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The emerging role of artificial intelligence in health technology incubators: A Narrative Review

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Abstract

Background: Artificial intelligence (AI) is increasingly recognized as a transformative technology in healthcare innovation and digital health ecosystems. Health technology incubators play a key role in supporting startups and translating innovations into clinical and commercial solutions, yet the integration of AI within these ecosystems remains underexplored.

Methods: A narrative review was conducted to examine the role of AI in health technology incubators. Relevant literature was identified through searches of major scientific databases, including PubMed, Scopus, Web of Science, and Google Scholar. The selected literature was screened for relevance and synthesized thematically.

Results: The findings indicate that AI can enhance health technology incubators through applications in business model innovation, health product development, clinical data analysis, policy-related decision-making, startup selection, and performance evaluation. Successful implementation requires adequate data resources, technological infrastructure, and a skilled workforce. Key challenges include ethical, legal, and governance issues, particularly those related to privacy, transparency, and accountability.

Conclusion: AI has the potential to improve the efficiency, effectiveness, and sustainability of health technology incubators by accelerating innovation and strengthening startup development. However, its successful adoption depends on robust infrastructure, governance frameworks, and further empirical validation in real-world settings.

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Highlights

What is current knowledge?

Innovation is a broad concept essential for healthcare and economic competitiveness, and incubators play a key role in supporting startups and reducing innovation risks. In healthcare, innovation is highly regulated due to safety, ethical, and clinical risks, making health technology incubators especially important. AI is increasingly applied in healthcare and entrepreneurship, improving efficiency, education, and startup performance.

What is new here?

- There is a lack of integrated research on AI within health technology incubators, as AI and incubator literature are generally studied separately. This review specifically examines how AI can enhance performance, governance, and innovation outcomes in health technology incubators.
- It highlights the combined role of AI in startup development, regulatory navigation, and accelerated innovation within healthcare ecosystems. It also identifies key challenges, limitations, and strategic directions for effective AI adoption in this context.

Introduction

The term innovation is inherently broad and encompasses a wide range of elements, including ideas, paradigms, scientific theories, products, services, processes, and organizational structures. Product innovation, for example, refers to the development and market introduction of a new physical product or tangible good (1). Service innovations are similar in nature but involve intangible goods, such as new methods of delivering logistics, consulting, or other service-based solutions (2). Innovation in healthcare is especially crucial due to the increasing pressure from aging populations, the growing burden of chronic diseases, and the rising costs associated with healthcare delivery. These challenges demand transformative approaches such as digital health technologies, new care models, and data-driven interventions to ensure healthcare systems remain sustainable and effective (3).

Beyond the healthcare sector, innovation plays a pivotal role in driving growth, adaptability, and competitiveness in both established firms and startups. A study of active firms in the Netherlands showed that innovation has a significant positive impact on firm survival (4). For startups, innovation serves as the foundation for market entry and differentiation. In this regard, business incubators and innovation centers play a strategic role by nurturing early-stage ideas, reducing operational risks, and equipping entrepreneurs with the tools and mentorship needed to transform innovation into long-term viability. Interactions among incubatees and between incubatees and incubation management enable more effective use of internal capabilities, thereby preventing strategic failures (5). Colombo and Delmastro (6), in examining technology business incubators (7), reported that incubatees demonstrate superior innovation performance compared with off-incubator firms.

Compared to other industries, the healthcare sector is generally more conservative, as the consequences of errors can be severe and potentially life-threatening. Consequently, most healthcare innovations are subject to strict oversight by regulatory and approval bodies, as well as cautious evaluation by physicians who implement the innovations in clinical practice. This heightened level of scrutiny underscores the critical role of health technology incubators, which not only support startups in navigating complex regulatory landscapes but also help ensure that innovations meet safety, efficacy, and ethical standards before reaching clinical implementation.

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The integration of artificial intelligence (AI) into incubators and business accelerators has demonstrated significant potential for enhancing entrepreneurial education and improving startup success rates (8). Likewise, AI is emerging as a transformative force within healthcare startups, driving innovation and operational efficiency (9). However, despite growing interest in AI-driven healthcare innovation and the expanding role of health technology incubators, limited attention has been paid to the intersection of these domains. Existing studies have largely examined AI applications in healthcare or the functions of innovation incubators separately, with relatively little focus on how AI can enhance the performance, governance, and innovation outcomes of health technology incubators. To address this gap, this narrative review explores the role and significance of AI implementation within health technology incubators, examines the challenges and limitations associated with its adoption, and proposes strategic recommendations for optimizing the performance and impact of AI-driven innovation in this context.

Methods

This article presents a narrative review examining the role of AI in health technology incubators. Relevant literature was identified through searches of major scientific databases, including PubMed, Scopus, Web of Science, and Google Scholar. The search focused on publications related to artificial intelligence, health technology incubators, digital health innovation, healthcare startups, innovation ecosystems, and AI-enabled healthcare technologies.

The retrieved literature was screened for relevance to the objectives of the study. Articles addressing AI applications in healthcare innovation, startup incubation, health technology development, digital health entrepreneurship, governance, and innovation management were considered for inclusion. Priority was given to peer-reviewed articles, policy reports, and authoritative publications that examined the opportunities, challenges, and implementation requirements of AI within healthcare innovation ecosystems.

The selected literature was reviewed and synthesized thematically. The findings were organized into four major domains: 1- applications of AI in health technology incubators, 2- infrastructure and capacity requirements for AI implementation, 3- ethical, legal, and governance considerations, and 4- strategic recommendations for the effective integration of AI into health technology incubators.

Given the emerging and interdisciplinary nature of this field, a narrative review approach was considered appropriate for providing a comprehensive conceptual synthesis of current knowledge, identifying existing gaps in the literature, and highlighting future directions for research and practice.

Health technology incubators: Missions and challenges

Entrepreneurial support organizations (ESOs) play a critical role in addressing the innovation-related challenges faced by startups in the health sciences sector. Within these innovation ecosystems, various ESOs, including business incubators and accelerators, offer vital support to early-stage ventures. By facilitating key developmental processes and providing strategic resources, these organizations contribute to the vitality, resilience, and long-term sustainability of health innovation ecosystems. In recent years, there has been a growing interest in establishing health-focused incubators and evaluating their impact on the healthcare sector (10).

The significant contribution of small enterprises to economic growth and market diversity is well established and widely acknowledged in the literature. Promoting and supporting increased activity in this sector are considered essential, and given the widely recognized success of incubators, policymakers regard them as a promising mechanism for achieving this objective (11). Conceptually, incubators are viewed as multifaceted entities that integrate various functions, such as business growth and development, new venture creation, peer-group networking, community revitalization, attraction of inward investment, infrastructure enhancement, entrepreneurial venturing, and real estate development (12,13).

In the healthcare sector, as in other industries, technology is rapidly emerging and advancing, clearly requiring both support and oversight. The integration of advanced technologies such as AI, machine learning, and blockchain is expected to transform healthcare by improving patient outcomes, streamlining operations, and increasing accessibility. These innovations enable more accurate diagnoses, personalized treatments, and better management of chronic conditions, ultimately leading to higher-quality care (14). In this context, health technology incubators play a vital role by providing infrastructure, mentorship, and strategic guidance to early-stage ventures that develop such innovations.

By supporting startups working at the intersection of healthcare and cutting-edge technology, health incubators not only accelerate the innovation process but also ensure that new solutions are developed in alignment with regulatory, ethical, and clinical standards. Their involvement is crucial for translating technological potential into real-world healthcare improvements. However, like other types of incubators, health technology incubators also face several challenges, one of the most critical being limited financial resources. Addressing this issue requires coordinated attention and investment from both the public and private sectors to ensure sustainability and effectiveness.

Given that incubators play a crucial role in fostering innovation within startups (15), and considering the undeniable impact of artificial intelligence in driving advanced innovations and technologies in the healthcare sector, another major challenge faced by health technology incubators is the lack of adequate data infrastructure and the shortage of AI specialists. Overcoming these limitations is essential for enabling incubators to effectively support AI-driven health innovations and to realize their full potential in advancing the healthcare ecosystem.

Applications of AI in health technology incubators

The classic definition of artificial intelligence (AI) was offered by McCarthy (1959), who stated that “AI is a type of machine that is inherent in intelligent behavior” (16). In modern usage, AI refers to the simulation of human cognitive processes by machines, particularly computer systems, enabling them to perform tasks that traditionally require human intelligence, such as learning, reasoning, problem-solving, and decision-making. In recent years, AI has been actively integrated into various human and social activities, influencing nearly every domain, including technology, business, and healthcare. As an advanced intellectual tool, AI has the potential to greatly assist humans in enhancing productivity and efficiency across a wide range of tasks, thereby driving innovation and improving outcomes in multiple sectors.

In the context of health technology incubators, the integration of AI offers transformative potential. Beyond its role in advancing health-related technologies, AI can contribute substantially to policymaking, optimize resource utilization, and improve the operational efficiency of these incubators. Furthermore, adopting AI strategically enhances the global competitiveness and long-term sustainability of health technology incubators, positioning them as pivotal drivers of digital health transformation. Accordingly, the following sections examine several key applications of artificial intelligence in the performance of both health-related technologies and health technology incubators.

Application of AI in business models: Technologies and companies can integrate artificial intelligence into their business models to drive growth and innovation. For example, Vodafone enhanced its customer services across multiple channels by incorporating AI-driven data analytics into its data management, thereby enabling greater personalization of products and services (17,18). According to Lee et al. (19), more than 80% of business executives believe that AI enables companies to maintain or gain competitive advantages, while over 70% conclude that AI creates opportunities for new business models (20-22). In the healthcare sector, Ignat Kulkov demonstrated that AI-based value creation has the potential to significantly transform global healthcare (23). A recent study presents a systematic review of AI-driven business model innovation across industries, offering a structured analysis of emerging research dimensions and a robust research agenda for managerial practice (24).

Within health technology incubators, AI-driven business model innovation can support the evaluation and development of startup ventures. By analyzing market trends, customer needs, investment patterns, and commercialization opportunities, AI can help incubator managers identify promising business models and provide more targeted support to emerging companies. This capability can improve startup selection, resource allocation, and long-term venture sustainability, thereby enhancing the overall effectiveness of incubation programs.

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Application of AI in health product design: AI plays a pivotal role in health product design, enabling startups and health technology firms to develop more effective, user-centered, and evidence-based solutions. By leveraging large-scale clinical and patient data, AI supports the identification of unmet medical needs, guides the design of patient-friendly medical devices, and enhances digital health applications through predictive modeling and personalized features. For instance, AI-driven simulations allow innovators to test prototypes virtually, reducing costs and accelerating the development cycle. Recent studies highlight that AI-assisted design not only improves product efficiency and safety but also fosters innovation pathways that would otherwise be unattainable using traditional methods (9,25,26).

For health technology incubators, AI-assisted product design offers an opportunity to accelerate the development and validation of innovative healthcare solutions. Incubators can leverage these capabilities to support startups in prototype development, product optimization, and user-centered design processes. As a result, incubated companies may reduce development costs, shorten time-to-market, and improve the likelihood of successful commercialization.

Applications of AI in clinical and epidemiological data analysis for the validation of innovative health technologies: Artificial intelligence is increasingly being recognized for its role in enhancing clinical validation processes for innovative health technologies. A notable example is the European Medicines Agency's recent qualification of the first AI-based tool, AIM-NASH, designed to assess liver biopsy samples for non-alcoholic steatohepatitis (NASH/MASH) in clinical trials. This milestone highlights how AI can contribute to improving diagnostic accuracy, streamlining validation procedures, and supporting the development of next-generation health technologies. Moreover, AI can help researchers obtain clearer evidence on the benefits of new treatments in clinical trials that include fewer patients, thereby reducing costs and accelerating the validation process (27). Beyond clinical trials, AI-driven epidemiological data analysis enables researchers and policymakers to track disease trends, model outbreaks, and evaluate the population-level impacts of new health technologies (28,29). Such capabilities make AI an indispensable tool in ensuring that novel innovations are not only effective but also scalable and safe for broader implementation.

Within health technology incubators, these capabilities can significantly enhance the evaluation and development of early-stage innovations. By leveraging AI-driven clinical and epidemiological analyses, incubator managers and startup teams can identify unmet healthcare needs, assess the potential impact of emerging technologies, and prioritize projects with greater clinical and commercial value. Such data-informed decision-making can improve resource allocation, reduce development risks, and increase the likelihood of successful technology translation into healthcare practice.

In addition, AI-based decision-support systems can assist incubator administrators in startup selection, performance monitoring, mentor allocation, and investment prioritization. These functions enable health technology incubators to make more objective and evidence-informed decisions throughout the incubation process, thereby strengthening both operational efficiency and innovation outcomes.

The role of AI in policymaking within health technology incubators: AI holds significant potential to enhance policymaking processes within health technology incubators. By enabling evidence-based and data-driven decisions, AI can improve the efficiency, transparency, and long-term sustainability of incubator policies. According to a recent scoping review (30), AI can provide policymakers with advanced analytical tools that strengthen the evaluation phase, reduce political bias, and support more logical and independent decision-making. Importantly, these AI-driven systems are not designed to replace human decision-makers but to augment their capacity for more informed and effective policy development. For health technology incubators, this integration means that resource allocation, regulatory alignment, and strategic planning can be managed with greater precision, ultimately improving their ability to support innovative startups and health-focused ventures.

Application of AI in startup selection and performance evaluation: Artificial intelligence can play a critical role in improving startup selection and performance evaluation processes within health technology incubators. Traditionally, the assessment of startup potential relies heavily on expert judgment, which may be influenced by subjective factors and limited information. AI-driven analytics can enhance this process by evaluating large volumes of structured and unstructured data, including market trends, business plans, financial indicators, technological readiness, and team characteristics. By identifying patterns associated with successful ventures, AI can assist incubator managers in selecting startups with higher growth potential and lower investment risk (31,32).

In addition to startup selection, AI can support continuous monitoring and evaluation of incubated companies. Machine learning algorithms can analyze key performance indicators, identify early signs of operational challenges, and provide predictive insights regarding future performance. These capabilities enable incubator managers to allocate resources more effectively, design targeted mentorship programs, and make evidence-based decisions regarding funding and strategic support (33). Consequently, AI-assisted evaluation systems can improve transparency, optimize resource utilization, and enhance the overall effectiveness of health technology incubators in fostering healthcare innovations.

Prerequisites and infrastructure for deploying AI in health technology

Successful implementation of AI within health technology incubators requires a robust foundation comprising hardware and software infrastructure, organizational readiness, and human capital development. Key components include:

Hardware requirements: AI algorithms, as the cornerstone of modern technological advancements, are designed to address a wide spectrum of tasks, from complex data analysis to the autonomous operation of systems. The interaction between these advanced algorithms and their underlying hardware implementation plays a pivotal role in advancing the field of AI, enabling the development of more efficient, powerful, and versatile applications. Providing access to GPUs, TPUs, and high-performance servers enables startups to process large-scale clinical and epidemiological datasets and train complex models effectively. In addition, high-bandwidth, low-latency networking and scalable storage systems are essential for supporting seamless data handling, reliable model deployment, and long-term sustainability (34,35). By offering such resources, incubators can empower health-focused startups to develop and validate advanced AI-driven solutions more efficiently and competitively.

Software infrastructure: In addition to hardware, health technology incubators must provide robust software environments that enable startups to design, train, and deploy AI models efficiently. Python remains the primary programming language due to its simplicity and the wide availability of machine learning and deep learning libraries developed by experts (36). Furthermore, Tensor Flow Extended (TFX) offers a comprehensive framework for building end-to-end AI pipelines, covering data preprocessing, model training, evaluation, and deployment. By leveraging TFX, incubators can ensure reproducibility, scalability, and reliability of AI-driven healthcare solutions while maintaining alignment with clinical standards. Automated model monitoring and retraining capabilities allow startups to continuously refine their models, supporting the creation of high-quality, practical AI applications that accelerate innovation and enhance patient outcomes (37).

Access to high-quality and standardized data: AI in health technology incubators relies on diverse data sources, including structured electronic health records (EHRs), laboratory results, wearable device data, unstructured clinical notes, and medical images such as radiological scans. Increasingly, multimodal deep learning techniques combine multiple data types, such as imaging, genomic, and EHR data, to build more robust and accurate models that enable precision medicine (38,39). Ensuring that data are of high quality, standardized, and interoperable while complying with frameworks such as the General Data Protection Regulation (GDPR) in the EU and the Health Insurance Portability and Accountability Act (HIPAA) in the US is vital for trustworthy AI in healthcare (40).

Training and capacity building: In health technology incubators, infrastructure alone is insufficient without skilled human resources. Prioritizing training programs and capacity-building initiatives is essential to empower startup teams with the technical expertise needed to leverage AI tools effectively. Fostering AI literacy and interdisciplinary collaboration enables startups to transform health

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innovation into practical, scalable solutions. Recent initiatives underscore the importance of such training. For instance, Harvard Medical School's "Leading AI Innovation in Health Care" program equips healthcare leaders with the strategic insight and practical tools required to implement AI effectively and responsibly in clinical settings (41). Along the same lines, the NIH Bridge2AI initiative supports the creation of a multidisciplinary educational framework aimed at fostering interdisciplinary capabilities and advancing ethically informed AI training across biomedical domains (42). These programs highlight the critical role of education in integrating AI into healthcare, ensuring that innovations are both effective and ethically sound.

Ethical, legal, and governance considerations for the deployment of AI

The ethical and legal deployment of AI in health technology incubators requires a comprehensive framework that ensures privacy, accountability, and compliance with international standards. According to the World Health Organization (WHO), healthcare data privacy is defined as the implementation of measures that ensure the confidentiality, integrity, and availability of patient information (43). Protecting patient privacy is a cornerstone of the ethical deployment of AI in healthcare. Evidence shows that best practices in healthcare data privacy are most effective when they are proactive, technologically integrated, and adapted to local conditions. Accordingly, health technology incubators should implement strong privacy protection measures, including monitoring tools aligned with internationally recognized standards such as the General Data Protection Regulation (GDPR), the Health Insurance Portability and Accountability Act (HIPAA), and the Protection of Personal Information Act (POPIA). These protective measures should be sufficiently flexible to accommodate local resource constraints and contextual differences (40). In addition, systematic staff training is essential to raise awareness and ensure regulatory compliance.

Another critical challenge in the use of AI in health technologies is the requirement for large amounts of labeled data for supervised learning (44). Annotating healthcare data demands specialized expertise, making the process both costly and time-consuming. In medical imaging, for instance, accurate labeling must be performed by radiologists or imaging specialists. Consequently, health technology incubators need to employ or collaborate with such experts to ensure the development of reliable and clinically valid AI-driven solutions.

Furthermore, accountability and transparency are essential requirements in AI-driven decision-making. Startups operating within health technology incubators should be encouraged to adopt explainable AI (XAI) techniques to minimize bias and strengthen trust among stakeholders. It is highly unlikely that patients will accept AI-generated decisions that they cannot understand (45). Moreover, given the high sensitivity of diagnosis and treatment in healthcare, human-centered explainable AI (HCXAI) is particularly valuable (46). Such approaches enable humans to understand the reasoning behind AI outputs and use them as informed inputs for their own decision-making (47), thereby enhancing both clinical reliability and ethical soundness.

Strategic recommendations for AI-integrated health technology incubators

To maximize the transformative potential of artificial intelligence within health technology incubators, several strategic actions are recommended. Effective integration of AI in healthcare and health technology incubators requires deliberate investment in human capacity development. This involves equipping entrepreneurs, healthcare professionals, and startup teams with the knowledge and skills needed to design, implement, and manage AI-based solutions effectively. The integration of AI into healthcare technologies is not merely a technological advancement but also a profound transformation in the operational, cultural, and ethical frameworks of healthcare organizations. To adapt to this shift, professionals must acquire specialized expertise in AI disciplines such as machine learning, deep learning, and natural language processing, enabling them to apply these tools both effectively and ethically (48).

The presence of experts capable of detecting subtle data distortions, often imperceptible to non-specialists, is particularly critical in health technology incubators (49). Furthermore, a recent systematic review underscores consensus on five key areas of competence essential for AI adoption: AI fundamentals, ethical and legal considerations, data analysis and management, communication and teamwork, and evaluation of AI tools (50).

In addition to human capacity development, successful implementation of AI within health technology incubators requires robust data governance frameworks, ethical oversight mechanisms, and adequate technological infrastructure (34,35). Ensuring data quality, privacy protection, transparency, and accountability is essential for the responsible use of AI in health innovation. Health technology incubators should also promote collaboration among academic institutions, healthcare organizations, industry partners, investors, and policymakers to facilitate knowledge exchange, resource sharing, and the effective translation of innovative technologies into healthcare practice. Such collaborative ecosystems can enhance both the operational effectiveness and long-term sustainability of AI-driven health innovations.

Results

The findings indicate that artificial intelligence (AI) has the potential to significantly enhance the performance of health technology incubators by supporting innovation, improving decision-making processes, optimizing resource allocation, and facilitating the development and validation of health technologies. AI applications extend beyond healthcare technologies themselves and also strengthen the strategic and operational functions of health technology incubators, including policymaking, startup evaluation, and business model innovation. However, several challenges were identified, particularly ethical, legal, and governance issues related to data privacy, transparency, and accountability.

Conclusion and directions for future research

Artificial intelligence has the potential to significantly enhance the efficiency, effectiveness, and sustainability of health technology incubators by accelerating innovation and strengthening startup development. As discussed throughout this review, AI applications extend beyond healthcare technologies themselves and can also strengthen the strategic and operational functions of health technology incubators, including policymaking, startup evaluation, and business model innovation. However, the successful adoption of AI within health technology incubators requires appropriate technological infrastructure, effective data governance mechanisms, ethical oversight, and a skilled workforce capable of developing and implementing AI-based solutions responsibly.

Looking ahead, future investigations should emphasize the design and validation of standardized AI competency models aligned with the specific needs of health technology incubators and healthcare professionals. These frameworks must integrate technical skills, ethical and legal dimensions, and robust data management practices. In addition, further empirical studies are needed to evaluate the real-world impact of AI adoption on incubator performance, startup success, and healthcare innovation outcomes. Collaborative efforts among academic institutions, healthcare organizations, health technology incubators, and AI professionals will be crucial for establishing comprehensive training programs that address these competencies and support the responsible deployment of AI in health innovation

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Ethical Statement

Ethical approval was not required for this study as it did not involve human participants or animal subjects.

Conflicts of Interest

The authors declare no conflict of interest.

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Author Contributions

All authors contributed to the study conception, design, data analysis, and manuscript preparation and approved the final manuscript.

Data Availability Statement

No new data were generated or analyzed in this study. All data used in this narrative review were obtained from publicly available sources, including peer-reviewed articles, indexed databases, and published literature.

Use of Artificial Intelligence

During the preparation of this manuscript, generative AI and AI-assisted technologies were used to improve the readability and language of the text. The authors reviewed and edited the content as necessary and take full responsibility for the content of the final published version.

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