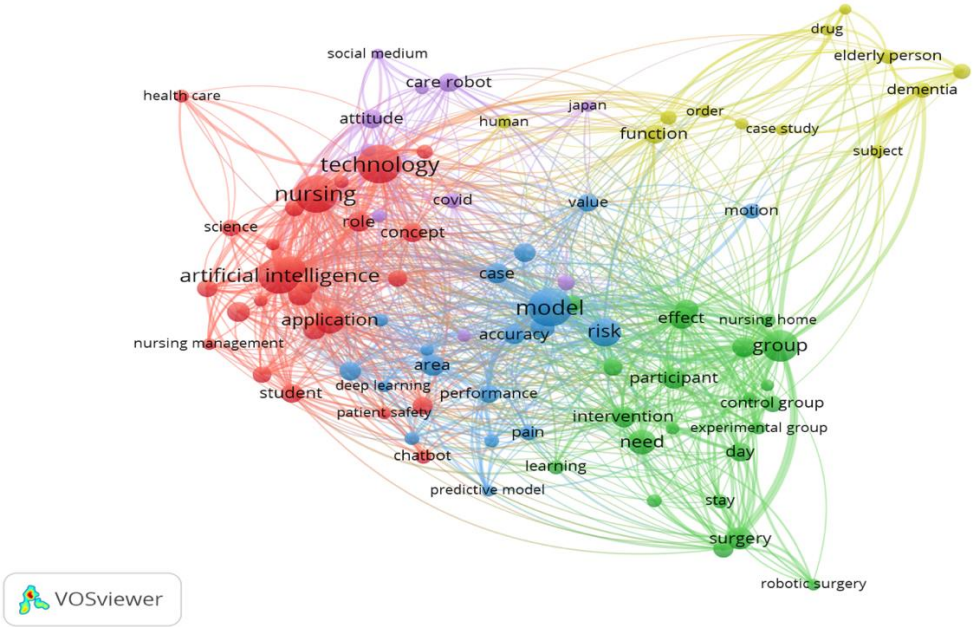

Figure 14. Title and abstract map

Discussion

The study analysed nursing care related to AI research using bibliometric data by examining the growth rate of publications, characteristics of research activities, publication patterns, and trends in research tendencies. Since its first publication in 1985, AI related to nursing care research had slow progress until 2017, with a total number of 83 articles published. The average publication within 32 years is 2–3 articles per year. However, an increase in research output was noted in the following six years, except for a drop in 2019. In the past 4 years, the publication growth rate reached 59.7%, which is almost 30 times the publication growth rate from 1985 to 2011. The recent rapid growth can be attributed to various factors, including the explosive adoption of AI in healthcare-related AI research (Topol, 2019).

The field of AI in healthcare, including nursing care, has attracted global attention, with high-income and developed countries being the main contributors. The USA alone contributed one-third of the research in this field, allocating a substantial budget for AI research, leading to cutting-edge, revolutionary life-enhancing innovations, rising technology industry, motivating workers, and boosting security interests (Jimma, 2023). It is not surprising that China and Taiwan appeared in the top-ten list of countries based on the number of publications despite being categorised as developing countries. Both countries have experienced strong economic growth that has been recognised globally (Kanwit, 2023; Nabila, 2023). Even several articles from these countries receive funding from various sources, including government grants, institutional budgets, and industry collaborations. However, this research field is still insufficient in non-high-income countries. According to a report by UNESCO (2016), low-income countries allocate only a small percentage of their GDP to research and development compared to high-income countries. This observation raises concerns as many low-income countries face challenges with their healthcare resources while experiencing a significant rise in public health issues due to swift globalisation and urbanisation (Matthias et al., 2016).

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DOI: 10.55573/JISED.096308

Based on the output and citation counts, AI related to nursing care research is generally favoured by large-scale journals related to health. Advancements in AI research have prompted the creation of journals to address the growing demand for publications in related fields like health technology, medical internet, and digital health. Locsin stands out as the most impactful author across all categories, including total citations, average citations, and h-index. With a nursing background, all of Locsin's publications are related to the usage of technology in nursing practice, such as AI and robots, which is congruent with the topic.

The findings suggest potential research hotspots in AI related to nursing care, with a particular focus on ethical considerations from an Islamic perspective. Montemayor et al. (2021) revealed inherent obstacles to the application of AI in clinical medicine and care, particularly in situations where empathy is crucial. Nursing care cannot or should not be entrusted to robots and AI because nursing is a highly humane practice involving certain tasks that should not be replicated by robots or AI (Ibuki et al., 2023). Moreover, Tan et al. (2021) summarised five major ethical issues related to the deployment of robotics and autonomous systems in long-term care, i.e., loss of autonomy, loss of human interaction and social connectedness, objectification and infantilisation, deception, and social justice. Therefore, further research should explore the Islamic perspective on ethical issues in nursing care, as none of the top ten publications, top keywords, or top trends addressed this matter. Additionally, publications in healthcare-related AI are expected to grow in the future (*Guo et al., 2020).*

This study has a few limitations. *Firstly, it* relies *exclusively* on the Scopus database, *which, while providing a diverse range of publications for the analysis, might not encompass all the relevant studies.* Subsequent research endeavours could derive additional value by integrating or amalgamating data from other databases, such as the World of Science, to explore potential research papers more comprehensively. *Secondly*, the study excludes articles published in languages other than English, which could lead to overlooking relevant information from various countries. Future studies might consider expanding the search scope to include relevant articles in different languages to enhance the breadth of literature.

Conclusion

This research sought to offer a comprehensive overview of articles related to AI in nursing care. The findings highlight information pertinent to the application of AI in nursing care through multiple search and screening iterations, utilising 10 refined search terms within a 38-year time span from 1985 to 2023. The following observations pertaining to AI related to nursing care were consummated from the analyses: 1) a significant and consistently increasing growth rate in AI research within nursing care was noted over the past four years; 2) high income and developed countries play a predominant role in the landscape of AI research pertaining to nursing care; 3) most AI studies focus on modelling, testing the tools, and the application of AI.

Funder

This research was supported by International Institute for Islamic Thought through Strategic Research Programme Grant (IIIT-SRP23-031-0031)

Volume: 9 Issues: 63 [June, 2024] pp. 119 - 135
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.jised.com
DOI: 10.55573/JISED.096308

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eISSN: 0128-1755
Journal website: www.jised.com
DOI: 10.55573/JISED.096308

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