



AWARENESS OF ARTIFICIAL INTELLIGENCE AND EMERGING SIMULATION TOOLS AMONG SENIOR PHYSIOTHERAPY STUDENTS: A SURVEY STUDY

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ABSTRACT

Background:

Artificial intelligence (AI) and emerging simulation technologies are increasingly being integrated into physiotherapy education, clinical practice, and personalized patient care. AI-driven tools, simulation laboratories, virtual reality (VR), and digital twin technologies support learning, enhance clinical decision-making, and facilitate skill development in a risk-free environment without compromising patient safety.

Objective:

To assess the level of awareness, knowledge, and perceptions of artificial intelligence (AI) and emerging simulation technologies among senior physiotherapy students, and to evaluate their readiness to adopt these technologies in future clinical practice.

Methodology:

A total of 134 senior Bachelor of Physiotherapy (BPT) students were recruited using a convenient sampling method with voluntary participation. Data were collected over a period of 12 months using a structured questionnaire. The collected data were analyzed using Microsoft Excel and SPSS software.

Results:

A total of 134 physiotherapy students participated in the study, of whom 81.3% were female and 18.7% were male. A statistically significant moderate positive correlation was observed between awareness and readiness to adopt AI technologies ($r = 0.58$, $p < 0.001$). This finding suggests that students with higher awareness of AI technologies are more likely to be willing to adopt these technologies in their future clinical practice.

Conclusion:

The present study concludes that senior physiotherapy students possess moderate to high levels of awareness regarding artificial intelligence and emerging simulation tools. Higher awareness is associated with greater readiness to integrate these technologies into clinical practice. These findings highlight the need to incorporate AI and emerging technologies into physiotherapy education to prepare future physiotherapists for technology-driven healthcare environments.

KEYWORDS: Artificial intelligence(AI), Physiotherapy Students, Simulation Labs, Digital Twinning, Virtual Reality (VR), Awareness, Knowledge Perception.

INTRODUCTION

Artificial intelligence (AI) and emerging digital technologies are rapidly transforming healthcare education and clinical practice. In physiotherapy, innovations such as simulation laboratories, digital twins, virtual and augmented reality (VR/AR), wearable sensors, robotics, and AI-powered decision-support systems are reshaping the way students learn, educators teach, and rehabilitation services are delivered. These technologies provide opportunities for experiential learning, personalized education, and improved patient care. A systematic review reported that simulation-based education significantly enhances students' cognitive, affective, and psychomotor learning outcomes, regardless of the type or fidelity of the simulation used (1).

The growing integration of AI into rehabilitation has further expanded the scope of physiotherapy practice. AI algorithms, combined with sensor-based technologies, enable continuous monitoring of patients, facilitate personalized rehabilitation programmes, predict treatment outcomes, and support evidence-based clinical decision-making. Similarly, digital twin technology creates virtual representations of patients using anatomical, physiological, and functional data, allowing clinicians to simulate different treatment approaches before implementing them in clinical practice (2). These technologies have the potential to improve rehabilitation outcomes while promoting individualized, patient-centred care.

In physiotherapy education, AI-powered learning platforms can provide adaptive learning experiences, automated feedback, intelligent tutoring systems, and easier



access to educational resources. Such technologies encourage self-directed learning and support the development of clinical reasoning skills. Despite these potential benefits, the adoption of AI-based educational tools remains inconsistent across institutions because of differences in technological infrastructure, faculty preparedness, and curriculum integration (3).

As AI becomes increasingly relevant to healthcare, it is important to understand how prepared future physiotherapists are to use these technologies. Awareness extends beyond simply recognizing the existence of AI-based tools; it also includes understanding their functions, potential applications, advantages, and limitations in clinical practice. Students' perceptions, attitudes, and readiness to adopt these technologies are important determinants of their future acceptance and effective use. A qualitative study among physiotherapy students reported that generative AI was perceived as a valuable virtual learning partner that supported knowledge acquisition, problem-solving, and clinical learning (4).

Simulation laboratories continue to play a vital role in physiotherapy education by providing safe, controlled, and realistic environments in which students can practice clinical skills without compromising patient safety. Both physical and virtual simulation experiences have been shown to improve students' confidence, clinical competence, communication skills, and decision-making abilities (5). Advances in digital twin technology further extend these educational opportunities by creating individualized virtual patient models capable of simulating treatment responses and predicting recovery trajectories. When integrated with wearable sensor data, digital twins can facilitate remote rehabilitation, optimize treatment planning, and improve patient engagement throughout the rehabilitation process (6).

The increasing use of these technologies has important implications for physiotherapy education. Future physiotherapists must develop not only strong clinical and manual skills but also adequate digital literacy to interpret AI-generated information, critically evaluate technology-assisted recommendations, and integrate digital tools into patient management. Successful implementation of AI and simulation technologies also depends on institutional readiness, including investment in infrastructure, faculty training, curriculum development, and equitable access to digital resources. Differences in technological availability may contribute to a digital divide, limiting students' opportunities to develop competencies in emerging healthcare technologies.

Although AI and simulation technologies are increasingly being incorporated into healthcare, there remains limited evidence regarding physiotherapy students' awareness and perceptions of these innovations, particularly in the Indian context. Understanding students' knowledge, awareness, and attitudes towards AI-driven technologies such as simulation laboratories, digital twins, VR/AR, wearable sensors, robotics, and predictive analytics is essential for identifying educational gaps and informing curriculum development. Such information can assist educators and policymakers in designing targeted educational strategies that prepare graduates for technology-enabled clinical practice.

Therefore, the present study aims to assess the awareness, knowledge, and perceptions of senior physiotherapy

students regarding artificial intelligence and emerging simulation technologies. By examining students' familiarity with both well-established educational tools, such as simulation laboratories, and emerging technologies, including digital twins and AI-assisted rehabilitation systems, this study seeks to provide insights that can guide curriculum planners, educators, and institutional decision-makers. Ultimately, the findings may contribute to developing a physiotherapy workforce that is not only clinically competent but also digitally literate and well-prepared for the evolving landscape of technology-driven rehabilitation.

METHODOLOGY

Study Design and Setting

An observational cross-sectional survey was conducted among senior Bachelor of Physiotherapy (BPT) students at the School of Physiotherapy, MGM University, Chhatrapati Sambhajnagar, Maharashtra, India. The study was carried out over a period of 12 months following approval from the Institutional Ethics Committee.

Participants

A total of 134 senior BPT students were recruited using a convenience sampling technique. Participation was voluntary, and all participants provided written informed consent before data collection.

Students enrolled in the Third Year and Final Year BPT programme with access to the internet were eligible to participate. Students who had completed their BPT programme, were not currently enrolled, declined participation, or submitted incomplete or duplicate responses were excluded from the study.

Data Collection

Data were collected using a structured self-administered questionnaire developed after an extensive review of the literature on artificial intelligence and simulation-based learning in healthcare education. The questionnaire was distributed electronically through Google Forms. Before administration, participants were informed about the objectives of the study, confidentiality of responses, and voluntary nature of participation.

The questionnaire consisted of two sections. The first section included demographic details such as age, gender, and academic year. The second section evaluated participants' awareness, knowledge, perception, and readiness regarding artificial intelligence and emerging simulation technologies used in physiotherapy education and clinical practice.

Awareness was assessed for technologies including simulation laboratories, digital twins, virtual reality (VR), augmented reality (AR), wearable sensors, robotics, predictive analytics, chatbots, and generative AI. Knowledge items assessed participants' understanding of AI applications in physiotherapy, while perception items explored attitudes towards usefulness, ease of use, ethical considerations, and integration of AI into physiotherapy education. Readiness assessed participants' willingness to adopt AI-driven technologies in future clinical practice.

Responses were recorded using a five-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree."



Composite scores were calculated for awareness (Questions 7–12), knowledge (Questions 13–16), perception (Questions 17–20), and readiness (Questions 21–24), with higher scores representing greater awareness, knowledge, positive perception, and readiness for adoption.

Statistical Analysis

The collected data were entered into Microsoft Excel and analysed using IBM SPSS Statistics. Descriptive statistics were used to summarise participant characteristics and questionnaire responses. Categorical variables were expressed as frequencies and percentages, whereas continuous variables were presented as mean $\pm$ standard deviation.

The Chi-square test was used to determine associations between demographic variables and awareness levels. Pearson's correlation coefficient (r) was used to examine the relationship between awareness and readiness towards adopting AI technologies. A p -value of less than 0.05 was considered statistically significant.

RESULTS

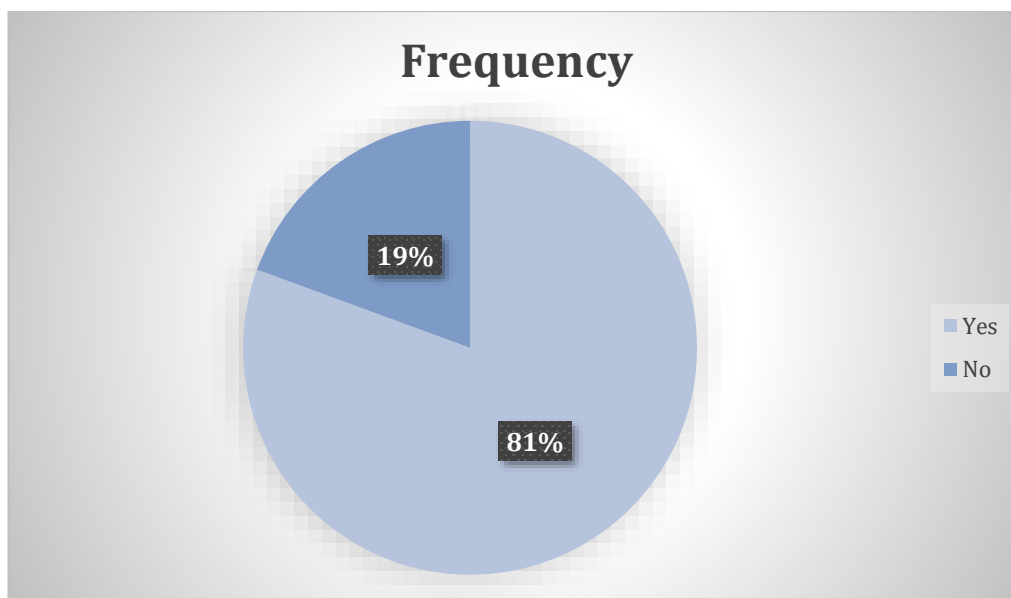
A total of 134 senior physiotherapy students participated in the study. All completed questionnaires were included in the final analysis. Descriptive statistics were used to summarise the participants' awareness, perception, knowledge, and readiness regarding artificial intelligence and emerging simulation technologies.

Previous Awareness of Artificial Intelligence

Among the participants, 108 students (80.6%) reported that they had previous awareness of artificial intelligence, whereas 26 students (19.4%) indicated that they had no prior awareness. These findings suggest that the majority of senior physiotherapy students were familiar with AI before participating in the survey.

Table 1. Previous Awareness of Artificial Intelligence

Response	Frequency	Percentage (%)
Yes	108	80.6
No	26	19.4
Total	134	100



Awareness of Different AI Technologies

Participants demonstrated varying levels of awareness regarding different AI-driven technologies. Generative AI was the most recognised technology, with 83.6% of students reporting awareness, followed by chatbots (77.6%), simulation

tools (73.1%), virtual reality (69.4%), wearable technology (65.7%), and robotics (56.7%). Digital twin technology had the lowest level of awareness, with only 38.8% of participants reporting familiarity.

Table 2. Awareness of AI Technologies

Technology	Frequency	Percentage (%)
Generative AI	112	83.6
Chatbots	104	77.6
Simulation tools	98	73.1
Virtual Reality	93	69.4
Wearable Technology	88	65.7
Robotics	76	56.7
Digital Twins	52	38.8



These findings indicate that students were more familiar with widely accessible AI technologies such as generative AI and chatbots, whereas awareness of advanced rehabilitation technologies, particularly digital twins, remained comparatively limited.

Perception Towards Artificial Intelligence

Participants demonstrated a positive perception towards the integration of artificial intelligence into physiotherapy

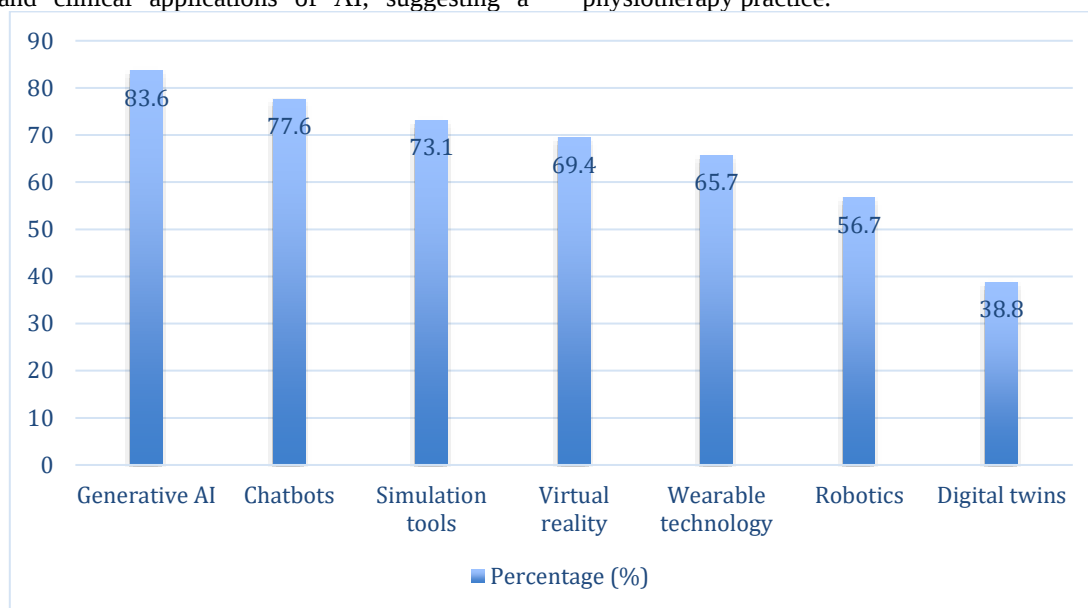
education and clinical practice. The majority agreed that AI improves physiotherapy education (82.8%), enhances clinical reasoning (79.1%), supports practical learning (76.9%), improves patient care (73.9%), supports clinical decision-making (74.6%), and should be incorporated into the physiotherapy curriculum (71.6%).

Table 3. Perception Towards Artificial Intelligence

Statement	Agree (%)
AI improves physiotherapy education	82.8
AI improves clinical reasoning	79.1
AI enhances practical learning	76.9
AI improves patient care	73.9
AI supports clinical decision-making	74.6
AI should be included in the curriculum	71.6

Overall, participants exhibited favourable attitudes towards the educational and clinical applications of AI, suggesting a

willingness to integrate these technologies into future physiotherapy practice.



Readiness for Adoption of AI Technologies

Assessment of readiness revealed that more than half of the participants (56.0%) demonstrated a high level of readiness to adopt AI technologies in future clinical practice. Moderate readiness was observed among 31.3% of students, while only 12.7% reported low readiness.

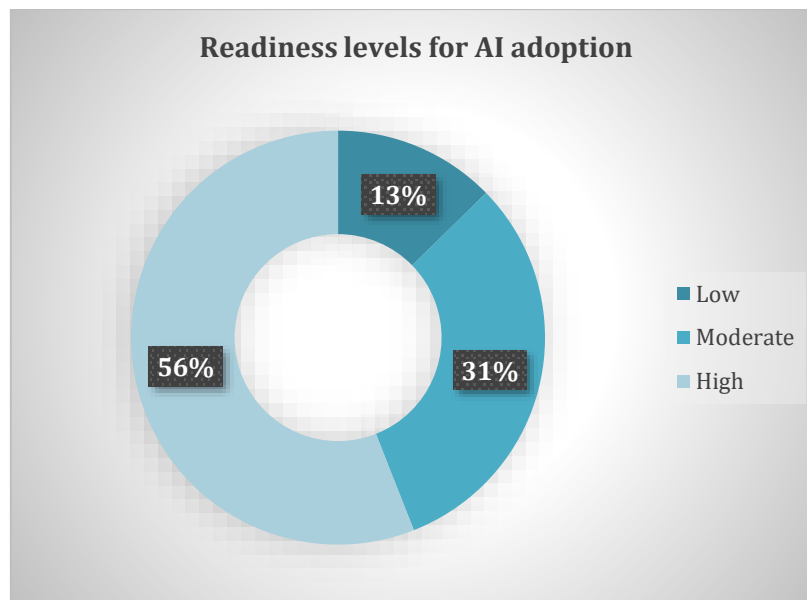
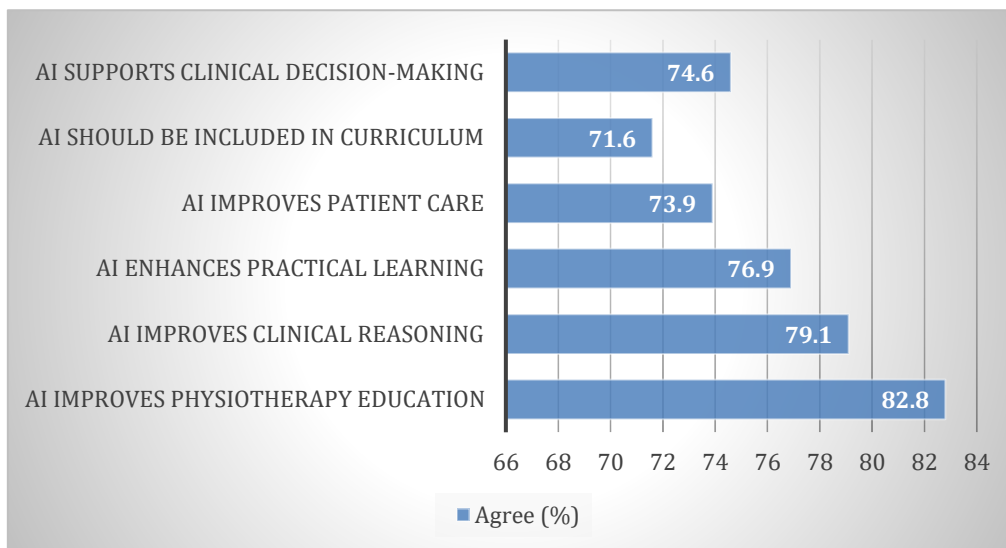
Table 4. Readiness for Adoption of AI Technologies

Readiness Level	Frequency	Percentage (%)
Low	17	12.7
Moderate	42	31.3
High	75	56.0
Total	134	100

These findings indicate that most senior physiotherapy students are receptive to integrating AI-driven technologies into future professional practice.

Correlation Between Awareness and Readiness

Pearson's correlation analysis demonstrated a statistically significant moderate positive correlation between awareness and readiness to adopt artificial intelligence technologies ($r = 0.58$, $p < 0.001$). This finding suggests that students with greater awareness of AI technologies were more likely to express readiness to incorporate these technologies into their future clinical practice.



DISCUSSION

The present study assessed the awareness, knowledge, perception, and readiness regarding artificial intelligence (AI) and emerging simulation technologies among senior Bachelor of Physiotherapy (BPT) students. With the rapid integration of AI into healthcare education and rehabilitation, understanding students' preparedness to adopt these technologies has become increasingly important. The findings of the present study demonstrate that although most students possess moderate to high awareness and favourable perceptions towards AI, awareness of advanced technologies such as digital twins remains limited. Overall, the participants expressed a positive attitude towards integrating AI into physiotherapy education and future clinical practice.

The demographic characteristics of the participants showed that females constituted the majority of the study population (81.3%), while males represented 18.7%. This distribution is consistent with the current enrolment trends observed in many physiotherapy programmes, where female students generally outnumber male students. Since the study

primarily focused on awareness and perceptions rather than gender-based comparisons, the unequal gender distribution is unlikely to have influenced the overall findings.

The present study found that **80.6%** of participants were already aware of artificial intelligence before participating in the survey. This finding reflects the increasing visibility of AI technologies in higher education, healthcare, and everyday digital applications. The widespread availability of generative AI platforms, intelligent search engines, and AI-assisted educational tools has likely contributed to this level of awareness among students. Similar observations have been reported by **Feigerlova et al.**, who concluded that artificial intelligence is becoming an integral component of health professions education and has the potential to improve learning outcomes through personalised instruction, adaptive learning, and timely feedback (1). Likewise, **Rezayi et al.** reported that physiotherapy students increasingly perceive AI as a valuable educational resource that complements traditional learning methods rather than replacing educators (5).



Among the various technologies assessed, generative AI demonstrated the highest level of awareness (83.6%), followed by chatbots (77.6%), simulation tools (73.1%), virtual reality (69.4%), wearable technology (65.7%), and robotics (56.7%). In contrast, digital twin technology showed the lowest awareness (38.8%). The higher awareness of generative AI and chatbots is expected because these technologies have become widely accessible through commonly used digital platforms and educational applications. Conversely, digital twins remain relatively novel within physiotherapy education and are primarily confined to research and specialised rehabilitation centres. Similar findings have been reported by **Mikolajewska et al.**, who highlighted that although digital twin technology has considerable potential for personalised rehabilitation, clinical decision-making, and remote patient monitoring, its implementation remains limited because of insufficient infrastructure, technical expertise, and educational exposure (3).

Knowledge assessment revealed that the majority of participants demonstrated a moderate level of knowledge regarding AI and emerging simulation technologies. Although students appeared familiar with the basic concepts and applications of AI, their understanding of advanced technologies and clinical implementation remained limited. These findings suggest that students are exposed to AI primarily through informal learning, social media, and independent exploration rather than structured academic instruction. This observation supports previous literature indicating that despite increasing awareness of AI, formal education related to artificial intelligence remains inadequate within many healthcare curricula. Strengthening curriculum content through dedicated educational modules, workshops, and simulation-based learning may therefore improve students' knowledge and confidence in applying AI within physiotherapy practice.

Participants also demonstrated positive perceptions towards integrating AI into physiotherapy education. More than three-quarters of the respondents agreed that AI improves physiotherapy education, enhances clinical reasoning, facilitates practical learning, supports patient care, and assists clinical decision-making. Furthermore, nearly three-quarters of the participants believed that AI should be incorporated into the physiotherapy curriculum. These findings indicate that students generally view AI as a supportive educational tool capable of enhancing learning rather than replacing clinical expertise. Similar findings were reported by **Ergezen Şahin et al.**, who demonstrated that AI-assisted educational interventions significantly improved clinical reasoning skills and diagnostic accuracy among physiotherapy students compared with conventional teaching methods (6). Likewise, systematic reviews have consistently reported that simulation-based educational approaches improve students' confidence, psychomotor skills, and overall learning outcomes across healthcare disciplines (7,10).

Readiness for adopting AI technologies was also encouraging. More than half of the participants (56.0%) demonstrated high readiness, while only a small proportion reported low readiness. These findings suggest that senior physiotherapy students are willing to embrace technological innovations provided adequate educational opportunities and

institutional support are available. This willingness is encouraging because readiness plays a critical role in the successful implementation of digital technologies within healthcare practice. Previous studies have similarly reported that healthcare students generally demonstrate positive attitudes towards AI but emphasise the need for structured training, faculty guidance, and practical exposure before these technologies can be effectively integrated into routine clinical practice (12,13).

One of the most important findings of the present study was the statistically significant moderate positive correlation between awareness and readiness ($r = 0.58$, $p < 0.001$). This indicates that students who possessed greater awareness of AI technologies were also more prepared to adopt these technologies in their future professional practice. This relationship suggests that improving awareness through curricular integration and educational initiatives may directly enhance students' willingness to utilise AI during clinical decision-making and patient management. The finding further reinforces the importance of introducing AI concepts early within undergraduate physiotherapy education.

Despite the overall positive findings, several challenges continue to hinder the integration of AI into physiotherapy education. Limited institutional infrastructure, inadequate faculty training, financial constraints, and restricted access to advanced simulation technologies remain significant barriers, particularly in resource-constrained educational settings. Ethical issues related to data privacy, algorithmic bias, accountability, and responsible use of AI also require careful consideration before widespread implementation. Consequently, AI should be viewed as an adjunct to clinical education and decision-making rather than a replacement for clinical reasoning, professional judgement, or patient-centred care.

The findings of the present study have important educational implications. As artificial intelligence continues to transform rehabilitation and healthcare delivery, physiotherapy curricula should incorporate structured learning experiences related to AI, simulation technologies, digital twins, virtual reality, robotics, and wearable technologies. Faculty development programmes, practical workshops, interdisciplinary collaborations, and simulation-based training may further enhance students' digital competencies and preparedness for future clinical practice. Equipping physiotherapy graduates with both clinical expertise and technological literacy will be essential for meeting the evolving demands of modern rehabilitation services.

Overall, the present study demonstrates that senior physiotherapy students possess favourable attitudes towards artificial intelligence and emerging simulation technologies. However, improving knowledge of advanced AI applications and increasing opportunities for practical exposure remain necessary to ensure that future physiotherapists are fully prepared to deliver technology-enabled, evidence-based, and patient-centred rehabilitation.

CONCLUSION

The present study assessed the awareness, knowledge, perception, and readiness regarding artificial intelligence (AI) and emerging simulation technologies among senior Bachelor



of Physiotherapy students. The findings indicate that most participants possessed moderate to high levels of awareness and demonstrated positive perceptions towards the integration of AI into physiotherapy education and clinical practice. Technologies such as generative AI, chatbots, and simulation laboratories were widely recognized, whereas awareness of advanced technologies such as digital twins remained comparatively low.

The study also revealed that more than half of the participants were highly prepared to adopt AI-driven technologies in their future professional practice. Furthermore, a statistically significant moderate positive correlation was observed between awareness and readiness, suggesting that students with greater awareness were more willing to incorporate AI into clinical practice. These findings emphasize the importance of improving awareness and digital literacy during undergraduate physiotherapy education.

The integration of structured AI-related learning, simulation-based training, and emerging digital technologies into physiotherapy curricula may enhance students' knowledge, confidence, and preparedness for technology-enabled healthcare. Strengthening institutional infrastructure, faculty development, and practical exposure to AI applications will be essential for preparing future physiotherapists to deliver evidence-based, patient-centred rehabilitation in an increasingly digital healthcare environment.

LIMITATIONS

The present study has certain limitations that should be considered while interpreting the findings. First, the study was conducted at a single institution using a convenience sampling technique, which may limit the generalizability of the results to physiotherapy students from other universities and geographical regions. Second, the relatively small sample size of 134 participants may not adequately represent the awareness and perceptions of all physiotherapy students.

The study relied on a self-administered online questionnaire; therefore, responses were based on participants' self-reported knowledge and perceptions and may have been influenced by response bias or social desirability bias. Furthermore, the cross-sectional design assessed awareness and perceptions at a single point in time and did not evaluate changes in knowledge or readiness following educational interventions.

Although the study assessed awareness, knowledge, perception, and readiness, it did not evaluate participants' actual competency, practical skills, or clinical application of artificial intelligence and emerging simulation technologies. Additionally, factors such as institutional infrastructure, availability of digital resources, faculty expertise, previous exposure to AI, and ethical or legal concerns were not explored in detail. These variables may influence students' acceptance and adoption of AI technologies and should be investigated in future studies.

FUTURE SCOPE

Future research should include larger, multicentre studies involving physiotherapy institutions from different regions to improve the generalizability of the findings. Comparative studies across different academic years and

healthcare disciplines may provide a broader understanding of digital literacy and technology acceptance among healthcare students.

Longitudinal studies are recommended to evaluate changes in awareness, knowledge, and readiness following structured educational interventions. The effectiveness of workshops, simulation-based learning, AI-integrated curricula, and faculty development programmes should also be investigated to determine their impact on students' competencies and clinical reasoning skills.

Future studies should focus on assessing the practical application of artificial intelligence through hands-on training using technologies such as virtual reality, augmented reality, digital twins, robotics, wearable sensors, and AI-assisted clinical decision-support systems. Research exploring faculty preparedness, institutional readiness, ethical considerations, data security, and barriers to AI implementation will further contribute to the successful integration of artificial intelligence into physiotherapy education and clinical practice.

As artificial intelligence continues to evolve rapidly, continuous research will be necessary to ensure that physiotherapy graduates possess the knowledge, digital competencies, and clinical skills required to practise effectively in technology-driven healthcare environments.

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