

Artificial Intelligence in Allied Health Sciences Education and Research in Pakistan: Navigating Innovation, Academic Transformation, and Emerging Dependency

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"Cite this Article" Received: 11 February 2026; Accepted: 08 March 2026; Published: 30 March 2026

Author Contributions: Concept: ZK and FN; Design: ZK, FN, and SN; Data Collection: ZK, FN, ZN, and AN; Analysis: ZK, SN, and SAM; Drafting: ZK, FN, ZN, AN, SN, and SAM.

Ethical Approval: The Superior University Lahore, Sargodha Campus, Pakistan. **Informed Consent:** Written informed consent was obtained from all participants; **Conflict of**

Interest: The authors declare no conflict of interest. **Funding:** No external funding; **Data Availability:** Available from the corresponding author on reasonable request;

Acknowledgments: NA

ABSTRACT

Background: Artificial intelligence is increasingly transforming healthcare education and research by supporting personalized learning, simulation-based training, literature retrieval, scientific writing, data analysis, and clinical decision support. In allied health sciences, these applications may enhance academic productivity, practical training, and access to evidence-based knowledge, particularly in resource-variable settings such as Pakistan. **Objective:** This narrative review aimed to synthesize current evidence on the role of artificial intelligence in allied health sciences education and research in Pakistan, with emphasis on educational applications, research utilization, academic dependency, ethical concerns, institutional barriers, and responsible implementation. **Methods:** A narrative review was conducted using literature published between 2017 and 2026 from PubMed, Scopus, Web of Science, Google Scholar, and relevant international policy and editorial guidance documents. Evidence was synthesized thematically across educational, research, ethical, institutional, and Pakistan-specific implementation domains. **Results:** The review identified AI-supported education, research assistance, clinical training, academic dependency, integrity risks, data privacy, faculty preparedness, infrastructure disparities, and policy gaps as major themes. AI may improve adaptive learning, simulation, academic writing, evidence synthesis, and research productivity; however, excessive reliance may weaken critical thinking, originality, clinical reasoning, and independent scholarship. **Conclusion:** Artificial intelligence should be integrated into allied health sciences education and research in Pakistan as a supervised, transparent, and ethically governed support tool. Institutional AI policies, faculty development, student AI literacy, assessment reform, data governance, and local validation are essential to ensure responsible and equitable implementation. **Keywords:** Artificial Intelligence, Allied Health Sciences, Medical Education, Healthcare Research, Academic Integrity, Pakistan

INTRODUCTION

Artificial intelligence (AI) has rapidly progressed from a computational concept into a transformative technology influencing healthcare, education, scientific research, and clinical decision-making. Its capacity to process large volumes of information, identify complex patterns, generate structured content, and support evidence-informed reasoning has created substantial opportunities for improving healthcare systems and professional education globally (1). Within medical and allied health sciences

education, AI is increasingly reshaping conventional teaching and learning by supporting personalized educational resources, virtual simulations, automated feedback, intelligent tutoring systems, and rapid access to scientific information, thereby enabling more adaptive and efficient learning environments (2, 3). Allied health sciences represent an essential component of modern healthcare delivery and include diverse disciplines such as Doctor of Physical Therapy, Medical Laboratory Sciences, Medical Imaging Technology, Optometry, Cardiac Perfusion Technology, Anesthesia Technology, Human Nutrition and Dietetics, and Aesthetic and Cosmetology Technology. Students and professionals in these fields require not only theoretical knowledge but also practical competence, clinical reasoning, evidence-based decision-making, ethical awareness, and patient-centered communication. Educational innovations that strengthen these competencies can therefore influence the quality, safety, and effectiveness of healthcare services (4, 5). Emerging evidence indicates that AI can support health professions education by improving literature retrieval, summarizing complex scientific information, enhancing academic communication, assisting research data analysis, supporting simulation-based learning, and expanding access to updated clinical knowledge (6, 7).

In countries such as Pakistan, where access to research infrastructure, specialist faculty, advanced simulation facilities, digital learning resources, and international academic databases may vary across institutions, AI offers a potentially important opportunity to reduce educational and research inequities. AI-enabled tools may assist students and faculty in accessing scientific literature, developing research skills, improving academic writing, organizing data, and engaging more effectively with global evidence. These benefits are particularly relevant for allied health sciences institutions, where educational resources and research capacity may differ substantially between public, private, urban, and peripheral academic settings. However, evidence specifically addressing the integration of AI into allied health sciences education and research in Pakistan remains fragmented, with limited synthesis of its educational applications, research utility, ethical risks, institutional preparedness, and implications for academic dependency.

Despite its advantages, the increasing use of AI in education and research has raised important concerns regarding students' learning behaviors, academic integrity, originality, professional competence, and critical thinking. The convenience of AI-assisted platforms may encourage students to complete assignments, presentations, literature reviews, and research tasks with limited personal engagement, potentially weakening independent analysis, scientific reasoning, and problem-solving ability (8, 9). These concerns are particularly important in healthcare education, where professional competence depends not only on information acquisition but also on clinical judgment, ethical decision-making, empathy, communication, contextual reasoning, and the responsible application of evidence in patient care (10, 11). Although AI can provide rapid educational and research support, it cannot replace the human expertise, mentorship, professional accountability, and experiential learning required for competent healthcare practice.

The rapid expansion of generative AI has also introduced complex challenges related to plagiarism, authorship, transparency, data privacy, accountability, and reliability of AI-generated information. Students and researchers may use AI-generated content without adequate verification, citation, disclosure, or understanding, thereby risking academic misconduct and reducing the credibility of scholarly work (9, 12). In healthcare research, these concerns are amplified by the possibility of inaccurate information, fabricated references, biased outputs, and inappropriate use of sensitive data. International organizations and editorial bodies have emphasized that AI may assist research and writing, but human authors remain fully responsible for the accuracy, originality, ethical integrity, and validity of all scholarly outputs.

Within Pakistan, AI integration in healthcare education is gradually emerging as part of broader digital transformation; however, institutional preparedness remains uneven. Current challenges include limited faculty training, lack of standardized AI policies, variable digital literacy, unequal infrastructure,

uncertainty regarding acceptable academic use, and insufficient integration of AI literacy into health sciences curricula (27–31). These challenges indicate the need for a balanced and context-specific approach in which AI is adopted as a supportive educational and research tool while preserving academic integrity, independent learning, critical appraisal, clinical reasoning, and professional responsibility. Therefore, this narrative review aimed to critically synthesize current evidence on the role of artificial intelligence in allied health sciences education and research in Pakistan, with particular emphasis on educational applications, research utilization, opportunities, academic dependency, ethical challenges, institutional barriers, and future strategies for responsible implementation.

MATERIAL AND METHODS

This study was conducted as a narrative review to critically examine the role of artificial intelligence in allied health sciences education and research in Pakistan. A narrative review design was selected because the topic extends across multiple interrelated domains, including healthcare education, allied health training, biomedical research, digital health, academic integrity, research ethics, institutional governance, and responsible technological implementation. The purpose of the review was not to estimate a pooled effect size or perform quantitative evidence synthesis, but to integrate diverse scholarly, ethical, educational, and policy-based evidence into a structured interpretation relevant to allied health sciences education and research within the Pakistani context.

The review included literature published between 2017 and 2026 to capture both foundational developments in artificial intelligence in healthcare and recent evidence related to generative AI, AI-assisted education, digital transformation, research support, and academic integrity. Electronic searches were conducted using PubMed, Scopus, Web of Science, and Google Scholar. The search strategy combined Medical Subject Headings, database-specific indexing terms, and free-text keywords using Boolean operators. The principal search terms included “Artificial Intelligence,” “Generative Artificial Intelligence,” “Machine Learning,” “Deep Learning,” “ChatGPT,” “Healthcare Education,” “Medical Education,” “Allied Health Sciences,” “Health Sciences Education,” “Healthcare Research,” “Clinical Decision Support,” “Academic Integrity,” “Research Ethics,” “Digital Health,” and “Pakistan.” These terms were used in different combinations to identify literature addressing AI applications in healthcare education, allied health sciences, biomedical research, academic writing, clinical decision support, ethical governance, and institutional implementation.

Eligible sources included peer-reviewed original research articles, systematic reviews, scoping reviews, narrative reviews, meta-analyses, book chapters, and official policy or guidance documents relevant to artificial intelligence in healthcare education, allied health sciences education, biomedical research, research ethics, academic integrity, digital health, and AI implementation in Pakistan. In addition to database searches, the reference lists of selected publications were manually reviewed to identify further relevant sources. International guidance documents from the World Health Organization, United Nations Educational, Scientific and Cultural Organization, International Committee of Medical Journal Editors, Committee on Publication Ethics, World Association of Medical Editors, European Commission High-Level Expert Group on Artificial Intelligence, and World Bank were also included because of their relevance to responsible AI governance, research transparency, digital health, data ethics, and scholarly publication standards.

Publications were considered eligible when they addressed AI applications in healthcare education, allied health sciences education, health professions training, academic research, scientific writing, clinical decision support, ethical considerations, institutional readiness, digital transformation, or Pakistan-specific healthcare education and research contexts. Studies and documents were excluded if they were not published in English, were conference abstracts without sufficient full-text information, duplicate records, letters to the editor without substantive scientific content, opinion pieces lacking relevant analytical depth, or sources unrelated to artificial intelligence, healthcare education, allied

health sciences, biomedical research, or responsible AI governance. Articles with insufficient methodological, conceptual, or policy relevance to the review objectives were also excluded.

The selection process was conducted in stages. Titles and abstracts were first screened for relevance to the review objectives, followed by full-text assessment of potentially eligible publications. Sources were prioritized when they had direct relevance to allied health sciences education, healthcare research, academic integrity, AI-assisted learning, ethical governance, institutional implementation, or the Pakistani healthcare education context. Greater interpretive weight was given to recent peer-reviewed studies, landmark publications, systematic or scoping reviews, and internationally recognized policy documents. Pakistan-specific literature was used to contextualize local institutional readiness, faculty preparedness, student knowledge, ethical concerns, and policy gaps, while global evidence was used to support broader interpretation where local evidence remained limited.

Relevant information was extracted from selected sources, including publication year, study design, country or setting, healthcare discipline, educational context, AI application, research use, ethical concern, institutional implication, implementation challenge, and principal finding. Extracted evidence was synthesized using a thematic narrative approach. Themes were developed deductively from the review objectives and refined through repeated reading of the selected literature. The final synthesis was organized around the following domains: artificial intelligence in allied health sciences education, applications of AI in healthcare research, opportunities for AI integration in Pakistan, academic dependency on AI, ethical challenges and academic integrity, institutional barriers, and future directions for responsible implementation.

Because this was a narrative review intended to provide interpretive synthesis rather than quantitative comparison or intervention-effect estimation, formal risk-of-bias assessment and meta-analysis were not performed. To strengthen credibility, the review prioritized peer-reviewed literature, landmark publications, recognized international guidance, and Pakistan-relevant evidence where available. The interpretation distinguished between established AI applications reported in the literature and potential applications relevant to allied health sciences education in Pakistan. The review was based entirely on published literature and publicly available policy documents; therefore, ethical approval and informed consent were not required.

Results / Thematic Narrative Synthesis

The evidence was synthesized thematically because the included literature addressed artificial intelligence across multiple educational, research, ethical, institutional, and policy domains rather than a single intervention, outcome, or population suitable for quantitative pooling. The synthesis identified seven major themes: applications of artificial intelligence in allied health sciences education, use of AI in healthcare research, opportunities for AI integration in Pakistan, academic dependency and learning risks, ethical and academic integrity concerns, institutional implementation barriers, and strategic priorities for responsible adoption. The available literature indicates that AI has substantial potential to support allied health sciences education and research, particularly through personalized learning, simulation-based training, literature retrieval, scientific writing support, diagnostic assistance, and data analysis. However, the evidence also shows that these benefits are accompanied by risks related to overreliance, reduced critical engagement, plagiarism, unreliable AI-generated information, data privacy concerns, faculty preparedness, digital inequity, and the absence of standardized institutional policies.

Table 1. Thematic Evidence Synthesis on Artificial Intelligence in Allied Health Sciences Education and Research

Theme	Main Evidence Focus	Educational or Research Relevance	Implementation Concern
AI-supported education	Personalized learning, intelligent tutoring, simulation, automated feedback	Adaptive learning, improved access to knowledge, enhanced student engagement	Overdependence, reduced independent learning

Theme	Main Evidence Focus	Educational or Research Relevance	Implementation Concern
Allied health training	Rehabilitation simulation, imaging interpretation, laboratory decision support, ocular screening	Improved exposure to discipline-specific clinical reasoning and technical skills	Limited infrastructure, need for expert supervision
Research support	Literature retrieval, writing assistance, data organization, preliminary analysis	Improved research efficiency and academic productivity	Hallucinated references, inaccurate synthesis, weak methodological oversight
Clinical decision support	Pattern recognition, diagnostic support, predictive modelling	Improved diagnostic learning and evidence-informed reasoning	Risk of algorithmic overreliance
Academic integrity	AI-generated assignments, essays, reviews, and manuscripts	Increased productivity and accessibility	Plagiarism, undisclosed AI use, unclear authorship contribution
Ethical governance	Transparency, accountability, data privacy, human oversight	Safer and more responsible use of AI tools	Weak institutional policies and inconsistent disclosure practices
Pakistan-specific implementation	Digital transformation, faculty readiness, AI literacy, institutional preparedness	Opportunity to reduce educational and research resource gaps	Unequal access, limited training, lack of national or institutional frameworks

The thematic synthesis shows that AI is best understood as a cross-cutting support system rather than a single educational intervention. Its strongest educational value lies in enhancing access to information, supporting individualized learning, and creating technology-enabled opportunities for simulation and clinical reasoning. In research, AI can improve efficiency in literature searching, language refinement, manuscript preparation, and preliminary data handling. However, the same features that make AI efficient also create educational and ethical vulnerabilities, particularly when students or researchers use AI-generated outputs without verification, disclosure, or meaningful intellectual engagement.

Artificial Intelligence in Allied Health Sciences Education

Artificial intelligence has begun to influence allied health sciences education by expanding the ways students access, process, and apply scientific knowledge. Conventional allied health training depends on lectures, textbooks, laboratory demonstrations, supervised clinical exposure, and practical skill development. AI-supported learning can complement these methods by offering adaptive learning resources, virtual patient scenarios, automated feedback, simulation-based practice, and rapid access to evidence-based information. These applications are relevant to allied health disciplines because students must integrate theoretical understanding with clinical reasoning, technical skills, communication, ethical awareness, and patient-centered decision-making.

Table 2. Reported and Potential Applications of Artificial Intelligence Across Allied Health Sciences Disciplines

Allied Health Discipline	AI Application Category	Educational Benefit	Evidence Status	Key Implementation Barrier
Doctor of Physical Therapy	Rehabilitation simulation, movement analysis, virtual patient scenarios	Clinical reasoning, functional assessment, rehabilitation planning	Reported internationally; potential for wider Pakistan implementation	Cost, infrastructure, faculty training
Medical Laboratory Sciences	Automated laboratory interpretation, diagnostic decision support	Analytical reasoning, laboratory data interpretation	Reported internationally; context-dependent local applicability	Algorithm validation, quality control
Medical Imaging Technology	Image interpretation, pattern recognition, image enhancement	Diagnostic learning, radiological interpretation support	Strong international relevance	Expert supervision, validation, medico-legal concerns
Optometry	Retinal screening, OCT interpretation, ocular image analysis	Diagnostic exposure, screening interpretation	Reported internationally	Accessibility, ethical use, technology cost
Cardiac Perfusion Technology	Simulation-based perfusion management, physiological monitoring	Procedural decision-making, emergency preparedness	Potential educational application	Limited simulation resources
Anesthesia Technology	Crisis simulation, AI-supported monitoring scenarios	Risk recognition, emergency response training	Potential educational application	Faculty training, high equipment cost
Human Nutrition and Dietetics	Nutritional assessment, dietary planning, predictive analytics	Personalized nutrition education, evidence-based planning	Emerging application	Data quality, privacy, cultural dietary variation

Allied Health Discipline	AI Application Category	Educational Benefit	Evidence Status	Key Implementation Barrier
Aesthetic and Cosmetology Technology	Skin assessment, treatment planning support	Visual assessment, treatment selection support	Emerging application	Limited evidence, regulatory oversight

AI applications differ substantially across allied health disciplines. Medical imaging, laboratory sciences, optometry, and rehabilitation have clearer links to existing AI-supported technologies because these fields involve image analysis, pattern recognition, diagnostic data interpretation, or functional assessment. In contrast, cardiac perfusion, anesthesia technology, nutrition, and cosmetology have promising but more context-dependent applications, especially in Pakistan where institutional resources and simulation facilities may vary. Therefore, AI should be presented not as a uniformly implemented educational tool across all allied health fields, but as a developing set of reported and potential applications requiring validation, supervision, and context-specific implementation.

Applications of Artificial Intelligence in Healthcare Research

The reviewed evidence indicates that AI is increasingly used in healthcare research to support literature searching, scientific writing, data management, preliminary analysis, evidence synthesis, and clinical prediction. These functions are particularly relevant for early-career researchers, students, and faculty members working in resource-limited academic settings. AI tools may improve productivity by helping researchers identify relevant literature, organize complex information, refine academic language, generate preliminary summaries, and manage large datasets. However, AI-assisted research requires strong methodological oversight because AI-generated outputs may contain incorrect interpretations, fabricated references, statistical errors, or unsupported claims.

Table 3. Artificial Intelligence Applications in Healthcare Research and Required Safeguards

Research Activity	AI-Supported Function	Potential Benefit	Main Risk	Required Safeguard
Literature searching	Retrieval, screening support, summarization	Faster access to relevant evidence	Missing key studies, biased retrieval	Database verification and manual cross-checking
Scientific writing	Language refinement, structure support, grammar improvement	Improved clarity and manuscript preparation	Undisclosed authorship contribution, generic writing	Transparent disclosure and human revision
Reference management	Citation suggestion, source organization	Improved workflow efficiency	Fabricated or inaccurate references	Verification against original sources
Data analysis	Pattern recognition, preliminary statistical support	Improved analytical efficiency	Incorrect model selection or interpretation	Statistical review and reproducible workflow
Clinical research	Prediction, classification, outcome modelling	Enhanced hypothesis generation and risk stratification	Algorithmic bias, overfitting, poor external validity	Validation, reporting transparency, clinical oversight
Evidence synthesis	Summary generation, theme extraction	Faster organization of literature	Oversimplification, hallucination, selective emphasis	Human-led synthesis and citation checking

AI can strengthen healthcare research when used as an assistive tool within a transparent and human-controlled workflow. Its value is highest when it improves efficiency without replacing methodological reasoning, critical appraisal, statistical judgment, or author accountability. For Pakistani allied health researchers, AI may reduce barriers related to academic writing, literature access, and research organization, but it may also introduce new risks if users rely on generated content without confirming source accuracy, data integrity, and scientific validity.

Opportunities for AI Integration in Pakistan

The Pakistan-specific evidence and contextual interpretation suggest that AI may help address several persistent challenges in allied health sciences education, including uneven access to specialist faculty, limited simulation resources, variable research mentorship, and disparities in digital infrastructure. AI-enabled educational platforms may support students in institutions with fewer academic resources by improving access to learning material, research guidance, and scientific literature. Faculty members

may also benefit from AI-supported teaching resources, assessment planning, and research productivity tools. However, the benefits of AI integration in Pakistan depend on institutional readiness, faculty development, ethical policies, digital literacy, and reliable infrastructure.

Table 4. Pakistan-Specific Opportunities and Barriers for AI Integration in Allied Health Sciences

Domain	Opportunity in Pakistan	Current Barrier	Institutional Priority
Student learning	Improved access to updated scientific content	Unequal digital access and variable AI literacy	AI literacy training
Faculty teaching	Support for content development and feedback	Limited faculty preparedness	Faculty development programs
Research productivity	Assistance with literature review, writing, and data handling	Weak research mentorship and verification practices	Research integrity training
Assessment	Case-based, oral, practical, and AI-resilient assessment redesign	Reliance on written assignments vulnerable to AI misuse	Assessment reform
Policy governance	Standardized acceptable-use frameworks	Lack of clear institutional AI policies	Institutional AI policy development
Clinical education	Simulation and decision-support exposure	Limited simulation labs and technology cost	Phased implementation
Equity	Support for peripheral and resource-limited institutions	Infrastructure disparities	Affordable and accessible AI strategies

AI integration in Pakistan should be approached as an institutional capacity-building issue rather than merely a technology-adoption issue. The major opportunity lies in using AI to support learning, research, and clinical reasoning where academic resources are unevenly distributed. The major risk is that institutions may adopt AI informally without policies, training, or safeguards, thereby increasing academic misconduct, widening digital inequity, and weakening the development of independent reasoning among students.

Academic Dependency and Learning Risks

A major theme emerging from the review is the risk of academic dependency on AI. While AI can assist students in understanding complex topics, summarizing literature, and improving academic communication, excessive reliance may reduce the effort required for reading, reasoning, writing, and problem-solving. In allied health sciences, this risk is especially important because professional competence depends on the ability to interpret patient information, evaluate evidence, make clinical decisions, communicate effectively, and act ethically. If students routinely use AI to complete academic tasks without active engagement, they may develop superficial knowledge and weaker clinical reasoning skills.

Table 5. Academic Dependency Risks Associated With Artificial Intelligence Use

Area of Student Development	AI-Related Risk	Possible Educational Consequence	Recommended Academic Response
Independent reading	Reliance on summaries	Reduced depth of knowledge	Require source-based reading tasks
Critical thinking	Acceptance of AI outputs without evaluation	Weak appraisal and reasoning	Use critique-based assignments
Scientific writing	Automated drafting	Reduced writing fluency and originality	Require draft history and reflective writing
Clinical reasoning	Dependence on generated answers	Poor decision-making in uncertain cases	Use case-based oral examination
Research skills	AI-generated literature reviews	Weak search and synthesis skills	Require documented search strategy
Professional judgment	Algorithmic overreliance	Reduced contextual decision-making	Emphasize human oversight and ethics
Academic honesty	Submission of AI-generated work as original	Misconduct and unreliable assessment	Implement AI disclosure policies

Academic dependency should not be interpreted as an argument against AI use. Rather, it indicates the need to redesign learning activities so that AI supports understanding instead of replacing intellectual effort. Educational institutions should shift from assignment formats that can be completed entirely

through generative AI toward assessments that require interpretation, defense of reasoning, practical demonstration, reflective learning, and supervised clinical application.

Ethical Challenges and Academic Integrity

The review identified academic integrity as one of the most important concerns associated with AI adoption. AI-generated text may appear original while still not representing the student's or author's own intellectual contribution. In research and publication, AI may assist with language editing and organization, but it cannot take responsibility for accuracy, originality, ethical compliance, or validity. These concerns are directly relevant to authorship, plagiarism, data privacy, patient confidentiality, and research transparency. International editorial and ethical guidance consistently emphasizes that human authors remain accountable for all submitted or published work.

Table 6. Ethical and Academic Integrity Concerns in AI-Assisted Education and Research

Ethical Area	Concern	Risk to Academic or Research Quality	Responsible Practice
Authorship	AI listed or treated as contributor	Misrepresentation of responsibility	Human authorship only
Transparency	Undisclosed AI assistance	Reduced trust and accountability	AI-use disclosure statement
Plagiarism	Submission of AI-generated work as original	Compromised academic integrity	Clear acceptable-use policy
Accuracy	Fabricated facts or references	Invalid scholarship	Verification against primary sources
Data privacy	Sensitive data entered into AI tools	Confidentiality breach	Secure data governance
Bias	Biased or non-contextual outputs	Inequitable or misleading recommendations	Critical review and local validation
Accountability	Unclear responsibility for AI-supported decisions	Ethical and medico-legal uncertainty	Human oversight and documentation

Ethical AI use requires more than warning students not to misuse technology. Institutions need clear policies defining acceptable and unacceptable AI use in assignments, examinations, research writing, data analysis, and publication. Researchers and students should disclose meaningful AI assistance, verify all AI-generated content, avoid entering sensitive patient data into unsecured systems, and ensure that human judgment remains central in academic and clinical decision-making.

Institutional Challenges in Pakistan

The evidence suggests that institutional implementation is a central challenge for responsible AI adoption in Pakistan. Many institutions may lack formal guidance on how AI can be used in teaching, assessment, assignments, research, and publication. Faculty members may also have variable levels of AI literacy, making it difficult to supervise student use or integrate AI meaningfully into curricula. Infrastructure limitations, including internet access, software availability, simulation resources, and technical support, may further restrict equitable implementation across institutions.

Table 7. Institutional Challenges and Practical Implementation Responses in Pakistan

Institutional Challenge	Likely Effect	Practical Response
Lack of AI policy	Unclear acceptable use and inconsistent enforcement	Develop institutional AI-use guidelines
Limited faculty training	Poor supervision and uneven adoption	Conduct faculty development workshops
Weak student AI literacy	Misuse, dependency, and uncritical acceptance	Integrate AI literacy into curriculum
Assessment vulnerability	Increased AI-generated assignments	Use oral, case-based, practical, and reflective assessment
Infrastructure gaps	Unequal access across institutions	Implement phased and low-cost digital strategies
Research integrity concerns	Inaccurate writing, fabricated references, poor verification	Require source checking and AI disclosure
Privacy concerns	Risk of sensitive data exposure	Establish data governance protocols
Lack of local validation	Uncritical use of imported tools	Encourage Pakistan-specific research and evaluation

The institutional challenge is not simply whether AI should be allowed, but how it should be governed, taught, supervised, and evaluated. Without structured implementation, AI may increase academic shortcuts and widen disparities between institutions with strong digital capacity and those with limited

resources. Responsible adoption in Pakistan therefore requires policy development, faculty training, student AI literacy, assessment reform, and ethical oversight.

Strategic Recommendations Emerging From the Synthesis

The review findings support a balanced approach in which AI is neither rejected nor adopted uncritically. AI should be integrated as a complementary educational and research tool that enhances access, productivity, and learning support while preserving critical thinking, clinical reasoning, academic integrity, professional accountability, and patient-centered judgment.

Table 8. Strategic Recommendations for Responsible AI Integration in Allied Health Sciences Education and Research

Stakeholder	Priority Action	Expected Outcome
Universities	Develop institutional AI policies	Standardized acceptable use and disclosure
Faculty	Receive AI-focused professional development	Improved supervision and responsible teaching integration
Students	Complete AI literacy and academic integrity training	Better critical appraisal and ethical AI use
Curriculum developers	Integrate AI concepts into allied health curricula	Graduates prepared for technology-enabled healthcare
Researchers	Verify AI-generated content and disclose AI assistance	Improved transparency and research credibility
Healthcare institutions	Use AI as clinical education support, not replacement	Safer decision-support learning
Policymakers	Develop national guidance for AI in healthcare education	More consistent institutional implementation
Regulatory bodies	Define standards for AI use in education and research	Greater accountability and ethical compliance

The strategic priorities emerging from the synthesis emphasize governance, literacy, supervision, and accountability. AI has the potential to support allied health sciences education and research in Pakistan, but its long-term value will depend on whether institutions can develop responsible systems for use. The most important implementation priorities are institutional policy development, faculty capacity-building, AI literacy for students, redesigned assessments, transparent research practices, and locally relevant evaluation of AI tools.

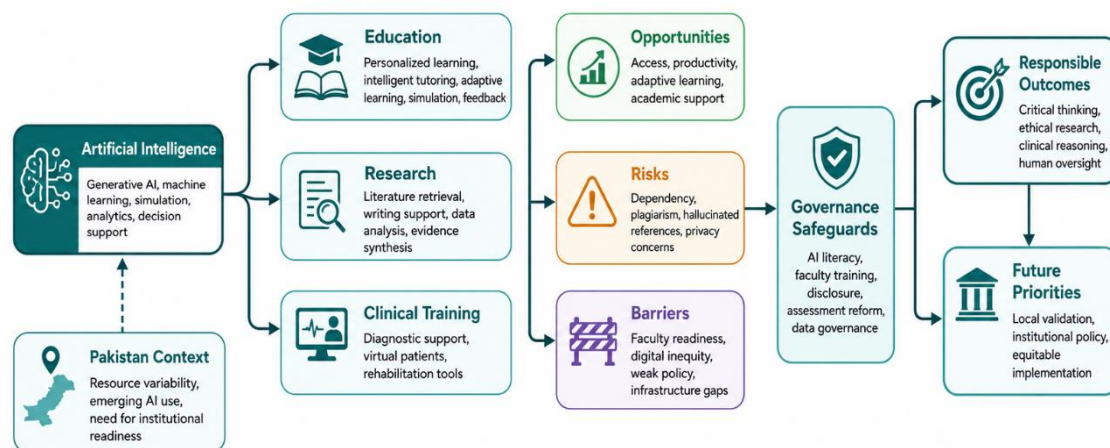


Figure 1 Conceptual framework illustrating responsible AI integration in allied health sciences education and research in Pakistan through education, research, clinical training, governance safeguards, and future implementation priorities.

Overall, the thematic synthesis indicates that artificial intelligence can substantially enhance allied health sciences education and research in Pakistan by improving access to learning resources, supporting research productivity, enabling simulation-based training, and preparing students for technology-enabled healthcare environments. However, the benefits of AI are inseparable from the need for ethical governance, human oversight, academic integrity, and institutional preparedness. AI should therefore be implemented as a supervised and transparent support system that strengthens, rather than replaces, independent learning, clinical reasoning, scientific judgment, and professional responsibility.

DISCUSSION

This narrative review synthesized current evidence on the role of artificial intelligence in allied health sciences education and research in Pakistan, with emphasis on educational transformation, research support, academic dependency, ethical concerns, institutional readiness, and responsible implementation. The review indicates that AI has considerable potential to enhance allied health sciences education by supporting personalized learning, intelligent tutoring, simulation-based training, automated feedback, literature retrieval, scientific writing assistance, data organization, and clinical decision-support exposure. These applications are particularly relevant to allied health disciplines because students and professionals are expected to combine theoretical knowledge with technical competence, clinical reasoning, evidence-based decision-making, ethical judgment, and patient-centered communication. However, the findings also show that AI should not be interpreted as a replacement for educators, researchers, or clinicians. Its educational value depends on structured integration, human supervision, critical appraisal, and institutional safeguards.

The findings are consistent with previous literature showing that AI can support health professions education by improving access to knowledge, enabling adaptive learning, and assisting learners in navigating complex scientific information (3–5). In allied health sciences, these capabilities may be especially useful in disciplines such as physical therapy, medical imaging, laboratory sciences, optometry, anesthesia technology, cardiac perfusion, nutrition, and other applied health programs where learning depends on both conceptual understanding and practical decision-making. AI-supported simulation, diagnostic pattern recognition, movement analysis, image interpretation, and virtual patient scenarios may help students develop applied reasoning in controlled learning environments. Nevertheless, these applications require expert oversight because clinical competence cannot be achieved through automated information alone. Effective allied health training continues to require supervised practice, contextual judgment, communication skills, ethical reasoning, and direct patient-centered experience.

In the Pakistani context, AI offers important opportunities but also exposes existing structural weaknesses in healthcare education. Variations in faculty expertise, research mentorship, institutional infrastructure, access to simulation facilities, digital literacy, and availability of academic resources may influence how effectively AI can be adopted. For students and faculty in resource-limited settings, AI may improve access to scientific literature, assist with academic writing, support preliminary research planning, and facilitate engagement with international evidence. These benefits could help reduce educational and research disparities if AI is implemented equitably. However, without institutional policies, faculty training, affordable infrastructure, and locally relevant guidance, AI adoption may remain informal, inconsistent, and potentially harmful. Pakistan-specific evidence has already highlighted concerns regarding readiness, faculty knowledge, student engagement, and ethical implications of AI in medical and health professions education (27–31).

A major concern identified in this review is the risk of academic dependency. Generative AI can produce summaries, assignments, presentations, essays, literature reviews, and manuscript drafts within seconds. While this may increase productivity, excessive reliance may reduce students' engagement with reading, analysis, reasoning, and scientific writing. In allied health sciences, this risk is not limited to academic performance; it may also affect future clinical competence. Students who repeatedly accept AI-generated answers without verification may develop weaker habits of critical appraisal, clinical reasoning, and independent problem-solving. These concerns are consistent with broader educational literature indicating that generative AI can support learning when used responsibly but may undermine intellectual development when used as a substitute for effortful cognition (8, 9, 12).

The implications for assessment are substantial. Traditional assignment-based assessment may no longer be sufficient to evaluate individual understanding in the era of generative AI. Institutions should

redesign assessment strategies to emphasize oral examinations, case-based discussions, objective structured clinical examinations, practical demonstrations, reflective writing, research defense, and supervised clinical reasoning tasks. These formats are more resistant to undisclosed AI use because they require students to explain, apply, justify, and defend their reasoning. Rather than banning AI entirely, academic programs should define acceptable and unacceptable use, require disclosure where appropriate, and design assessments that evaluate understanding beyond written output.

The review also highlights important ethical and academic integrity challenges. AI-generated content may appear original while lacking genuine intellectual contribution. In research and publication, AI may assist with language editing, organization, literature mapping, or preliminary analysis, but it cannot be credited as an author because it cannot take responsibility for accuracy, originality, accountability, or ethical compliance. International editorial guidance emphasizes that human authors remain fully responsible for all submitted work, including verification of references, accuracy of claims, transparency of AI use, and integrity of data interpretation (21–23). These principles are particularly important in healthcare research, where inaccurate information, fabricated references, biased outputs, or inappropriate use of sensitive patient data may have academic, ethical, and clinical consequences.

Data privacy and governance require particular attention. Healthcare education and research often involve patient records, clinical images, laboratory values, rehabilitation data, and other sensitive information. Entering identifiable or confidential data into unsecured AI platforms may compromise patient privacy and violate ethical standards. Institutions should therefore develop clear data governance protocols, including restrictions on uploading sensitive patient information, guidance on secure AI platforms, approval procedures for AI-assisted research, and documentation of AI use in scholarly work. Such safeguards align with international recommendations emphasizing transparency, accountability, privacy protection, and human oversight in AI use for health (10, 12, 24, 25).

Faculty preparedness emerged as another key implementation issue. Responsible AI integration cannot occur if faculty members themselves are uncertain about AI capabilities, limitations, ethical risks, and appropriate educational use. Faculty development should therefore include AI literacy, prompt evaluation, detection of unreliable outputs, responsible research practices, assessment redesign, data privacy, and discipline-specific AI applications. Faculty should also be trained to help students use AI as a learning aid rather than a shortcut. In this sense, AI integration should be treated as a curricular and pedagogical reform rather than merely a technological upgrade.

The findings support a balanced model of AI adoption in which technology is used to enhance access, productivity, and learning support while preserving human expertise and professional accountability. AI should be positioned as a complementary tool that supports students, faculty, researchers, and clinicians, but its outputs must remain subject to human verification and ethical review. This is especially important for allied health sciences education in Pakistan, where the long-term objective should not be simply to increase AI use, but to develop critically thinking, ethically responsible, research-literate, and technologically competent healthcare professionals.

This review has several limitations. First, as a narrative review, it did not perform formal risk-of-bias assessment or meta-analysis, and the findings should therefore be interpreted as thematic synthesis rather than pooled evidence. Second, the available Pakistan-specific literature on AI in allied health sciences remains limited, requiring the review to draw partly on broader medical education, healthcare research, and international policy literature. Third, AI is a rapidly evolving field, and evidence, tools, policies, and educational practices may change quickly. Fourth, the review included English-language literature only, which may have excluded locally relevant non-English documents or institutional policies. Finally, because many AI applications in allied health education are emerging or context-dependent, some discipline-specific applications should be understood as reported or potential uses rather than uniformly implemented practices across Pakistan.

Future research should evaluate AI literacy among allied health students and faculty, institutional readiness for AI adoption, effectiveness of AI-supported teaching interventions, ethical patterns of student AI use, and the impact of AI-assisted assessment reform. Pakistan-specific empirical studies are needed to assess how AI is currently being used across allied health institutions, whether students are becoming dependent on AI-generated work, and which governance models are most practical for local implementation. Research should also examine the validity, safety, and educational effectiveness of AI tools in specific allied health disciplines, including physical therapy, laboratory sciences, imaging technology, optometry, nutrition, anesthesia technology, and cardiac perfusion. Such evidence will be essential for developing contextually appropriate policies that support innovation without compromising academic integrity, clinical reasoning, or professional competence.

CONCLUSION

Artificial intelligence has significant potential to strengthen allied health sciences education and research in Pakistan by improving access to scientific information, supporting personalized learning, enhancing simulation-based training, assisting academic writing and literature retrieval, and promoting technology-enabled healthcare education. However, these benefits are accompanied by important risks, including academic dependency, reduced critical engagement, plagiarism, unreliable AI-generated information, data privacy concerns, faculty preparedness gaps, infrastructure disparities, and lack of institutional policy. The responsible integration of AI therefore requires a balanced approach in which AI functions as a supportive tool rather than a substitute for human expertise, clinical reasoning, ethical judgment, and independent scholarship. Universities and healthcare institutions in Pakistan should prioritize AI literacy, faculty development, transparent disclosure practices, assessment reform, data governance, and locally relevant implementation policies. The long-term value of AI in allied health sciences will depend not on the availability of the technology alone, but on its ethical, supervised, and context-sensitive use to develop competent, critically thinking, research-capable, and professionally accountable healthcare graduates.

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