

Perceptions of Pharmacy Students Toward Artificial Intelligence in Pharmacy

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Abstract

Introduction: The advancement of community and clinical pharmacy services relies on the ongoing enhancement of patient care, and artificial intelligence (AI) can be a pivotal factor in this progression. Despite the growing use of AI in different areas of pharmacy, there is less awareness among pharmacy students toward this technology. **Material and Methods:** This study was a descriptive cross-sectional survey. A total of 100 pharmacy students from Sudan participated in the study. Data were collected through an online electronic questionnaire. The data collected included information about sociodemographics: knowledge toward AI, attitude toward AI, and satisfaction of students with the use of AI in their pharmacy practice. **Results:** More than two-thirds of the participants (70%) heard about AI, half of them (52%) did not know any application of AI in pharmacy, and 61% of participants were not taught about AI in medical school. On the other hand, 60% of participants did not know the application of AI in pharmacy, whereas 20% stated it can be applied to help in marketing, communications, dispensing, and manufacturing of drugs, more than half of the participants (54%) they thought that the use of AI in pharmacy is good, but that does not replace the role of the pharmacist in the field of pharmacy. There is a statistically significant association between the name of the university and the satisfaction of students with the use of AI in their pharmacy practice ($P = 0.003$). **Conclusion:** AI entails the amalgamation of human expertise and resources with AI. As research on AI progresses, with numerous intriguing applications currently underway, some may perceive it as a necessary malevolence, even among those who view it as an adversary. Comprehensive knowledge and familiarity with AI are indispensable in all areas of pharmacy practice. Pharmacy students should receive instruction in the fundamental principles of data science and the basics of AI as part of their study, namely through a health informatics program.

Keywords: Artificial intelligence, pharmacy, students

INTRODUCTION

Artificial intelligence (AI) is a field of research that focuses on the development of intelligent computer systems capable of producing outcomes that mimic the human cognitive process.^[1] This process often involves acquiring data, devising efficient mechanisms for utilizing the acquired data, presenting definitive or approximate conclusions, making self-corrections, and making adjustments.^[2] AI is commonly employed to analyze machine learning algorithms to replicate the cognitive functions performed by humans.^[2,3] AI technology is utilized to conduct more precise analyses and achieve valuable interpretation.^[3]

AI technology combines a range of valuable statistical models and computational intelligence.

AI technology has recently become an integral component of various industries, with numerous practical applications in technical and scientific domains. Upon contemplation of the previous 25 years, the field of pharmacy has

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effectively tackled the increasing need for prescriptions, encountering shortages of pharmacists, escalating operational expenses, and reduced reimbursements. The pharmacy has effectively utilized advanced technological automation to enhance workflow efficiency and reduce operational expenses, while simultaneously prioritizing safety, precision, and efficiency in all pharmacy environments. Automated dispensing allows pharmacists to allocate more time to interact with a larger number of patients, while simultaneously improving their health results.^[4]

The initial implementation of computers in pharmacies is believed to have occurred in the 1980s. Since then, computers have been extensively employed in various aspects of pharmacy, including data collection, retail pharmacy management, clinical research, drug storage, pharmacy education, and clinical pharmacy. With the advent of AI, the future evolution of the pharmacy sector is unpredictable. Multiple expert systems have been created in the field of medicine to aid physicians in the process of medical diagnosis.^[5] Recently, several programs focusing on drug therapy have been described.^[4] They provide guidance on drug interactions, monitoring drug therapy, and selecting drugs from a formulary. AI has the potential to affect various elements of pharmacy, and pharmacists should contemplate these possibilities as they may eventually manifest in the field of pharmacy.

Integrating AI in the healthcare sector faced major challenges following the Sudan conflict, such as the breakdown of healthcare services, the destruction of hospitals, the migration of healthcare personnel, and the decline in medical education and training. The objective of this study is to determine the extent of awareness among pharmacy students in Sudan regarding AI and its implications, as well as to assess their understanding of various AI practices.

MATERIALS AND METHODS

Study design and sample size

A web-based survey was distributed to pharmacy students in Sudan using social media apps (WhatsApp, Facebook, and Messenger) and e-mail during the period from April 1, 2024, to May 15, 2024. This study was a cross-sectional study, and the questionnaire was developed by authors after reviewing previous studies^[1,2,4] and validated by Sudanese students and doctors. Responses were anonymous without any identifying data, and a convenience sampling technique was used to pick the sample population.

The valid questionnaire consisted of four sections: (1) sociodemographic section; (2) Knowledge section; (3) attitude section; and (4) Satisfaction of students with the use of AI in their pharmacy practice.

Statistical analysis

The data were analyzed using Statistical Package for Social Sciences, version 25.0 (IBM Corp., Armonk, NY, USA). The frequencies of different variables were shown using frequency tables. The Chi-square test was used to examine the statistical correlation between the categorical variables. A $P < 0.05$ indicated that the association was statistically significant.

RESULTS

Demographic variables

Students who participated in the study were 100 from more than five universities and colleges, 75% were females [Figure 1], and more than half of the participants (57%) were in their fifth academic year [Figure 2].

Knowledge of AI among pharmacy students

More than two-thirds of participants (70%) heard about AI, half of them (52%) did not know any application of AI in pharmacy, and 61% of participants were not taught about AI in medical school [Table 1].

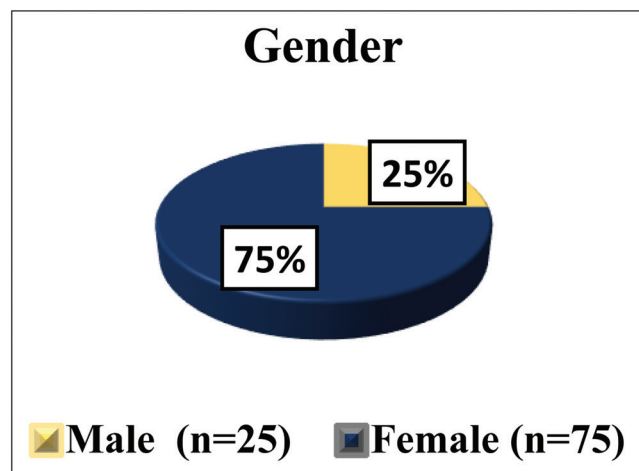


Figure 1: Distribution of participants according to gender

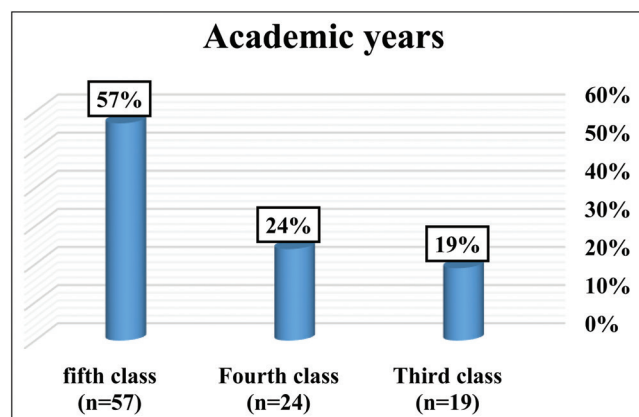


Figure 2: Distribution of participants according to academic years

On the other hand, 60% of participants did not know the application of AI in pharmacy, whereas 20% stated it can be applied to help in marketing, communications, dispensing, and manufacturing of drugs [Figure 3].

Attitude of students toward AI in pharmacy

Table 2 summarizes students' attitudes toward AI in pharmacy. The majority of the participants agreed with all questions, the statement that "AI is an effective and helpful tool for data mining based on huge medical and pharmacological data" represents the highest percent of agreement 97% followed by "AI facilitates and accelerates drug discovery and development" and "AI opens hope for a

bright and developed future in pharmacy" which represent 96%. On the other hand, 83% of participants agreed that "AI helps the pharmacist to spend more time on direct patient communication by managing repetitive tasks" which represents the lowest percentage of agreement.

Satisfaction of students with the use of AI in their pharmacy practice

More than half of the participants 54% thought that the use of AI in pharmacy is good, but that does not replace the role of the pharmacist in the field of pharmacy [Figure 4].

There was no statistically significant association between the name of the university and the student's thoughts about AI in medical school ($P = 0.79$) since chi-square had $P > 0.05$, whereas there was a statistically significant association between the name of the university and satisfaction of students with the use of AI in their pharmacy practice ($P = 0.003$) since chi-square had $P < 0.05$. There was no statistically significant association between the academic years and knowing about any application of AI in pharmacy ($P 0.08$) since chi-square had $P > 0.05$.

Table 1: Frequencies of participant's response to knowledge items

Item	Yes (%)	No (%)
Have you heard about AI before?	70	30
Do you know about any application of AI in pharmacy?	48	52
Have you ever been taught about AI in medical school?	39	61

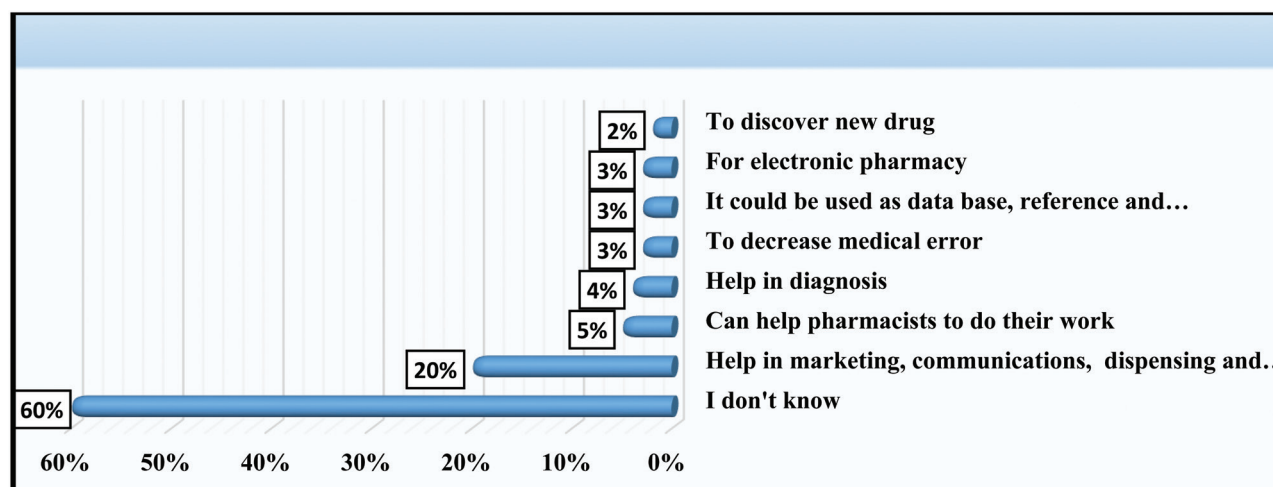


Figure 3: Frequencies of participant's response to AI applications in pharmacy

Table 2: Student attitude toward AI in pharmacy

Question	Agree (%)	Disagree (%)
AI has a significant and positive impact on the pharmacy	95	5
AI helps the pharmacist spend more time on direct patient communication by managing repetitive tasks	83	17
AI is an effective and helpful tool for data mining based on huge medical and pharmacological data	97	3
AI facilitates decision-making by making the medical and pharmacological processes faster and smarter	94	6
AI will help educate people by publishing educational articles on medication use	89	11
AI use can reduce the cost of practical trial and human error	92	8
AI facilitates and accelerates drug discovery and development	96	4
AI can enhance and facilitate the communication between the pharmacist and patients (e.g. via chat or e-mail)	90	10
AI introduces well useful and satisfying services for patients and pharmacists	95	5
Intelligence opens hope for a bright and developed future in pharmacy	96	4

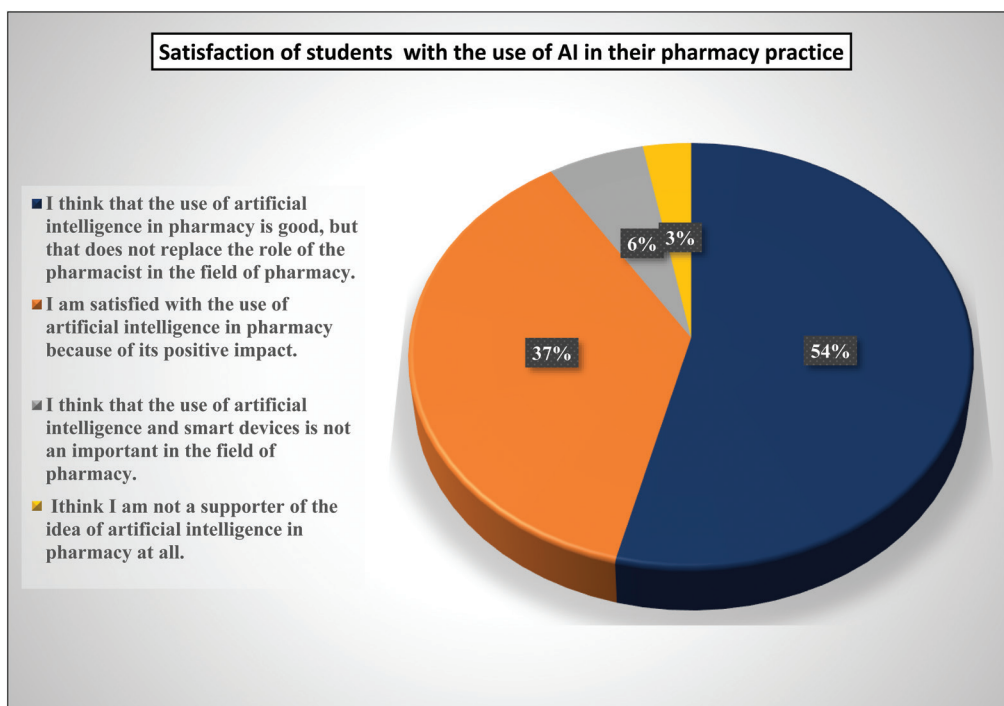


Figure 4: Satisfaction of students with the use of AI in their pharmacy practice

DISCUSSION

AI is a field of computer science that is, dedicated to developing computer programs capable of doing activities that typically necessitate human intelligence.^[6]

In the field of pharmacy, AI has already begun to influence areas such as drug discovery,^[7] drug design,^[8] medication delivery,^[9] and pharmacy practice,^[10] especially in developed countries. Nevertheless, it is anticipated that simultaneous progress in information technology and AI will profoundly transform global health in low- and middle-income countries.^[11]

The utilization of this technology has the potential to greatly modify the practice of pharmacy. One of the challenges in clinical pharmacy practice is to learn how to effectively utilize these technologies to uncover unique health data trends and provide significant advantages to patients.^[12,13] This study was conducted to investigate the knowledge, attitudes, and practices of 100 pharmacy students regarding AI.

Of the demographic characteristics of the respondents, 75% were female, which reflects the dominance of female gender in the pharmacy sector and is consistent with previous studies.^[14,15] More than half of the participants (57%) were in the fifth academic year, which reflects the participants where colleagues fifth-year students conducted the research.

More than two-thirds of the participants (70%) heard about AI, and half of them (52%) did not know about

any application of AI in pharmacy, this is in line with Al Ahmari's^[16] study, they also reported that the majority of participants (77.1%) did not have basic knowledge about the working principles of AI, and 63.3% did not know about the application of AI in dentistry.

In our study, 61% of participants were not taught about AI in medical school. Comparably, the majority of the participants in the study by Banerjee *et al.*^[17] also agreed that their current curricula provided adequate AI training (92%), and they supported the idea of more formal AI training (81%). Due to their status as digital natives, students are more prone to encountering AI tools during their education. Furthermore, it is essential to integrate AI-focused courses into pharmacy curricula and ongoing education and training programs. This will enhance the understanding, proficiency, and practical implementation of AI in pharmacy practice, particularly for pharmacy faculty members. They must stay up-to-date with the rapidly advancing field.^[15]

Similarly, a study conducted in Saudi Arabia revealed that pharmacy students demonstrated a high level of understanding and knowledge regarding AI. Furthermore, they indicated that most students held favorable views regarding the ideas, advantages, and use of AI.^[18]

Regarding the impact of AI on pharmacy practice in Sudan, the majority of the participants agreed in all statements in this matter despite half of them did not know any application of AI in pharmacy and 61% of participants did not teach about AI in medical school.

AI is an effective and helpful tool for data mining based on huge medical and pharmacological data representing the highest percent of agreement 97% followed by “AI facilitates and accelerates drug discovery and development” and “AI opens hope for a bright and developed future in pharmacy” which represent 96%. On the other hand, 83% of participants agreed that “AI helps the pharmacist to spend more time on direct patient communication by managing repetitive tasks” which represents the lowest percentage of agreement.

In a study conducted in Saudi Arabia, it was found that pharmacy students had a commendable level of awareness regarding AI. Furthermore, they indicated that most of the students held favorable views regarding the ideas, advantages, and use of AI.^[18]

These findings align with a wider trend in healthcare, where AI is increasingly recognized as a valued collaborator in clinical decision-making and patient care.^[19]

More than half of the participants 54% thought that the use of AI in pharmacy is good, but that does not replace the role of the pharmacist in the field of pharmacy.

Even though the role of AI is increasing in pharmacy nowadays, it has the potential to significantly impact and redirect pharmacists' attention away from simply dispensing pharmaceuticals to offering a wider array of patient-care services. By utilizing AI, pharmacists can optimize the effectiveness of medications and promote better health outcomes for individuals. AI offers pharmacies a crucial chance to foster more collaboration across various entities that cater to the same patient. For patients, AI can serve as a valuable tool in optimizing healthcare services, offering guidance on cost-effective healthcare options, facilitating effective communication with healthcare professionals, maximizing the value of wearable data, providing lifestyle guidance, integrating diet and exercise, and promoting treatment compliance and adherence.^[20]

There was a statistically significant association between the name of the university and the satisfaction of students with the use of AI in their pharmacy practice ($P = 0.003$) since chi-square had $P < 0.05$, this could be due to the lack of formal education and training in AI for pharmacy students and faculty members, which is consistent with previous research studies.^[21,22]

Limitations of the study

Currently, a cross-sectional study design lacks the potential to demonstrate causality, despite its cost and applicability. In addition, the students' low response rate and the tiny sample size of 100 are insufficient for generalization.

CONCLUSION

To conclude, immediate action must be taken to improve the current state of undergraduate pharmacy students in

Sudan, to increase their knowledge, and to shape their attitudes toward the utilization of AI in medicine. A considerable percentage of the participants did not know any application of AI in pharmacy indicating that they do not utilize AI in their work endeavors. In addition, the medical profession is often seen as benefiting from the employment of this technology due to its ability to improve the diagnostic process and enhance patient treatment. Therefore, it is necessary to include more education and training on AI-related courses in pharmacy curricula to enhance student's understanding and abilities in this field. This can result in a more effective implementation of AI in pharmacy practice, with a specific focus on fundamental computational principles and AI terminology.

Data availability statement

All data in the study are available from the corresponding author upon request.

Ethical policy and Institutional Review Board statement

Participants had the option to withdraw from the cross-sectional research at any point, and their participation was entirely voluntary. Responses were anonymous without any identifying data. The research investigation was authorized by the ethics committee of the National University—Sudan (no. NU-REC/013-024/13).

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Conflict of interests

There are no conflicts of interest.

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