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Short communication

The future pharmacist: Integrating artificial intelligence into pharmacy education –Students' perspective

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Introduction

Artificial intelligence (AI) is rapidly transforming healthcare by supporting clinical decision-making, optimizing medication management, enhancing pharmacovigilance, and accelerating pharmaceutical research. As AI becomes increasingly integrated into pharmacy practice, future pharmacists must acquire the knowledge and competencies necessary to use these technologies effectively and ethically. Understanding pharmacy students' perceptions and readiness for AI is essential for developing modern pharmacy curricula.

Despite the growing adoption of AI in healthcare, evidence regarding pharmacy students' knowledge, attitudes, and preparedness for AI integration remains limited, particularly in undergraduate pharmacy education. Understanding students' perceptions and educational needs is essential for informing curriculum development and ensuring that future pharmacists are equipped with relevant digital competencies. Xhaferi (2024) reported that students considered ChatGPT a valuable tool for enhancing academic practices, especially in generating ideas, improving writing quality, and accessing quick information, although concerns regarding reliability and over-reliance were also noted.

Therefore, this study aimed to assess pharmacy students' knowledge, attitudes, perceived benefits, concerns, and educational needs regarding the use of artificial intelligence, as well as their readiness for its integration into future pharmacy professional practice in North Macedonia.

The findings may inform the integration of AI into pharmacy curricula to better prepare future pharmacists for technology-driven healthcare.

Materials and methods

A descriptive cross-sectional survey design was employed to investigate pharmacy students' perceptions regarding artificial intelligence and its integration into pharmacy education. Most attitudinal items were measured using a five-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree."

The study included 92 undergraduate pharmacy students (male and female) from all years of study at the Faculty of Pharmacy, who were invited to participate voluntarily. Participation was anonymous, and informed consent was obtained from all participants before completion of the questionnaire.

The questionnaire was developed based on relevant literature and included items addressing AI awareness, current use of AI tools, perceived benefits and risks, attitudes toward AI in pharmacy practice, and the need for AI-related education. Data were analyzed using descriptive statistics to summarize participants' responses. In addition, inferential statistical tests were applied to examine associations between students' year of study, prior

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AI experience, and their attitudes toward artificial intelligence. This methodological approach provided a comprehensive overview of students' perceptions and educational needs regarding the integration of AI into pharmacy education.

Results and discussion

The majority of students reported familiarity with artificial intelligence through widely used platforms such as ChatGPT, Google Gemini, and other educational applications. AI was primarily used for academic purposes, including literature searches, summarizing scientific articles, preparing assignments, and generating study materials.

However, knowledge and practical experience with AI applications in pharmacy practice, particularly in clinical pharmacy and pharmaceutical decision support, were limited. Inferential statistical analyses indicated a statistically significant association between students' year of study and their familiarity with artificial intelligence ($p < 0.05$), with higher-year students demonstrating greater exposure and use of AI tools.

Overall, students expressed positive attitudes toward the integration of AI into pharmacy education and future professional practice.

These findings indicate a gap between students' familiarity with general AI tools and their understanding of AI applications in pharmacy practice. This suggests that exposure to AI within pharmacy education remains insufficient.

A similar finding was reported by Chan and Hu (2023), who found that pharmacy students frequently used AI tools for learning activities, including summarizing information and completing academic tasks, while expressing positive perceptions of AI's potential to enhance education.

In contrast, Iwasawa et al. (2023) reported that pharmacy students with greater AI awareness demonstrated significantly better understanding of artificial intelligence concepts; however, their exposure to clinical and pharmacy-specific applications remained limited.

Conclusion

This study sheds light on pharmacy students' perspectives regarding the integration of artificial intelligence into pharmacy education. While students demonstrated strong familiarity with general AI tools and positive attitudes toward their use, their knowledge of AI applications in pharmacy practice remained limited. These findings emphasize the need to incorporate AI-related knowledge, practical skills, and ethical considerations into pharmacy curricula to better prepare future pharmacists for an increasingly technology-driven healthcare system.

The study has some limitations because it was conducted at a single institution, which limits the generalizability of the findings to other settings.

Future research should include multiple universities with larger and more diverse samples to improve representativeness. Pharmacy curricula should incorporate structured AI training with a focus on clinical applications and practical skills.

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