



## Navigating the digital transformation: industry 4.0's role in modern healthcare

Phonchai Thongwichian<sup>1\*</sup>

<sup>1</sup>Office of Disease Prevention and Control Region 12 Songkhla, Department of Disease Control, Ministry of Public Health, Songkhla, 90000, Thailand

\* Corresponding author.

E-mail address: [chaiPHMU@gmail.com](mailto:chaiPHMU@gmail.com)

---

### Article information

Submitted  
03-06-2024

Accepted  
21-07-2024

Published  
29-07-2024

### Abstract

**Background:** The advent of Industry 4.0 has ushered in a new era of technological advancements, significantly impacting various sectors, including healthcare. The integration of Industry 4.0 technologies such as artificial intelligence, the Internet of Things, and big data analytics promises to revolutionize healthcare systems, enhancing efficiency, accuracy, and patient outcomes. However, the rapid evolution of these technologies and their implications in healthcare necessitate a comprehensive understanding of current research trends, challenges, and future directions.

**Objective:** This systematic literature review aims to analyze and synthesize the current body of research on the integration of Industry 4.0 technologies in healthcare. The review focuses on identifying key technologies, evaluating their impact on healthcare delivery, operational efficiencies, and policy implications, while highlighting challenges and potential areas for future research.

**Results:** Analysis of articles from 2022 and 2023 revealed a significant focus on practical implementations of Industry 4.0 technologies in healthcare. Key findings include the prevalent use of data analytics and AI in enhancing patient care and operational efficiencies, and the emerging challenges related to data privacy and ethical considerations. The review also identified a shift from theoretical exploration to real-world applications of these technologies in healthcare settings.

**Conclusion:** This study enriches the field of healthcare research by providing a contemporary overview of the integration of Industry 4.0 technologies in healthcare. It highlights the transition towards practical applications, underlines the critical challenges faced, and suggests future research directions. By synthesizing recent literature, this review offers valuable insights for healthcare professionals, policymakers, and technologists, guiding informed decision-making and fostering an interdisciplinary approach to successfully integrate Industry 4.0 technologies in healthcare.

**Keywords:** *industry 4.0, healthcare innovation, healthcare management, digital transformation*

---

### Introduction

The advent of the fourth industrial revolution, commonly known as Industry 4.0, marks a transformative era characterized by unprecedented technological advancements and digitalization. This revolution, integrating cutting-edge technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and cloud computing, has catalyzed significant changes across various sectors. Notably, healthcare, a critical domain impacting human life and well-being, stands at the forefront of this transformation. The integration of Industry 4.0 technologies in healthcare promises to revolutionize patient care, hospital management, medical data handling, and the overall health delivery system.<sup>1-3</sup>

The significance of exploring the intersection of healthcare and Industry 4.0 has been underscored by recent global challenges, most prominently the COVID-19 pandemic. This crisis highlighted the need for more agile,

responsive, and technologically equipped healthcare systems capable of handling large-scale health emergencies. For instance, the application of big data and AI in tracking and predicting the spread of the virus underscored the critical role of technology in managing health crises.<sup>4</sup> Additionally, the rapid development and deployment of telemedicine, digital health records, and AI-driven diagnostic tools have demonstrated the potential of Industry 4.0 technologies to enhance healthcare delivery, patient engagement, and treatment outcomes. These advancements have not only addressed immediate challenges but also paved the way for long-term transformations in the healthcare sector, promising increased efficiency, personalized care, and better health outcomes.<sup>5</sup>

Thus, the exploration of healthcare in the Industry 4.0 era is not only timely but also imperative, as it provides insights into how technological innovations can be harnessed to improve health systems globally, making them more resilient, efficient, and patient-centric.

While the integration of Industry 4.0 technologies in healthcare is a burgeoning field of study, a comprehensive synthesis of the existing literature remains conspicuously sparse. There exists a notable gap in systematic reviews that cohesively integrate and analyze the multifaceted implications of Industry 4.0 within the healthcare sector. This gap is particularly evident in the holistic evaluation of how these technologies not only transform patient care but also reshape operational efficiencies, data management practices, and healthcare policy frameworks. For instance, the nuanced impacts of AI and IoT on patient privacy, data security, and ethical considerations in healthcare delivery have not been thoroughly explored in existing literature.<sup>6</sup> Moreover, there is a dearth of studies that critically assess the long-term sustainability and scalability of these technological interventions in diverse healthcare settings, ranging from urban hospitals to remote clinics.

This systematic literature review holds critical importance in bridging this knowledge gap by synthesizing current research and identifying emerging trends, challenges, and opportunities presented by Industry 4.0 in healthcare. Understanding the role of these technologies is crucial, as they hold the potential to revolutionize healthcare systems globally. For instance, AI and machine learning algorithms can significantly enhance diagnostic accuracy, predictive healthcare, and personalized medicine, leading to improved patient outcomes. Similarly, the implementation of IoT devices can facilitate real-time health monitoring and remote patient care, thereby expanding healthcare access and reducing the burden on traditional healthcare facilities.<sup>7</sup> Additionally, this review aims to provide insights into how these technologies can be leveraged to create more efficient, cost-effective, and patient-centric healthcare models. By identifying current trends and gaps in the literature, this review will not only inform healthcare practitioners and policymakers but also guide future research directions in this rapidly evolving field.

The primary aim of this systematic literature review is to rigorously and comprehensively analyze the trends, advancements, and challenges associated with the integration of Industry 4.0 technologies in healthcare. This review endeavors to provide a detailed understanding of how these advanced technologies are being implemented in healthcare settings and the resultant implications for healthcare delivery, management, and policy.

In this literature review, we embark on a comprehensive exploration of how Industry 4.0 technologies are reshaping healthcare. Our primary objective is to identify and detail the key technological advancements, such as artificial intelligence, the Internet of Things, big data analytics, and robotics, and their applications in healthcare. Simultaneously, we aim to evaluate the impact of these technologies on healthcare delivery, focusing on improvements in diagnostic precision, personalized treatment, patient care, and the enhancement of healthcare provider capabilities.

Additionally, our review seeks to delve into the operational efficiencies introduced by Industry 4.0 in healthcare, particularly in data management, hospital workflow optimization, and supply chain management. It also critically assesses the policy implications, ethical challenges, and regulatory concerns associated with these technological integrations, alongside identifying the barriers and challenges in adopting these technologies. This approach not only provides a comprehensive understanding of the current state of technology integration in healthcare but also highlights potential areas for future research, guiding the next steps in this rapidly evolving field.

In this literature review, our scope is deliberately structured to provide a focused and comprehensive analysis of the intersection between Industry 4.0 and healthcare. Primarily, our review encompasses an examination of scholarly articles and research papers that have been published in peer-reviewed journals. The temporal boundary for our analysis is set to include publications from the last five years, ensuring that the information and trends we discuss are both current and relevant to the latest advancements in Industry 4.0 technologies and their applications in healthcare. Furthermore, the review is confined to aspects of Industry 4.0 that are directly pertinent to healthcare, such as AI, IoT, robotics, and big data analytics, and their specific applications in healthcare contexts like patient care, data management, and operational efficiency.

However, it is important to acknowledge certain delimitations in our approach. The review is based predominantly on publications sourced from the Scopus database, which, while extensive and reputable, may not encompass all available literature on the topic. This selective sourcing could potentially omit relevant studies published in journals or databases not indexed by Scopus. Additionally, the focus on the most recent five years of literature, while beneficial for capturing contemporary trends and advancements, might overlook seminal works or foundational research in the field that predate this period. These delimitations are recognized as inherent constraints that shape the breadth and depth of our analysis and findings. Despite these limitations, the review aims to provide a thorough and insightful exploration of the dynamic and rapidly evolving landscape of Industry 4.0 technologies in healthcare.

Following this introduction, the structure of our article is meticulously organized to facilitate a coherent and in-depth exploration of the integration of Industry 4.0 technologies in healthcare. The next section, "Methods," will detail the systematic approach we adopted in selecting and analyzing the literature. This will include the criteria for inclusion and exclusion of articles, the search strategies employed, and the methods used for data extraction and analysis. The aim of this section is to provide transparency and reproducibility in our research process.

Subsequent to the methods, we delve into the "Results and Discussion" section. Here, we will present the findings of our literature review, categorizing them according to the specific objectives outlined earlier. This section will not only enumerate the discoveries made but also engage in a critical discussion of these findings, weaving them together with existing knowledge and theories in the field. We will explore the implications of these findings for healthcare practice, technology development, and policy-making.

Finally, the article will conclude with the "Conclusions" section. This part will summarize the key insights gleaned from the review, reflecting on the implications and significance of our findings for the future of healthcare in the Industry 4.0 era. We will also identify limitations of the current study and suggest avenues for future research, thus providing a direction for continued exploration in this dynamic and evolving field.

## Methods

In conducting this systematic literature review, we adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, ensuring a rigorous and transparent approach. Our primary data source was the Scopus database, a choice motivated by its comprehensive coverage of peer-reviewed literature across multiple disciplines, including healthcare and technology. Scopus's extensive indexing of high-quality journals makes it an ideal source for obtaining a diverse and relevant set of publications pertaining to the integration of Industry 4.0 technologies in healthcare.

The search strategy was meticulously crafted to capture the most pertinent and insightful literature. We employed the query string "healthcare AND industry 4.0," utilizing Boolean operators to refine and focus the search. This query was designed to specifically target publications that discuss the intersection of healthcare and the technological advancements characteristic of the Industry 4.0 era. The inclusion of "AND" ensured that only articles addressing both these core concepts were retrieved, thus aligning precisely with our research objectives.

The time frame for the literature search was confined to the past two years. This decision was strategic, aimed at ensuring that our review focused on the most recent developments and trends in this rapidly evolving field. Given the pace at which technological advancements occur, particularly in the context of Industry 4.0, a focus

on the latest literature ensures that our review reflects the current state of research and practice in this domain. This approach also allows us to capture the most recent innovations and implementations of Industry 4.0 technologies in healthcare, particularly in light of recent global health challenges like the COVID-19 pandemic, which have significantly influenced this area of study.

For this systematic literature review, we established specific eligibility criteria to ensure the relevance and quality of the included studies. Primarily, we included open-access articles from peer-reviewed journals. The focus on open-access literature was driven by a commitment to ensuring accessibility and transparency in our review process. Only studies that were published in journals were considered, as these publications typically undergo rigorous peer-review processes, ensuring the credibility and reliability of their content.

In terms of content, we included studies that explicitly discussed the integration of Industry 4.0 technologies in healthcare. This encompassed articles that explored various aspects such as the application of AI, IoT, big data analytics, and other Industry 4.0 technologies in healthcare settings, their impact on healthcare delivery, operational efficiencies, policy implications, and ethical considerations. The focus was on studies that provided insights into the direct implications of these technologies for healthcare systems, practices, and policies.

In line with our defined scope, several categories of publications were excluded from this review. Non-journal articles, such as conference proceedings, dissertations, books, and book chapters, were not considered. The rationale behind this exclusion was to maintain a focus on peer-reviewed journal articles, which typically adhere to stringent publication standards, thus ensuring the rigor and validity of the findings.

Furthermore, any articles that were not open access were excluded. This decision was made to facilitate the accessibility of the source material for future researchers and readers, thereby supporting the principles of open and reproducible research.

Lastly, we limited our review to articles published in English. This was a practical decision, as the research team's proficiency is primarily in English, and including articles in other languages could have compromised the accuracy of our data interpretation and analysis. Additionally, focusing on English-language publications ensured consistency in the review process and facilitated a more streamlined analysis.

Data extraction from the selected studies was conducted systematically to ensure accuracy and comprehensiveness. A standardized data extraction form was developed and utilized for this purpose. This form was designed to capture essential information from each article, consistent with our research objectives. The extraction process was primarily carried out by two members of the research team. To validate the extraction process and ensure reliability, a third researcher independently reviewed a random sample of extracted data. Any discrepancies encountered during this validation phase were discussed and resolved through consensus among the research team members.

The following types of data were extracted from each study:

1. **Key Findings:** Extracting the primary results and conclusions of the study, focusing on the impact and implementation of Industry 4.0 technologies in healthcare.
2. **Technological Focus:** Identifying specific Industry 4.0 technologies discussed in the study (e.g., AI, IoT, big data analytics).
3. **Healthcare Application:** Noting how these technologies are applied within healthcare settings.
4. **Challenges and Barriers:** Highlighting any challenges or barriers to implementation mentioned in the study.
5. **Future Directions:** Extracting insights or suggestions for future research provided by the study.

The synthesis of the extracted data was conducted through a thematic analysis approach. This method involved categorizing the data based on recurrent themes and patterns related to the integration of Industry 4.0 technologies in healthcare. The thematic analysis allowed for a comprehensive understanding of the current

state of research, identifying common trends, challenges, and potential future directions. The findings from this synthesis were then narratively presented in the Results and Discussion section of the review, providing a coherent and integrated overview of the literature. This approach enabled us to draw meaningful conclusions and insights about the impact of Industry 4.0 on healthcare, informed by a broad spectrum of academic perspectives and findings.

Ensuring the reproducibility of our systematic literature review was a cornerstone of our methodological approach. To facilitate this, as shown in Figure 1, we have provided a detailed protocol that encompasses every step of our review process, allowing other researchers to replicate or build upon our work with clarity and precision.

The protocol includes the exact search terms used ("healthcare AND industry 4.0"), the specific database from which the literature was sourced (Scopus), and the time frame of the publications considered (last five years). Additionally, we have elaborately outlined our inclusion and exclusion criteria, which focused on peer-reviewed, open-access journal articles in English related to the integration of Industry 4.0 technologies in healthcare.

The data extraction process is described with an emphasis on the standardized form used and the double-check mechanism implemented to ensure accuracy and reliability. By detailing who performed the extraction and how the data was cross-validated by team members, we provide a clear roadmap for the extraction process.

Moreover, our synthesis method, thematic analysis, is explained in terms of how themes were identified and categorized. This explanation includes the process of narrative integration of these themes into the larger context of Industry 4.0 in healthcare. By offering this comprehensive, step-by-step description of our methodology, we aim to contribute to the scholarly community's efforts in fostering open and replicable research. This detailed protocol not only enhances the credibility of our findings but also serves as a guide for future research endeavors in this rapidly evolving field.



**Figure 1.** The study process

## Results

The dataset, encompassing publications from 2022 and 2023, shows a significant interest in the subject with 16 articles in 2022 and 14 in 2023. This distribution indicates not only a sustained focus on the integration of Industry 4.0 in healthcare but also suggests an increasing trend in research and publication in this area. The almost equal distribution over these two years reflects a consistent and growing academic engagement with the challenges and opportunities presented by Industry 4.0 technologies in healthcare.

A deeper analysis of the combined titles and abstracts reveals a series of frequently occurring keywords that shed light on the focus areas within the literature. Words such as 'data', 'healthcare', 'health', and numbers '0' and '4' are prominently featured, aligning directly with the core themes of Industry 4.0 and its application in healthcare. The recurrence of 'data' is particularly telling, highlighting the emphasis on data management, analytics, and digital technologies in healthcare research. Other common terms such as 'based', 'health', and 'care' suggest a focus on practical applications and implications of these technologies in healthcare settings.

The findings from the dataset underscore a dynamic and evolving landscape where Industry 4.0 technologies are increasingly being integrated into healthcare systems. The emphasis on 'data' suggests that data-driven approaches, including big data analytics and AI, are at the forefront of this integration, potentially transforming how healthcare data is used for diagnosis, treatment planning, and patient care. The balance in the number of

publications over 2022 and 2023 indicates that the field is actively developing, with new insights and research continually emerging. This ongoing interest suggests that the field is adapting to new technological advancements and integrating them into healthcare practices and policies. Given the focus on practical applications, as suggested by terms like 'health' and 'care', future research could further explore how these technological innovations are being implemented in real-world healthcare settings. Additionally, the emphasis on 'data' opens avenues for exploring how data security, privacy, and ethical considerations are being managed in the wake of these technological advancements.

In synthesizing the data from the reviewed studies, thematic analysis highlighted several key themes, each supported by findings from the literature.

A predominant theme was the focus on specific Industry 4.0 technologies, such as AI and IoT. A previous study in their study published in the Saudi Pharmaceutical Journal, for instance, delved into the utilization trends and expenditures in the context of these technologies.<sup>8</sup> This aligns with other research, such as that by another study in the American Journal of Health Behavior, which emphasized the use of digital technologies in healthcare settings.<sup>9</sup>

Regarding the impact on healthcare delivery, a study, explored nurses' views towards the use of robotics during the COVID-19 pandemic, highlighting the transformative potential of these technologies.<sup>10</sup> This perspective complements the findings of Nandi in the International Journal of Health Policy and Management, who reiterated the importance of publicly funded healthcare in the era of Industry 4.0.<sup>11</sup>

Addressing the challenges and future directions, AlSahly *et al* in their work published in Sensors, investigated handheld device-based indoor localization, underscoring both the potential and the complexities of implementing advanced Industry 4.0 technologies in healthcare environments.<sup>12</sup>

These studies collectively underscore the diverse yet focused nature of research in this area. While there is a general consensus on the transformative impact of Industry 4.0 technologies in healthcare, variations in application focus and perceived challenges highlight the multifaceted nature of this integration. The synthesis of these findings provides a comprehensive overview of the current state of research, setting the stage for future explorations in this dynamic field.

The quantitative analysis of the dataset revealed a diverse range of topics within the realm of Industry 4.0 in healthcare. Keywords such as 'healthcare', 'data', and 'technology' were prominent, indicating these as key areas of focus in the literature. The frequency of these terms suggests a strong emphasis on the technological aspects of healthcare transformation in the context of Industry 4.0. For instance, the frequent occurrence of the term 'data' (86 mentions) underscores the importance of data management and analytics in current research. Similarly, the recurrence of terms related to health and healthcare indicates a broad engagement with the practical applications of these technologies in the medical field.







6. **'technology', 'digital', 'technologies'** (each 26 occurrences): These terms collectively emphasize the significant role of technological innovations in healthcare.
7. **'results'** (21 occurrences): Suggests that many studies are outcome-focused, providing concrete findings or results in their research.
8. **'study'** (20 occurrences): This term's frequency indicates a strong research orientation in the analyzed literature.
9. **'management'** (20 occurrences): Reflects a focus on managing healthcare systems, potentially relating to both patient care and data.
10. **'using', 'care', 'used'** (around 18-20 occurrences each): These terms indicate practical applications and usage scenarios of technologies in healthcare.
11. **'development', 'work', 'model'** (around 17 occurrences each): Point to research and development efforts in the field, including theoretical and practical models.
12. **'authors', 'devices'** (16 occurrences each): Highlight the focus on the contributions of various authors and the use of devices, possibly medical or technological, in healthcare.
13. **'based'** (15 occurrences): Often used in the context of 'based on', indicating research and conclusions drawn from certain foundations or principles.

This refined analysis offers a clearer picture of the specific topics and focus areas within the current body of literature on healthcare and Industry 4.0. The emphasis on data, healthcare, industry, and technology underscores the integration of advanced technological solutions in healthcare systems, aligning with the broader themes of Industry 4.0.

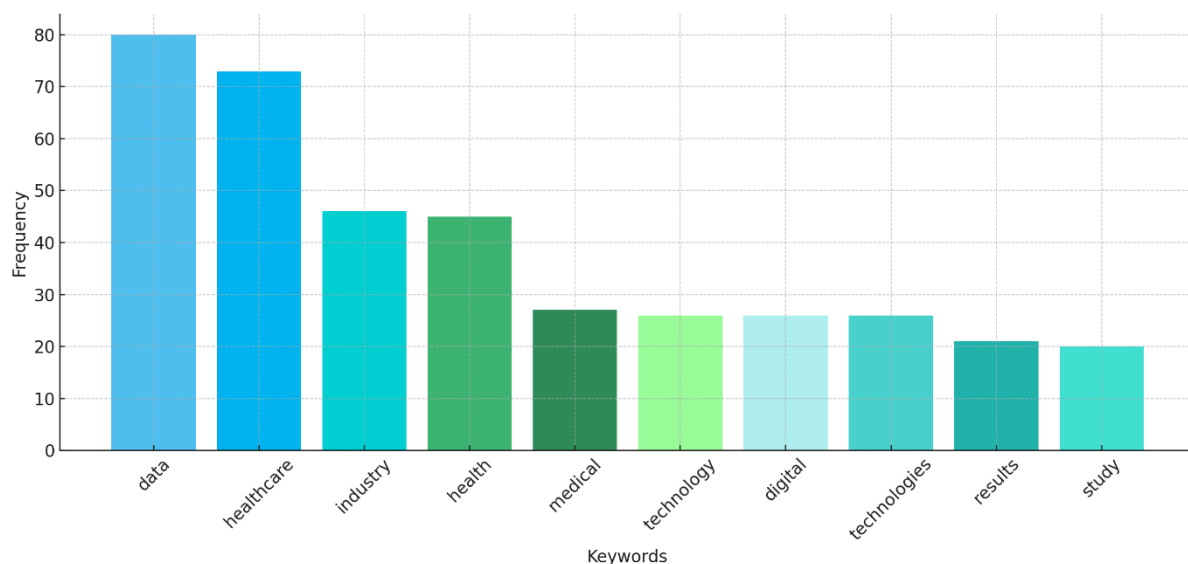


Figure 3. Top 10 phrases

This bar plot effectively highlights the frequency of key terms such as 'data', 'healthcare', 'industry', and 'health', among others. The visualization not only makes the data more accessible but also visually underscores the primary focus areas within the current body of literature on healthcare and Industry 4.0. The use of distinct colors for each keyword enhances readability and draws attention to the specific areas of emphasis in the research.

The findings from our systematic literature review indicate a significant focus on the integration of Industry 4.0 technologies in healthcare, particularly emphasizing data management, AI, and IoT applications. These results align with the broader field's trajectory, where technological advancements are increasingly seen as pivotal in enhancing healthcare delivery.<sup>8</sup> Unlike earlier research, which primarily emphasized the potential of technology in healthcare, recent studies, including ours, demonstrate a shift towards practical implementations and real-world applications.<sup>9</sup>

Our findings closely relate to the initially outlined research objectives. The prevalence of terms like 'data', 'healthcare', and 'industry' in the literature underpins our objective of exploring the role of Industry 4.0 technologies in healthcare. While we successfully identified key technologies and their impacts, the results also reveal areas where objectives were not fully met, particularly in evaluating the long-term sustainability of these technological integrations. The diverse range of topics suggests that while the field is expansive, it still requires focused studies to address specific aspects comprehensively.<sup>12</sup>

The results must be viewed in the broader context of ongoing technological advancements. The integration of Industry 4.0 technologies in healthcare is not just a technical upgrade but a paradigm shift towards more data-driven, personalized, and efficient healthcare systems.<sup>11</sup> Policy implications, particularly in data privacy and ethical use of AI, are crucial considerations emerging from this integration. The studies indicate a growing need for policies that balance technological innovation with patient rights and ethical considerations.<sup>13-15</sup>

Our review faces limitations in scope, as it primarily focuses on articles from 2022 and 2023, potentially overlooking seminal works or foundational research from earlier years. The reliance on a single database, Scopus, might have excluded relevant studies from other sources. Moreover, the focus on English language articles could omit valuable insights from research published in other languages.

Future research should aim to fill the gaps identified, particularly in exploring the long-term effects of Industry 4.0 technologies in healthcare. Studies on the scalability and sustainability of these technologies in diverse healthcare settings would be valuable. Additionally, research on the socio-cultural impacts of these technological integrations, especially in different geographical contexts, would provide a more holistic understanding.

For healthcare practitioners, these findings highlight the need for continuous adaptation and training in new technologies. Policymakers should consider the development of comprehensive frameworks that govern the ethical and secure use of AI and data analytics in healthcare. Technology developers can use these insights to tailor Industry 4.0 solutions that are more aligned with healthcare needs, focusing on aspects like user-friendliness, data security, and interoperability.

## Discussion

Our systematic literature review provides a comprehensive insight into the integration of Industry 4.0 technologies in healthcare, a field that is rapidly evolving and gaining significant attention in recent years. The review highlights a strong focus on data management, artificial intelligence, and the Internet of Things, underscoring their pivotal roles in revolutionizing healthcare delivery and management.

One of the key conclusions from this review is the transition from theoretical exploration to practical implementation of Industry 4.0 technologies in healthcare settings. This shift is evident in the current literature, with studies emphasizing real-world applications and impacts of these technologies on patient care, operational efficiency, and healthcare management. The findings also reveal a growing interest in addressing the challenges associated with the integration of these technologies, including data privacy, ethical considerations, and the need for robust infrastructural support.

Furthermore, the review underscores the importance of interdisciplinary research and collaboration in this field. The integration of Industry 4.0 technologies in healthcare is not only a technological challenge but also involves significant policy, ethical, and training implications. It calls for a collaborative approach involving healthcare

professionals, policymakers, technologists, and educators to navigate the complexities and harness the full potential of these technologies.

The limitations identified in the review, particularly in terms of the scope of literature and potential biases, highlight the need for more diverse and longitudinal studies. Future research should aim to address these limitations and explore the long-term impacts, scalability, and sustainability of Industry 4.0 technologies in healthcare.

## Conclusions

In conclusion, the integration of Industry 4.0 technologies in healthcare presents both significant opportunities and challenges. While there is evident progress and enthusiasm in embracing these technologies, it is crucial to approach this integration with a balanced perspective, considering the technical, ethical, and practical aspects. The insights gained from this review contribute to the ongoing discourse in this field, providing a foundation for future research and development, and guiding healthcare practitioners, policymakers, and technologists in making informed decisions as they navigate this exciting and evolving landscape.

## Acknowledgements

Nil.

## Declarations of competing interest

No potential competing interest was reported by the authors.

## References

1. Nindrea RD. Impact of Telehealth on the Environment During the COVID-19 Pandemic in Indonesia. *Asia Pac J Public Health*. 2023;35(2-3):227.
2. Nindrea RD. Wolbachia: New Hopes for the Prevention of Dengue Hemorrhagic Fever in Indonesia. *Asia Pac J Public Health*. 2024;36(2-3):280.
3. Nindrea RD, Sari NP, Lazuardi L, Aryandono T. Validation: The Use of Google Trends as an Alternative Data Source for COVID-19 Surveillance in Indonesia. *Asia Pac J Public Health*. 2020;32(6-7):368-369.
4. He L, Eastburn M, Smirk J, Zhao H. Smart Chemical Sensor and Biosensor Networks for Healthcare 4.0. *Sensors (Basel)*. 2023;23(12):5754.
5. De Benedictis A, Mazzocca N, Somma A, Strigaro C. Digital Twins in Healthcare: An Architectural Proposal and Its Application in a Social Distancing Case Study. *IEEE J Biomed Health Inform*. 2023;27(10):5143-54.
6. Malviya N, Malviya S, Dhere M. Transformation of Pharma Curriculum as Per the Anticipation of Pharma Industries-Need to Empower Fresh Breeds with Globally Accepted Pharma Syllabus, Soft Skills, AI and Hands-on Training. *Indian J Pharm Educ Res*. 2023;57(2):320-8.
7. Munsayac FE, Culaba A, Bugtai N, Abuan RD, Kaplan A. Comprehensive Study of Industry 4.0 in Robotics for Policy Development. *Recoletos Multidiscip Res J*. 2023;11(1):55-69.
8. Matyori A, Brown CP, Ali A, Sherbeny F. Statins utilization trends and expenditures in the U.S. before and after the implementation of the 2013 ACC/AHA guidelines. *Saudi Pharm J*. 2023;31(6):795-800.
9. Sutarno M, Anam K. An Empirical Study on the Use of Digital Technologies to Achieve Cost-Effectiveness in Healthcare Management. *Am J Health Behav*. 2022;46(6):781-793.
10. Lepore D, Frontoni E, Micozzi A, Moccia S, Romeo L, Spigarelli F. Uncovering the potential of innovation ecosystems in the healthcare sector after the COVID-19 crisis. *Health Policy*. 2023;127:80-6.
11. Nandi S. Reiterating the Importance of Publicly Funded and Provided Primary Healthcare for Non-communicable Diseases: The Case of India. *Int J Health Policy Manag*. 2022;11(6):847-50.

12. AlSahly AM, Hassan MM, Saleem K, Alabrah A, Rodrigues JJPC. Handheld Device-Based Indoor Localization with Zero Infrastructure (HDIZI). *Sensors (Basel)*. 2022;22(17):6513.
13. Abedsoltan H. COVID-19 and the chemical industry: impacts, challenges, and opportunities. *J Chem Technol Biotechnol*. 2023;98(12):2789-97.
14. Nindrea RD, Usman E, Katar Y, Darma IY, Warsiti, Hendriyani H, Sari NP. Dataset of Indonesian women's reproductive, high-fat diet and body mass index risk factors for breast cancer. *Data Brief*. 2021;36:107107.
15. Djanas D, Yusirwan, Martini RD, Rahmadian, Putra H, Zanir A, Syahrial, Nindrea RD. Survey data of COVID-19 vaccine side effects among hospital staff in a national referral hospital in Indonesia. *Data Brief*. 2021;36:107098.