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Transformative Trends in Medical and Pharmacy Education: Insights from Technological and Curricular Innovations; a Scoping Review

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Abstract

This scoping review seeks to deliver an in-depth overview of new patterns and prospective directions in medical and pharmacy education, responding to the growing need for educational models that can keep pace with a rapidly changing healthcare environment. A structured literature search was performed across several databases to locate pertinent publications released between April 2014 and April 2024. Studies focusing on trends, foresight, and anticipated developments in medical and pharmacy education were eligible for inclusion. Data were extracted and synthesized using a rigorous process with independent reviewers and standardized extraction tools. Key themes were derived through systematic coding and conceptual mapping.
Among 926 identified records, 22 studies met the inclusion criteria and were analyzed, uncovering multiple major trends: (1) Application of artificial intelligence (AI), virtual/augmented reality (VR/AR), and other digital tools to improve education and competency development; (2) Curriculum redesigns prioritizing interprofessional learning, value-based healthcare, population health, and social determinants of health; (3) Expansion of multidisciplinary frameworks integrating genomics, biotechnology, and data science; (4) Greater attention to disease prevention and long-term management of chronic conditions; (5) Development of ethical guidelines and competency benchmarks for effective human–AI interaction. Overall, the findings underscored the importance of harmonizing technological progress with foundational clinical abilities and humanistic principles. This review outlines substantial shifts in medical and pharmacy education and offers guidance for educators and policymakers seeking to align curricula and pedagogical strategies with the evolving healthcare context. Leveraging innovations such as AI and VR/AR, while fostering flexibility, interdisciplinary teamwork, and patient-centered practice, is vital to sustaining educational relevance. Preparing a workforce skilled in human–AI collaboration and grounded in multidisciplinary knowledge will be essential for future healthcare systems.

Keywords: Medical education, Pharmacy education, Future trends, Foresight, Forecasting

Introduction

Medical and pharmacy education are central to developing the future healthcare workforce and have a direct impact on patient outcomes and public health [1]. As healthcare systems undergo continuous transformation due to technological innovation, demographic transitions, and evolving disease profiles, medical and pharmacy education encounters both notable challenges and new opportunities [2, 3]. Addressing these dynamics requires careful assessment of existing trends alongside anticipatory evaluations of forthcoming changes [4].

Historically, medical education has demonstrated a capacity to evolve in response to societal healthcare demands [5]. Progressing from apprenticeship-based training to contemporary interdisciplinary and competency-driven curricula, the discipline has repeatedly adapted to ensure practitioners acquire the expertise necessary for high-quality care delivery [6]. Nevertheless, the accelerating pace of change within healthcare continues to pressure medical and pharmacy education programs to remain current and adequately

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prepare graduates for increasingly complex practice settings [7, 8].

More recently, the incorporation of digital innovations—including virtual and augmented reality simulations, web-based learning systems, and data-driven analytics—has transformed educational delivery in medicine and pharmacy [9–11]. These tools present new possibilities for enriched learning, improved skills acquisition, and strengthened interprofessional engagement [12]. Concurrently, the heightened focus on interprofessional education and collaborative care has driven curricula toward more integrated and team-oriented instructional models [13, 14].

Furthermore, medical education must adapt to demographic shifts, novel health threats, and the growing incidence of chronic illnesses. Embedding concepts related to prevention, aging populations, and chronic disease care within training programs is essential to equip future professionals to serve older populations and confront the expanding burden of non-communicable diseases [15–19].

Moreover, the regulatory framework influencing medical and pharmacy education is in a state of continual change. Revisions to accreditation benchmarks, licensing policies, and defined scopes of professional practice increasingly shape how educational programs are developed and delivered [20]. Balancing compliance with these evolving regulations while safeguarding educational standards and promoting innovation remains a persistent difficulty for academic institutions and regulatory authorities [21].

Considering these converging trends and pressures, an in-depth examination of the anticipated future path of medical and pharmacy education is essential. Through analysis of technological progress, instructional methodologies, population trends, regulatory evolution, and other driving elements, this scoping review seeks to generate an integrated view of expected transformations. The knowledge derived from this work is intended to enable educators, academic leaders, and policymakers to proactively adjust educational models, curricula, and strategies, ensuring that future healthcare practitioners possess the competencies required to deliver effective, patient-centered care within a rapidly shifting healthcare system. Ultimately, this future-oriented assessment aims to support continuous enhancement of medical and pharmacy education, contributing to improved patient outcomes and broader healthcare system advancement. Specifically, this scoping review focuses on identifying and evaluating emerging forward-looking trends—technological, curricular, societal, and policy-driven—in medical and pharmacy education, with the goal of providing practical direction for curriculum designers and education policymakers planning for the next decade of health professions training.

Materials and Methods

Protocol

This scoping review was conducted in strict accordance with the methodological guidance issued by the Joanna Briggs Institute (JBI) for scoping reviews [22]. The JBI framework was selected for its methodological rigor and systematic structure, which support consistency and transparency throughout all stages of the review.

Eligibility criteria

Among the 926 records retrieved through database searching, 22 studies fulfilled the predefined eligibility requirements and were retained for final inclusion. Most records were excluded during screening due to irrelevance to the review objectives, insufficient reporting, or noncompliance with the established criteria.

Inclusion criteria

Inclusion criteria were defined to identify studies offering relevant perspectives on future-oriented developments in the field. Eligible publications were those released between April 2014 and April 2024, allowing assessment of both recent developments and emerging directions. Studies addressing medical education (undergraduate, postgraduate, and continuing education), pharmacy education (entry-level, postgraduate, and continuing education), or interprofessional education involving medical and pharmacy trainees or professionals were considered. Key thematic areas included innovations in educational delivery (e.g., virtual reality, online instruction), curriculum redesign and pedagogical advancement, incorporation of emerging healthcare concepts (e.g., precision medicine, digital health), interprofessional and team-based learning approaches, and the implications of demographic change and evolving disease burdens. The primary guiding question for this scoping review was: “What emerging trends and future directions in medical and pharmacy education should inform curriculum design and policy development?” Inclusion and exclusion parameters were derived from this question to

capture literature addressing prospective changes in medical and pharmacy education.

Exclusion criteria

To maintain conceptual focus and relevance, several exclusion criteria were applied. Studies concentrating solely on non-medical or non-pharmacy health professions were excluded. Research limited to narrowly defined medical or pharmacy subspecialty education, without implications for broader educational trends, was also omitted. Studies primarily focused on continuing professional development for practicing healthcare providers, without direct relevance to formal educational programs, were excluded. Additionally, conference abstracts, editorials, commentaries, and opinion articles lacking original empirical evidence or substantive policy analysis were not eligible for inclusion.

By implementing these rigorously defined inclusion and exclusion criteria, this scoping review aims to synthesize the most informative and applicable literature concerning future trends in medical and pharmacy education. This approach ensures that the review's findings deliver meaningful insights and actionable recommendations to support adaptation of educational programs in response to the evolving demands of contemporary healthcare.

Information sources and search strategy

A comprehensive electronic search of the literature was carried out on April 11, 2024, across several databases, including PubMed, Scopus, and Web of Science. The search strategy incorporated multiple keyword combinations, such as "future", "forecast*", "foresight*", "Pharma*", "Medical", and "education". Although Medline was not queried as a standalone database, PubMed was utilized, as it indexes the majority of Medline records. Subsequent updates of this review may include a direct Medline search to further strengthen coverage.

Study selection process

All records retrieved through the electronic search were imported into Mendeley Desktop for management and screening. Duplicate entries were removed, after which two reviewers (MB and BF) independently examined titles and abstracts according to predefined inclusion and exclusion criteria. Publications deemed potentially relevant underwent full-text retrieval for detailed evaluation. This multistep screening procedure ensured systematic and unbiased determination of study eligibility. Studies were excluded for reasons such as irrelevance to future-oriented themes, lack of original empirical or policy-related content, or exclusive focus on disciplines outside the scope of this review (e.g., dentistry or nursing).

Data items and data abstraction

Data extraction was independently performed by two reviewers (NZ and FS) using a standardized abstraction template developed to capture essential information from the included studies. Extracted variables included study characteristics, stated objectives, methodological approaches, and principal findings related to trend identification and forecasting within medical and pharmacy education. This structured process ensured consistency and completeness in data collection, supporting robust synthesis and interpretation.

Synthesis of results

The narrative synthesis began with repeated and careful examination of the extracted data from each included study to develop a comprehensive understanding of findings relevant to anticipated developments in medical and pharmacy education. Two reviewers (initials) independently coded and organized these findings into broad thematic domains using a uniform extraction framework.

Identified themes were subsequently reviewed and refined through an iterative consensus-building process between the reviewers. Overlapping themes were merged, while distinct concepts were reorganized into separate categories reflecting overarching trends. A narrative synthesis methodology, as described by Popay *et al*. (2006), was applied to integrate evidence across heterogeneous study designs without conducting a meta-analysis. This process involved repeated coding cycles, theme refinement, and conceptual mapping.

Analytical strategies

To strengthen analytical rigor, multiple strategies were incorporated within the narrative synthesis approach:

1. Detailed characterization of study designs and methodological features to provide appropriate contextual grounding.
2. Examination of connections within and across identified trends using conceptual mapping techniques.

3. Evaluation of the credibility and relevance of each data source, considering factors such as study design and alignment with the review objectives.
4. Identification and interpretation of inconsistent findings or opposing viewpoints across studies.
5. Critical appraisal of the evidentiary strengths and limitations underpinning each emergent trend.

The resulting synthesis presents a detailed narrative overview and conceptual representation of the principal emerging trends projected to influence the future direction of medical and pharmacy education. These trends were further classified, interpreted, and discussed in relation to existing scholarship and conceptual frameworks **(Table 2)**.

Quality appraisal

In accordance with scoping review principles, no formal methodological quality evaluation was performed on the included studies. The purpose of this review was to chart the extent and characteristics of the existing literature related to the topic, prioritizing comprehensive evidence mapping over critical assessment of individual study quality.

Reporting

The review was conducted and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) framework, ensuring systematic and transparent presentation of the findings [21]. Compliance with this internationally accepted reporting standard supports clarity, reproducibility, and effective dissemination of results to academic, educational, and policy audiences.

Results and Discussion

Selection of sources of evidence

The database search retrieved 926 records in total. Contributions from individual databases included PubMed (n = 287), Scopus (n = 323), and Web of Science (n = 316). After the removal of duplicate records, 419 unique studies remained for further evaluation.

These studies underwent a structured screening process involving detailed examination of titles and abstracts to determine eligibility. The overall study identification and selection process is illustrated in **Figure 1**. Studies addressing exclusively medical education or pharmacy education were retained when they provided insight into future-oriented developments relevant to the respective field.

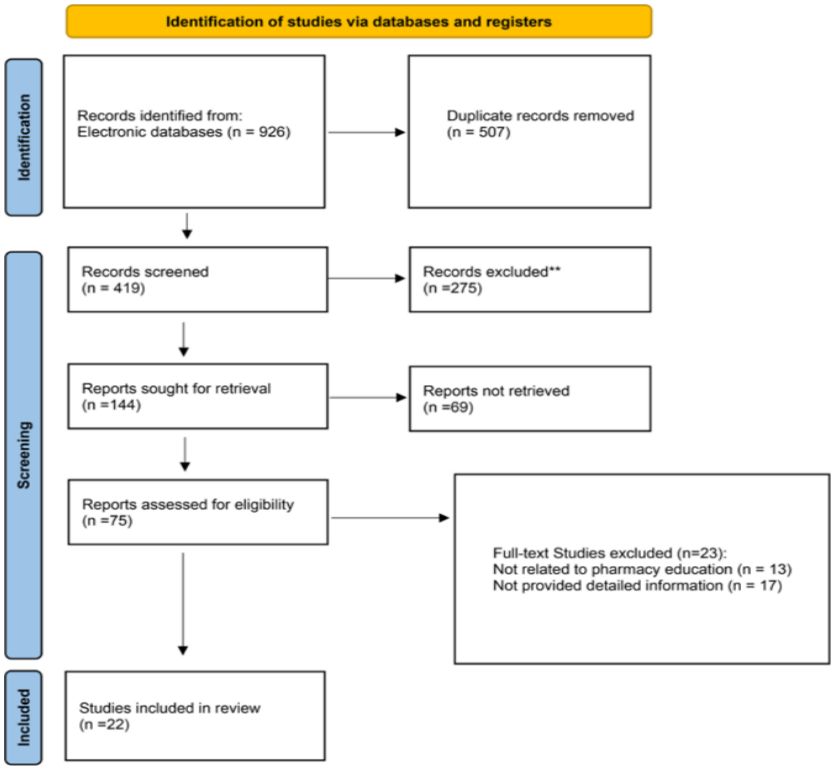

Figure 1. PRISMA flow diagram summarizing study selection. Note: reports not retrieved (n = 69) were unavailable due to lack of full-text access (e.g., subscription barriers, inaccessible journals, or removal from databases). Records excluded* (n = 275) were screened out at the title/abstract stage for failing to satisfy inclusion criteria (e.g., absence of relevance to medical or pharmacy education, lack of future-focused content, or insufficient methodological information).*

Characteristics of sources of evidence

Of the 75 articles assessed at the full-text level, 22 fulfilled the predefined eligibility criteria and were included in the final synthesis. Among these, 18 studies (82%) explored technological developments such as artificial intelligence and virtual reality, whereas 12 studies (55%) addressed curriculum modification or interdisciplinary educational models.

Results of individual sources of evidence

An overview of the included studies, detailing their key characteristics and principal findings, is presented in **Table 1**. This table serves as a concise reference point for understanding the scope and contributions of each study included in the review.

Table 1. Overview of included studies

No.	References	Country	Article Type	Rephrased Article Summary
1	[22]	Malaysia	EDITORIAL	The editorial examines the obstacles and consequences of incorporating digital technologies and artificial intelligence into medical education, stressing the importance of updating teaching approaches and curricula to equip upcoming physicians for a healthcare landscape dominated by technology.
2	[16]	Saudi Arabia	ORIGINAL	Written from a 2050 viewpoint, the article traces the development of medical education in the 21st century, pointing out flaws in the existing system and forecasting a move to briefer, specialized training in a multidisciplinary setting, with greater focus on patient quality of life.
3	[23]	Lebanon	ORIGINAL	The medical education field is tackling its difficulties via educational technologies, especially through virtual patients (VPs)—interactive scenario-based tools. These VPs encourage profound learning, clinical reasoning, and competency-focused training, while their data can aid research to advance medical education.
4	[21]	USA	EDITORIAL	The piece explores upcoming directions in medical education, underscoring the incorporation of cutting-edge technologies, economical healthcare provision, and fostering a worldwide professional mindset in learners. It stresses competency-driven education and readiness for effective, fair healthcare delivery.
5	[24]	UAE	EDITORIAL	The editorial investigates AI's revolutionary impact on medical education, advocating for the use of AI instruments, virtual/augmented reality, and gamification to improve learning and diagnostic accuracy. It also calls for worldwide access and tailored, flexible systems to better train future healthcare professionals.
6	[25]	USA	REVIEW	The review covers emerging trends in medical education, such as AI and virtual reality integration. AI supports customized learning, better diagnostics, and ethical understanding, whereas VR simulates clinical encounters to boost empathy and skills, transforming education through adaptive and immersive methods.
7	[26]	Canada	REVIEW	The primary emerging trend emphasized is advancing beyond merely duplicating patient-specific anatomy to reproducing physiological characteristics and biomechanical behaviors of human tissues using innovative materials, composites, and printing techniques.
8	[27]	Saudi Arabia	Letter to the Editor	The trends noted include the expanding use of AI and chatbots in medical education, but with strong advocacy for human supervision, ethical

				guidelines, high-quality training data, and ongoing improvements to counter risks and shortcomings of AI in this area.
9	[28]	USA	EDITORIAL	The editorial stresses the urgent requirement to overhaul medical training across all stages to develop physicians skilled in AI, while preserving essential abilities, and tackling issues such as fair access and effects on the workforce.
10	[29]	USA	EDITORIAL	The piece imagines a future medical education framework that utilizes technology for more interactive, personalized, and expandable learning, prioritizing the acquisition of practical competencies over simple knowledge transmission.
11	[30]	Saudi Arabia	ORIGINAL	The main trends center on thoughtfully embedding AI into every phase of medical training, while upholding clinical proficiencies, resolving equity issues, and adjusting to AI's influence on medical specialties and the workforce.
12	[31]	Saudi Arabia	ORIGINAL	The article advocates for standardized national outcomes, unified curricula, modern teaching techniques, better evaluations, strengthened hands-on training, and collaboration among stakeholders to elevate pharmacy education in Saudi Arabia.
13	[32]	Saudi Arabia	REVIEW	The review points to the necessity for individualized, tech-supported learning, skill-building outside conventional programs, research emphasis, value-oriented strategies, and ethical handling to successfully incorporate AI into medical education.
14	[33]	USA	ORIGINAL	Overall, the trends involve employing technology, simulations, mobile applications, and interactive techniques to foster engaging, autonomous, competency-oriented learning that matches contemporary healthcare demands and student preferences.
15	[34]	USA	REVIEW	The authors call for evidence-based studies in these domains to inform the responsible and effective inclusion of generative AI in medical education programs and methodologies.
16	[15]	USA	COLLOQUIUM INTRODUCTION	This work sought to consolidate the potential benefits and drawbacks of generative AI in medical education, identifying common themes in recent publications on applications and obstacles, to direct future research and investigations.
17	[35]	Canada	CROSS-SECTIONAL STUDY	The central emerging trend is incorporating AI-focused curricula and preparation into medical programs to equip graduates for AI-influenced healthcare, while overcoming implementation barriers; details on formats and teaching methods are still evolving.
18	[36]	South Korea	REVIEW	The authors compile trends from reviewing diverse innovative educational initiatives in the literature designed to ready medical students for upcoming healthcare scenarios shaped by tech progress, patient variety, and community requirements.
19	[37]	Ireland	ORIGINAL	The article spotlights the growth of webinars and e-learning as innovative yet reachable alternatives in medical education, facilitating cross-disciplinary exchanges while minimizing travel and environmental impact relative to conventional conferences.
20	[38]	Pakistan	EDITORIAL	In essence, adopting AI language models like ChatGPT in medical education is viewed as unavoidable, yet requiring strong regulations, human monitoring, and a balanced strategy where AI augments—rather than supplants—human contributions, critical analysis, and creativity.
21	[39]	USA	REVIEW	Key trends include VR evolving into a standard element of comprehensive, cross-disciplinary medical training that develops both technical abilities and human qualities like empathy in a consistent, reachable, and economical way.

22	[40]	USA	EDITORIAL	Fundamentally, the editorial urges bold, visionary changes in medical education to build a workforce equipped for the scientific and technological shifts transforming healthcare provision and preventive measures.

Synthesis of results

The integrated synthesis highlighted multiple emerging directions within medical and pharmacy education. These directions encompassed technological progress, regulatory influences, and evolving expectations among learners and stakeholders. **Table 2 and Figure 2** summarize the identified trends derived from the included studies. **Figure 2** visually represents the thematic organization of these trends, grouping them into areas such as digital and technological innovation (e.g., VR/AR, AI), curriculum and instructional transformation, interprofessional education, and human–AI collaboration. Collectively, these findings illustrate both system-level changes in educational philosophy and specific technological drivers shaping future educational practice.

Table 2. Newly identified trends derived from the review in the field of medical and pharmacy education

No.	Category	Rephrased Trend Description	References
1	Social	Movement toward individualized treatments based on genomics, influencing the training of future physicians.	[22]
2	Social	The curriculum will transform patient care outcomes by placing greater emphasis on quality of life and successful patient reintegration into society, beyond mere diagnosis and treatment.	[16]
3	Social	Escalating healthcare expenses will necessitate changes in medical education, prioritizing preparation of students for cost-effective care through knowledge of health policy, population health, healthcare financing, and social determinants of health.	[21]
4	Social	Modifications to curricula aimed at equipping students for emerging value-based and cost-conscious healthcare models that incorporate social determinants of health and population health management.	[21]
5	Social	Greater focus on cultivating competencies such as communication, social pharmacy, information technology, and medication safety within the curriculum.	[31]
6	Social	Emphasis on evolving the pharmacist's role from product-oriented to patient-oriented care.	[31]
7	Social	Medical training must prioritize building abilities in statistics, communication, teamwork, risk management, and compassion alongside core knowledge.	[32]
8	Social	Adoption of a humanistic perspective on patient safety: • Promoting compassionate physicians who deeply understand patients, value their own roles, and form strong patient relationships. • Encouraging teamwork between medical students and other healthcare professionals to enhance patient safety.	[36]
9	Social	Increased priority on "soft skills" including communication, negotiation, and persuasion for technically oriented medical positions in the data-driven economy, highlighting a discrepancy between industry needs and current academic emphasis.	[15]
10	Social	Shift in emphasis from solely diagnosing and treating diseases to greater attention on health promotion, prevention, risk assessment, translational research, and behavioral sciences.	[40]
11	Social	Replacement of continuing medical education (CME) with continuing professional development (CPD), expanding beyond clinical knowledge to include managerial, social, and personal competencies.	[16]
12	Social	Adoption of multidisciplinary patient care models, where allied healthcare professionals take on larger roles in collaboration with physicians.	[16]
13	Social	Curriculum updates to match rapid progress in life sciences, supported by global partnerships, extensive health databases, IT tools, and advanced data analysis methods.	[40]
14	Technological	Growing integration of digital tools such as podcasts, videos, mobile applications, video games, simulations, and wearables in teaching environments.	[22]

15	Technological	Application of AI for diagnostics by matching patient data or images against vast databases, including facial recognition for genetic disorders and AI-assisted dermatology evaluations.	[22]
16	Technological	Expanded application of animations, augmented reality, and virtual reality to illustrate physiological processes and pathologies.	[22]
17	Technological	Wider adoption of virtual patients (VPs)—multimedia, interactive case scenarios—to tackle key issues in medical training.	[23]
18	Technological	Employing VPs to foster deeper learning via active, constructive, and interactive tasks like summarizing cases or ranking differential diagnoses.	[23]
19	Technological	Growing incorporation of technologies like artificial intelligence, robotics, genomics, and nanotechnology into medical education, improving diagnostics, therapies, and training through simulation and telemedicine.	[21]
20	Technological	Greater reliance on tech-supported methods such as virtual patients, simulations, and online modules for instruction and evaluation.	[21]
21	Technological	AI is playing a central role in medical training by offering AI-based tools, customized learning paths, and enhanced diagnostic accuracy, including AI games, virtual patients, and image retrieval systems for training.	[24]
22	Technological	Use of virtual reality (VR) and augmented reality (AR) to deliver immersive, hands-on learning in simulated clinical settings.	[24]
23	Technological	Incorporation of AI-driven games and gamification features (e.g., points, badges, leaderboards) to boost engagement, teamwork, and tailored learning.	[24]
24	Technological	Inclusion of AI education in medical curricula to improve diagnostic skills, support personalized learning, and raise ethical awareness regarding AI in healthcare.	[24]
25	Technological	Deployment of VR headsets and displays for realistic, interactive simulations that replicate clinical situations and solidify theoretical knowledge.	[25]
26	Technological	Addition of gamification and AI games within VR to heighten engagement and deliver adaptive, personalized learning experiences.	[25]
27	Technological	Improved availability, accessibility, and affordability of 3D printing technology and expertise for broader use in medical training.	[26]
28	Technological	Advancement of composite and hybrid printing materials to more accurately replicate the properties of human tissues such as skin, organs, and blood vessels.	[26]
29	Technological	Expanded role of chatbots and AI in medical education, requiring human supervision to mitigate risks of inaccurate or harmful outputs.	[27]
30	Technological	Embedding artificial intelligence training into medical school programs to prepare future doctors for practical AI applications.	[28]
31	Technological	Greater adoption of the flipped classroom model, where students review lectures or materials independently before engaging in active, case-based discussions and teamwork in class.	[29]
32	Technological	Utilization of tools like video lectures, online platforms, tablets, and smartphones for content delivery and interactive education.	[40]
33	Technological	Incorporation of AI and advanced analytics into medical curricula to teach students effective use in clinical settings.	[30]
34	Technological	Application of modern teaching strategies emphasizing self-directed learning, active participation, and technology (e.g., flipped classrooms, simulations, digital boards).	[31]
35	Technological	AI delivering customized content and experiences adapted to each student's knowledge gaps, pace, and preferences for better comprehension.	[32]
36	Technological	Use of virtual patients and augmented reality for safe, realistic practice of clinical scenarios.	[32]
37	Technological	Training medical students to adapt to fast-evolving AI and machine learning technologies in healthcare.	[32]
38	Technological	Technology-enhanced active learning (TEAL) via games, simulations, and interactive tools to engage modern medical learners.	[33]

39	Technological	Virtual patient simulations (VPS) offering safe practice for clinical reasoning and decisions prior to real patient interactions.	[33]
40	Technological	Interactive technologies for teaching community and primary care topics aligned with Affordable Care Act requirements.	[33]
41	Technological	Exploration of virtual environments, electronic health records, virtual anatomy resources, and clinical case simulations.	[33]
42	Technological	Heightened use of computational models and visualizations to comprehend intricate biological, technological, and social healthcare systems.	[15]
43	Technological	Stronger focus on data literacy, computational modeling, and visualization skills as decision-making increasingly depends on large datasets and model interpretations.	[15]
44	Technological	Delivery of individualized, context-specific learning experiences suited to each student's requirements.	[15]
45	Technological	Training students for effective human-AI teamwork, emphasizing human strengths as AI automates routine tasks.	[15]
46	Technological	Preparing the healthcare workforce for widespread AI integration.	[35]
47	Technological	Incorporation of AI topics into official medical education programs.	[35]
48	Technological	Learner-centered education supported by advanced tech: • Personalized active learning through virtual patients, simulations, AR, etc. • Peer collaboration via online communities and mobile devices. • Broader access to resources independent of location.	[36]
49	Technological	Growing reliance on large language models like ChatGPT for support in medical training and clinical decisions.	[38]
50	Technological	Routine integration of VR as a standard supplementary tool in medical curricula and ongoing education, becoming more common in training.	[39]
51	Technological	Rise in e-learning webinars as alternatives or complements to conventional conferences and lectures.	[37]
52	Technological	Use of webinars to facilitate multidisciplinary learning by featuring experts from various subspecialties on shared topics.	[37]
53	Technological	Expansion of online platforms and open-access resources (e.g., “Heart University”) for distributing webinars and e-learning materials.	[37]
54	Technological	Growth of multiplayer and interprofessional VR cases for cross-discipline teamwork practice in virtual clinical settings.	[39]
55	Technological	Multidisciplinary educational approach integrating fields like genetics, biotechnology, nanotechnology, and 3D printing for personalized preventive care.	[29]
56	Economic	Increasing healthcare expenditures will prompt medical education reforms, focusing on efficient care through understanding of policy, population health, financing, and social determinants.	[21]
57	Economic	Escalating healthcare costs will necessitate reforms in medical training to promote efficient delivery, including policy, population health, financing, and social determinants knowledge.	[21]
58	Political	Involvement of varied stakeholders—including academia, science, health sectors, patients, and policymakers—in reshaping medical education for future needs.	[40]
59	Value	Ethical guidelines and restrictions on AI language models in medical education to avoid the dissemination of incorrect or harmful content.	[27]
60	Value	Balancing AI tool training with cultivation of fundamental clinical skills to prevent excessive dependence on technology.	[28]
61	Value	Legal and ethical issues in training physicians on AI to comply with changing care standards and reduce malpractice risks.	[28]
62	Value	Curriculum design that effectively combines AI competence with innate clinical skill development.	[30]
63	Value	Legal and ethical concerns regarding physician AI training to meet evolving care standards and prevent malpractice.	[30]

64	Value	Establishment of ethical guidelines ensuring AI algorithms are transparent, equitable, unbiased, and respect data privacy and consent.	[32]
65	Value	Building learners' ability to critically assess AI: • Training in appraising AI output accuracy and quality. • Developing skills for handling uncertainty and biased/incomplete AI data. Enhancing "AI literacy" through curricula.	[34]
66	Value	Re-evaluating assessment strategies: • Revising goals and methods given AI's simulation of advanced thinking. • Examining effects on assessment reliability and competency judgment.	[34]
67	Value	Risk of over-reliance on AI potentially diminishing human cognitive skills for basic tasks.	[38]
68	Value	Humanistic patient safety focus: • Fostering empathetic physicians who understand patients, value roles, and build strong bonds. • Promoting interprofessional collaboration among students for safety.	[36]
69	Value	Prioritizing early clinical immersion and practical experience from training start, e.g., via "patient-specialist" programs.	[16]
70	Value	Substantial reduction in medical education duration: 3-year core curriculum post-high school, followed by 2-year advanced track (physician, allied health, or scientist), then 2-year specialty training.	[16]

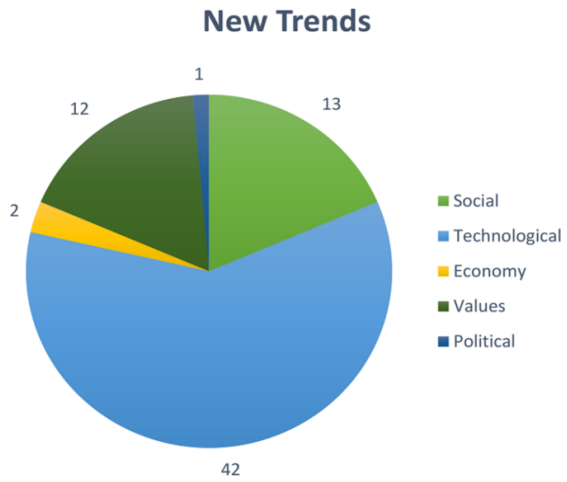

Figure 2. Emerging trends identified from the review in medical and pharmacy education

Social trends

The reviewed studies point to a growing movement toward patient-focused models of care, stronger interprofessional collaboration, and greater integration of social determinants of health within educational programs. Increased emphasis is also placed on communication competencies, human-centered practice, and the incorporation of population health concepts and preventive medicine into training.

Technological trends

The evidence underscores the accelerating adoption of artificial intelligence (AI), virtual and augmented reality (VR/AR), simulation-based learning, virtual patient systems, and digital learning environments as major drivers of educational change. These innovations enable individualized, immersive, and competency-oriented instruction, while simultaneously introducing ethical challenges related to governance, accountability, and overdependence on AI-driven tools.

Economic trends

Escalating healthcare expenditures were repeatedly cited as a catalyst for transformation in medical and pharmacy education. Educational reforms increasingly aim to prepare learners for value-driven and cost-conscious care, alongside strengthening knowledge of health economics, policy frameworks, financing mechanisms, and efficient resource utilization.

Political trends

Multiple studies highlighted the significance of policy development and active stakeholder participation, emphasizing the influence of regulatory authorities, academic institutions, and governmental bodies in shaping future-oriented curricula capable of addressing global health system demands.

Value-based trends

Ethical dimensions featured prominently, particularly in relation to AI adoption. The literature stresses the necessity of establishing guiding principles that reconcile technological progress with compassion, patient protection, transparency, and sound professional decision-making as a cornerstone of future educational models.

Drawing on the identified patterns—most notably those associated with AI implementation, interdisciplinary

education, and patient-centered approaches—several priorities for future workforce training become evident. This scoping review offers an integrated overview of the transformative forces expected to redefine medical and pharmacy education in the years ahead. The findings are consistent with prior research examining how technological innovation, instructional evolution, and changing healthcare demands are reshaping educational practices [41–44]. While this review concentrates on medical and pharmacy education, the highlighted trends and competency needs—such as proficiency in AI, collaborative practice, and adaptive skill development—are equally applicable across the broader spectrum of health professions education. As such, these insights may support cross-disciplinary curriculum design throughout healthcare training programs.

Technological integration and human–AI collaboration

The adoption of artificial intelligence (AI), virtual reality (VR), and augmented reality (AR) stands out as a central theme, echoing conclusions reported by multiple scholars [45–48]. These tools hold substantial promise for enriching educational experiences, advancing practical skill acquisition, and improving diagnostic accuracy. Nevertheless, as noted by Davenport and Kalakota [49], successful integration of AI requires a measured strategy that preserves foundational clinical skills and humanistic elements of care.

A number of studies further highlight the necessity for comprehensive ethical standards and regulatory guidance addressing concerns such as data protection, algorithmic openness, and bias within AI systems [50–52]. These issues align closely with the present review's findings, reinforcing the need for collaboration among educators, policymakers, and technologists to develop curricula and governance structures that maximize the complementary strengths of humans and AI.

Curricular reforms and future workforce preparation

The call for curriculum transformation to support value-based and economically sustainable care models aligns with arguments advanced by Skochelak and Stack [53]. Their work emphasizes preparing future practitioners with expanded competencies that include health policy literacy, population-level health strategies, and awareness of social determinants of health.

In addition, the strong focus on interprofessional teamwork and effective communication mirrors recommendations from the Interprofessional Education Collaborative (IPEC) [54]. As healthcare delivery systems continue to grow in complexity, the capacity to work across professional boundaries and manage integrated care processes will be a defining requirement for the next generation of healthcare professionals.

Multidisciplinary approaches and precision medicine

The findings of this review highlight the growing necessity of multidisciplinary frameworks and the incorporation of domains such as genomics, biotechnology, and data science into educational programs. This perspective is consistent with the position articulated by the National Academies of Sciences, Engineering, and Medicine [55], which advocates for the development of a "science of healthcare delivery" that draws on multiple disciplines to enhance patient outcomes and healthcare system effectiveness.

In parallel, the importance of preparing graduates for precision medicine and data-intensive healthcare is reinforced by guidance from the American Association of Colleges of Pharmacy (AACP) [56]. Their curricular recommendations stress embedding pharmacogenomics, bioinformatics, and analytical competencies to prepare future pharmacists for personalized therapeutic approaches and evidence-informed decision-making.

Future needs and required training

Drawing on the trends identified in this review and supported by the wider literature, several priority areas for future training and capacity building can be identified:

1. *AI literacy and human–AI collaboration:* Medical and pharmacy programs should emphasize learners' ability to work effectively alongside AI technologies. This involves developing foundational knowledge of AI systems, ethical awareness, and skills to critically appraise outputs generated by AI tools [57].
2. *Interprofessional and teamwork skills:* As healthcare delivery increasingly relies on collaborative models, interprofessional education (IPE) and structured training in teamwork and communication will be essential [58]. Educational strategies such as simulations, problem-based cases, and shared clinical placements can support the development of these competencies.

3. *Data analytics and decision-making:* With the expanding role of evidence-based and data-driven care, instruction in data analytics, biostatistics, and critical evaluation of research evidence is increasingly important [59]. Learners must be equipped to interpret complex datasets and apply insights to clinical reasoning and decision-making.
4. *Adaptive expertise and lifelong learning:* In the context of rapid healthcare transformation, fostering adaptability and sustained engagement in lifelong learning is vital [60]. Curricula should promote metacognitive awareness, self-directed learning, and the capacity to integrate knowledge from diverse and evolving sources.
5. *Patient-centered care and empathy:* Alongside technological integration, continued emphasis on empathy, patient-centered practice, and effective communication with patients and families remains fundamental [61]. Educational approaches such as reflective practice, narrative medicine, and emotional intelligence training can support these human-centered skills.
6. *Leadership and change management:* As healthcare systems evolve, future professionals will require leadership capabilities and the ability to manage and influence organizational change [62]. Training in systems thinking, change management, and strategic leadership can prepare learners for these responsibilities.
7. *Entrepreneurship and innovation:* The expansion of digital health, personalized medicine, and disruptive care models underscores the value of entrepreneurial thinking and innovation skills [63]. Curricula may incorporate design thinking, lean innovation principles, and opportunities to develop and present novel solutions.

Addressing these future-oriented needs will require coordinated efforts among educational institutions, healthcare organizations, and regulatory authorities to design integrated and forward-looking curricula. Ongoing review and refinement of training programs will be essential to ensure continued relevance and effectiveness in a rapidly changing healthcare environment.

By integrating technological advances while emphasizing adaptable, future-focused competencies, medical and pharmacy education can prepare graduates to navigate healthcare complexity, provide high-quality patient-centered care, and contribute to transformative change across the healthcare system.

Strengths and limitations

Although this scoping review offers a broad overview of emerging trends and anticipated directions in medical and pharmacy education, several limitations should be considered when interpreting the results.

First, the review was confined to peer-reviewed academic publications identified through database searches. Grey literature sources, including policy documents, industry analyses, and governmental reports, were not included. Given the fast pace of technological and educational innovation, such sources may offer additional perspectives that could further inform understanding of future trends.

Second, the search strategy was restricted to studies published between April 2014 and April 2024. While this period was selected to capture contemporary and emerging evidence, influential work published prior to 2014 may have been excluded. Moreover, studies published after April 2024 were not incorporated, potentially omitting the most recent developments in this area.

Third, the scope of the review was limited to medical and pharmacy education. Literature addressing future developments across the broader spectrum of healthcare education or allied health professions was excluded. Although this focus enabled a detailed examination of the target disciplines, it may have overlooked transferable insights from related educational fields that could shape the future of medical and pharmacy education.

Fourth, the process used to select studies depended on reviewers' judgments when evaluating eligibility and relevance according to predefined inclusion and exclusion criteria. Although steps were taken to ensure consistency and minimize bias, there remains a risk that pertinent studies were unintentionally excluded or that non-relevant studies were included due to interpretive differences or human oversight.

Finally, the identification of patterns and synthesis of findings relied on a narrative methodology, which by nature incorporates a level of subjectivity. Despite the use of analytical measures to strengthen the reliability and credibility of the results, the influence of the researcher interpretation during data synthesis cannot be completely ruled out.

Accordingly, the results of this scoping review should be interpreted in light of these constraints. Future investigations could mitigate these limitations by drawing on a wider range of literature sources, broadening the scope to encompass related healthcare education fields, and applying more rigorous or mixed analytical methods to corroborate emerging trends. In addition, although the databases selected provided extensive coverage, relevant studies indexed in other sources, such as Medline or CINAHL, may have been missed. Subsequent reviews may benefit from incorporating additional health- and education-focused databases.

Conclusion

This scoping review offers an extensive synthesis of emerging trends anticipated to influence the future direction of medical and pharmacy education. The findings demonstrate the substantial role of technological advances—including artificial intelligence, virtual reality, and augmented reality—in transforming educational delivery and learning environments. Nevertheless, successful adoption of these tools depends on preserving essential clinical skills and humanistic principles alongside innovation.

Beyond technological change, the review highlights the necessity of curriculum redesign to reflect evolving healthcare systems that prioritize value-based and economically sustainable care. Strengthening competencies in interprofessional teamwork, population health, and awareness of social determinants of health is essential for preparing the next generation of healthcare professionals.

The review further emphasizes the importance of multidisciplinary integration, particularly the incorporation of genomics and data science, to support training in precision medicine and data-informed care. Responding to shifting disease patterns through enhanced education in prevention and chronic disease management also emerges as a critical priority.

Despite its limitations, this review provides meaningful guidance for educators, policymakers, and healthcare leaders seeking to adapt educational strategies to anticipated changes. Advancing innovation while emphasizing adaptable, forward-looking competencies will be central to sustaining the relevance and effectiveness of medical and pharmacy education within an increasingly dynamic healthcare landscape.

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