Creative Education, 2024, 15, 2582-2596
https://www.scirp.org/journal/ce
ISSN Online: 2151-4771
ISSN Print: 2151-4755

Artificial Intelligence: A Knowledge, Attitude, and Practices Survey among Pharmacy Students at the University of Zambia

Steward Mudenda[1*], Ruth Lubinda[1], Maisa Kasanga[2], Zanga Musakuzi[3], Shafiq Mohamed[4], Webrod Mufwambi[1]

[1]Department of Pharmacy, School of Health Sciences, University of Zambia, Lusaka, Zambia
[2]Department of Pathology and Microbiology, University Teaching Hospitals, Lusaka, Zambia
[3]Medsearch Zambia, Lusaka, Zambia
[4]York and Scarborough Teaching Hospitals NHS Foundation Trust, York, UK
Email: *steward.mudenda@unza.zm

How to cite this paper: Mudenda, S., Lubinda, R., Kasanga, M., Musakuzi, Z., Mohamed, S., & Mufwambi, W. (2024). Artificial Intelligence: A Knowledge, Attitude, and Practices Survey among Pharmacy Students at the University of Zambia. *Creative Education, 15,* 2582-2596.
https://doi.org/10.4236/ce.2024.1512157

Received: November 18, 2024
Accepted: December 21, 2024
Published: December 24, 2024

Abstract

Introduction: Artificial Intelligence (AI) is a field of computer science that mimics human intelligence in learning and problem-solving processes. There is a paucity of information regarding students' knowledge, attitudes, and practices regarding AI. This study assessed the knowledge, attitudes, and practices of pharmacy students regarding AI. **Materials and Methods:** This descriptive cross-study was conducted among 262 pharmacy students at the University of Zambia using a structured questionnaire from August 2024 to September 2024. Data collected were analyzed using Statistical Package for Social Science (SPSS) version 23.0. The statistical significance was set at a 95% confidence level (p-value less than 0.05). **Results:** Of the 262 participants, 237 (90.4%) were aged between 20 and 30 years, 253 (96.6%) were familiar with the concept of AI, and 257 (98.1%) were aware of ChatGPT. Overall, 186 (71.3%) had inadequate knowledge, 186 (71.3%) had negative attitudes, and 135 (51.7%) had suboptimal practices towards AI. The results show a lower attitude compared to knowledge and practice levels. Inadequate knowledge and attitude were associated with gender ($X^2 = 11.612$, $p = 0.001$ for knowledge level) and ($X^2 = 1.812$, $p = 0.003$ for attitude level). Additionally, inadequate practice showed significant associations with years of study ($X^2 = 8.991$, $p = 0.028$ for practice level) and residence ($X^2 = 5.593$, $p = 0.014$ for practice level). **Conclusion:** The present study found that most pharmacy students had inadequate knowledge, attitudes, and practices concerning AI. As a result, there is a need to increase awareness about AI among healthcare students and its usefulness in the delivery

*Corresponding author.

of healthcare services. The study's outcomes offer valuable insights for educating pharmacy students about AI and its applications within the pharmaceutical industry and the healthcare system. Therefore, we recommend that AI be incorporated into the curricula for the training of pharmacy students and continuous professional development programs for pharmacy personnel.

Keywords

Artificial Intelligence, ChatGPT, Technology, Pharmacy Students, Zambia

1. Introduction

Artificial intelligence (AI) involves the use of computers to perform cognitive tasks, usually associated with human minds, particularly learning and problem-solving (Zawacki-Richter et al., 2019). The development of AI dates back to 1955 when John McCarthy organized a two-month workshop at Dartmouth College in the USA to clarify and develop ideas about thinking machines, which he later termed AI (Zawacki-Richter et al., 2019). It is now evident that AI has developed rapidly in the last 10 years (Menke, Homberg, & Koch, 2023). Evidence has since demonstrated the need for a greater emphasis on AI education within pharmacy curricula because of the growing need to incorporate AI education into pharmacy curricula (Busch et al., 2024: pp. 649-661). According to research conducted in Jordan, for medical education to fully utilize AI's potential for better patient care and training, it was imperative that AI themes be included in the curriculum and that numerous obstacles be addressed (Al-Qerem et al., 2023). Additionally, students need to be better prepared for the incorporation and implementation of AI in education (Al-Qerem et al., 2023). To influence future curriculum development, it is necessary to evaluate the viewpoints of students across healthcare specialties (Teng et al., 2022).

A survey reported that pharmacy students in the Middle East and North Africa (MENA) became more aware of AI technology but still faced large gaps in their knowledge and application of AI in pharmacy practice (Hasan et al., 2024). AI in healthcare has opened up many application opportunities to enhance patient care, offer real-time data analytics, and facilitate ongoing patient monitoring (Mudenda & Mohamed, 2024: pp. 16-21). At the same time, health informaticists and clinicians must have good data analytics and visualization experience to utilize, analyze, and build AI solutions in clinical practice (Hasan Sapci & Aylin Sapci, 2020). Research conducted in Morocco indicated that AI is expanding and flourishing as a tool or system that carries out a certain intelligent activity (also known as artificial narrow intelligence or ANI) (Jaldi, 2023). Students studying natural and biological sciences were likely to come across an AI-based tool in their future professional jobs due to the growing prevalence of AI, whether in a commercial or research context (Menke, Homberg, & Koch, 2023). Additionally, there were

several hazards and advantages associated with AI, and its advancement could have violated certain basic freedoms and rights but local and international AI research hubs were formed to promote the growth of AI enterprises across the continent (Jaldi, 2023).

Students are reported to have diverse views regarding the use of AI in their studies and healthcare, with some feeling that AI is useful while some are not (Jaiteh et al., 2024: pp. 506-511; Ibrahim et al., 2023; Albayati, 2024; Mousavi Baigi et al., 2023; Seo et al., 2021; Mosleh et al., 2023: pp. 1391-1400; Jackson et al., 2024; Jebreen et al., 2024). Some studies have shown that students had positive perceptions that AI is useful in their education (Caucheteux et al., 2024: pp. 101-113; Chan & Hu, 2023). Consequently, some studies have shown that students were sceptical about the use of AI in education and were concerned with ethical issues such as plagiarism which has negative impacts on their education (Lubowitz, 2023: pp. 1121-1122; Peres et al., 2023: pp. 269-275). Students have also been reported to have fears and uncertainty about how AI would affect their ability to join the workforce (Marrone et al., 2024). Understanding the students' perceptions concerning AI is critical to help policymakers develop strategies on how to introduce and implement AI universities to enhance learning and teaching experiences (Chan & Hu, 2023).

During the period of study, there were no published studies regarding pharmacy students' knowledge, attitudes, and practices toward AI in Zambia. It was against this background that this study assessed pharmacy students' knowledge, attitudes, and practices (KAP) regarding AI. We believe the findings may be used to promote the introduction of AI in Zambian Universities.

2. Materials and Methods

2.1. Study Design, Site, and Population

This descriptive cross-sectional study was conducted from August 2024 to September 2024 among pharmacy students at the Ridgeway Campus of the University of Zambia in Lusaka, Zambia. Various healthcare programs are offered at this Campus, including Medicine, Biomedical Sciences, Physiotherapy, Public Health, Nursing, Radiography, and Pharmacy (Mudenda et al., 2023: pp. 1-12). The study included all pharmacy students enrolled at the University of Zambia who consented to be part of the study. The study excluded all pharmacy students who did not give consent to be part of the study and those who were not available during the data collection period.

2.2. Sample Size Estimation and Sampling Technique

A total of 743 undergraduate pharmacy students were registered at the University of Zambia, of which 192 were second-year, 221 were third-year, 183 were fourth-year, and 147 were fifth-year of study. This site was chosen because it was where pharmacy students got their knowledge in a public university setting in the capital city, Lusaka. Based on this population, a minimum required sample size of 260

was estimated using Taro Yamane's formula. Taro Yamane's formula takes into consideration a known population of interest (Joskow & Yamane, 1965: pp. 678-680). The study utilized a simple random sampling method using computer-generated random numbers for all registered pharmacy students at the University of Zambia.

2.3. Data Collection

Data collection was conducted using an adapted questionnaire from a previous study (Swed et al., 2022). The questionnaire was pre-validated for its simplicity, understandability, accuracy, clarity, and relevance by experts in the field of public health and pharmacy. This was followed by piloting the questionnaire among 15 pharmacy students who were not part of the main study. The questionnaire comprised four parts: Part I: four questions on the sociodemographic information of participants; Part II: five questions on the knowledge of participants on AI; Part III: five questions on the attitude of participants towards AI; and Part IV: five questions on the practices of participants regarding AI. The total number of points under knowledge, attitude, and practice were five (5) for each variable. Good KAP was considered a score of 60% and above. Hence, for the statistical analysis, yes = 1, no = 0, and Good knowledge is upper than 3 points (Swed et al., 2022). Regarding the attitude variable, for the statistical analysis, neutral, disagree = 0, agree = 1, and Good attitude are upper than 3 points (Swed et al., 2022). Concerning the practice variable, for the statistical analysis, yes = 1, No = 0, and Good practice is upper than 3 points (Swed et al., 2022).

2.4. Data Analysis

The collected data were entered into a Microsoft Excel spreadsheet 2013 and cleaned. The gathered data were exported to the Statistical Package for Social Sciences (SPSS) version 23 for analysis. Descriptive statistics was performed for the sociodemographics, knowledge, attitude, and practice data. The relationship between sociodemographics and KAP regarding AI was determined using the Chi-squared test, and wherever possible, Fisher's exact test was used. Statistical significance was set at a 95% confidence level ($p < 0.05$).

2.5. Ethical Approval

Ethical approval was obtained from the University of Zambia, School of Health Sciences Research Ethics Committee (UNZAHSREC). The study protocol was approved under protocol ID: 20231270128 from UNZAHSREC and the National Health Authority (NHRA) under the reference number NHRA0S32/25/7/2024. This study was a questionnaire-based study that involved direct or physical interaction with the participants. All participants were provided with information sheets and informed and written consent was obtained from them before commencing the research. The participants were informed of the purpose of the study. All information collected during all stages of the research was handled with strict confidentiality and

used only for this research. The information collected was coded to ensure that no identification details were disclosed or written on the questionnaires.

3. Results

3.1. Sociodemographic Characteristics of Participants

From a total of 262 study participants recruited, it was found that the majority (237, 90.4%) of participants were aged between 20 and 30 years, and 155 (59.2%) were females. In terms of academic standing, the majority were third-year students (121, 46.2%), followed by fourth-year students (102, 38.9%). Additionally, it was found that most participants (233, 88.9%) resided in urban areas. The details of the participant's sociodemographic characteristics are shown in Table 1.

Table 1. Sociodemographic characteristics of participants.

Variable	Characteristic	Frequency	Percent
Gender	Female	155	59.2
	Male	107	40.8
Age (Years)	20 - 30	237	90.4
	31 - 40	23	8.8
	41 - 50	2	0.8
Year of Study	Second	26	9.9
	Third	121	46.2
	Fourth	102	38.9
	Fifth	13	5.0
Residential Address	Urban	233	88.9
	Rural	29	11.1

3.2. Knowledge of Participants towards Artificial Intelligence

Most participants (253, 96.6%) were familiar with the concept of AI, and 257 (98.1%) were aware of ChatGPT. However, only 89 (34.0%) of respondents knew about machine learning, and 124 (47.3%) were aware of AI applications in health sciences and pharmacy. The details of the participants' knowledge of AI are represented in Table 2.

Table 2. Knowledge of participants towards artificial intelligence.

Knowledge questions	Yes n (%)	No n (%)
Do you know what artificial intelligence (AI) is?	253 (96.6)	9 (3.4)
Do you know about machine learning and deep learning (Subtype of A)?	89 (34.0)	173 (66.0)
Do you know what ChatGPT is?	257 (98.1)	5 (1.9)
Do you know about any application of AI in the Health Sciences-Pharmacy field?	124 (47.3)	138 (52.7)
Have you ever been taught about AI in pharmacy training?	47 (17.9)	215 (82.1)

3.3. Attitudes of Participants towards Artificial Intelligence

The majority (133, 50.8%) of participants agreed that AI is essential in health sciences and pharmacy, and most participants (125, 47.7%) believed AI should be included in the Pharmacy training curriculum. Consequently, (4 (17.9%) of the participants thought that AI would replace pharmacists in the future. There was also significant optimism about AI's future role in pharmaceutical practice, with 136 (51.9%) expecting its widespread use. The details of the participant's attitude towards AI are represented in Table 3.

Table 3. The attitude of participants towards artificial intelligence.

Statement (s)	Agree n (%)	Neutral n (%)	Disagree n (%)
Do you believe that AI is essential in the Health Sciences-Pharmacy field?	133 (50.8)	120 (45.8)	9 (3.4)
Do you think AI should be included in the curriculum of the Pharmacy program?	125 (47.7)	110 (42.0)	27 (10.3)
Do you believe AI will replace pharmacists in the future?	47 (17.9)	67 (25.6)	148 (56.5)
Do you expect AI to have wide use in pharmaceutical practice in the future?	136 (51.9)	79 (30.2)	47 (17.9)
Do you know about the application of AI in the pharmacy field?	72 (27.5)	110 (42.0)	80 (30.5)

3.4. Practice of Participants towards Artificial Intelligence

The majority of participants (240, 91.6%) had used AI in their studies. However, only 3 (1.1%) attended a workshop on AI in pharmacy. A small proportion of 48 (18.3%) have read articles on AI, while 5 (1.9%) have received verified certificates in AI. When considering future applications, 122 (46.6%) of participants would be open to using AI in clinical workflows for diagnostic purposes, while 140 (53.4%) remained hesitant. The details of the participants' practice towards AI are presented in Table 4.

Table 4. The practice of participants towards artificial intelligence.

Statement (s)	Yes n (%)	No n (%)
Have you ever applied AI technology in your studies?	240 (91.6)	22 (8.4)
Have you ever attended a workshop about AI in Pharmacy?	3 (1.1)	259 (98.9)
Have you ever read any article on AI in Pharmacy?	48 (18.3)	214 (81.7)
Have you ever received a verified certificate in AI?	5 (1.9)	257 (98.1)
In the future, as a pharmacist, would you consider using a clinical workflow where patient diagnostic information collected in the pharmacy is analyzed by AI?	122 (46.6)	140 (53.4)

3.5. Overall Knowledge, Attitude, and Practice towards Artificial Intelligence

Most participants, 186 (71.3%) had inadequate knowledge, 186 (71.3%) had negative attitudes, and 135 (51.7%) had bad practices regarding AI. The details of the participant's overall KAP concerning AI are presented in Table 5.

Table 5. Overall, knowledge, attitude, and practice towards artificial intelligence.

Variable	Good, n (%)	Inadequate, n (%)
Knowledge	75 (28.7)	186 (71.3)
Attitude	75 (28.7)	186 (71.3)
Practice	126 (48.3)	135 (51.7)

3.6. Relationship between Participant's Sociodemographic Characteristics and Level of Knowledge of Artificial Intelligence

There was no relationship between the participant's age, year of study, and residential address knowledge. However, there was a relationship between gender and the level of knowledge of AI among pharmacy students (Table 6). Most male students had good knowledge of AI compared to female students (Table 6).

Table 6. Relationship between participants' sociodemographic characteristics and level of knowledge of artificial intelligence.

Variable	Characteristics	Attributes	Good n (%)	Inadequate n (%)	X^2	*p*-value
Knowledge	Gender	Female	32 (20.78%)	122 (79.22%)	11.612	0.001
		Male	43 (40.19)	64 (59.81%)		
	Age (Years)	20 - 30	70 (29.66%)	166 (70.34%)	1.455	0.585
		31 - 40	5 (21.74%)	18 (78.26%)		
		41 - 50	5 (0.00%)	2 (100.00%)		
	Year of Study	Second	7 (26.92%)	19 (73.08%)	3.956	0.286
		Third	30 (24.79%)	91 (75.21%)		
		Fourth	36 (35.29%)	66 (64.71%)		
		Fifth	2 (16.67%)	10 (83.33%)		
	Residential Address	Urban	70 (30.17%)	162 (69.83%)	2.105	0.106
		Rural	5 (17.24%)	24 (82.76%)		

3.7. Relationship between Participants Sociodemographic Characteristics and Level of Attitude towards Artificial Intelligence

There was no relationship between the participant's age, year of study, and residential address with attitude. However, there was a relationship between the gender of students and their level of attitude towards AI (Table 7). Most male students had positive attitudes towards AI compared to female students (Table 7).

Table 7. Relationship between participants' sociodemographic characteristics and level of attitude regarding artificial intelligence.

Variable	Characteristics	Attributes	Positive n (%)	Negative n (%)	X^2	*p*-value
Attitude	Gender	Female	34 (22.08%)	120 (77.92%)	1.812	0.003
		Male	41 (38.32%)	66 (61.68%)		
	Age (Years)	20 - 30	68 (28.81%)	168 (71.19%)	0.521	0.813
		31 - 40	6 (26.09%)	17 (73.91%)		
		41 - 50	1 (50%)	1 (50%)		

Continued

Attitude	Year of Study	Second	6 (23.08%)	20 (76.92%)	7.379	0.069
		Third	30 (24.79%)	91 (75.2%)		
		Fourth	38 (37.25%)	64 (62.75%)		
		Fifth	1 (8.33%)	11 (91.67%)		
	Residential Address	Urban	66 (28.45%)	166 (71.55%)	0.084	0.0462
		Rural	9 (31.03%)	20 (68.97%)		

3.8. Relationship between Participant's Sociodemographic Characteristics and Level of Practice regarding Artificial Intelligence

There was no relationship between the participant's age and gender with practice towards AI. However, there was a relationship between the year of study and residential address with students' practice towards AI (Table 8). Fourth and fifth-year students and those residing in urban areas had good practices towards AI compared to their counterparts (Table 8).

Table 8. Relationship between participant's sociodemographic characteristics and level of practice regarding artificial intelligence.

Variable	Characteristics	Attributes	Good n (%)	Bad n (%)	X^2	*p*-value
Practice	Gender	Female	69 (44.81%)	85 (55.19%)		0.111
		Male	57 (53.27%)	50 (46.73%)		
	Age (Years)	20 - 30	111 (46.98%)	125 (53.02%)	1.609	0.467
		31 - 40	14 (60.87%)	9 (39.13%)		
		41 - 50	1 (50%)	1 (50%)		
	Year of Study	Second	11 (42.31%)	15 (57.69%)	8.991	0.028
		Third	48 (39.67%)	73 (60.33%)		
		Fourth	60 (58.82%)	42 (41.18%)		
		Fifth	7 (58.33%)	5 (41.67%)		
	Residential Address	Urban	118 (50.86%)	114 (49.14%)	5.593	0.014
		Rural	8 (27.59%)	21 (72.41)		

4. Discussion

To the best of the researcher's knowledge, this was the first study to assess the knowledge, attitudes, and practices regarding AI among pharmacy students at the University of Zambia.

In this study, a total sample of 262 participants was sampled, of which it was found that the majority were between the ages of 20 - 30 years (237, 90.4%) and 155 (59.2%) females. In terms of academic standing, the majority were third-year students (121, 46.2%), followed by fourth-year students (102, 38.9%). Additionally, it was found that most participants resided in urban areas (233, 88.9%). This demographic distribution provides a broad representation of younger students in

urban settings, particularly in their third and fourth years of study. A study that was conducted in the Middle East and North Africa (MENA) found that 615 (70.3%) of the respondents were females, which reflects the dominance of the female gender in the pharmaceutical sector at the educational level and were in the age group of 16 - 35 years (Hasan et al., 2024). Another study that was carried out in nine countries in the Middle East and North Africa (MENA) region showed that females outnumbered males, with 2768 (61.6%) female participants, and most of the respondents (3486,77.6%) living in urban areas (Allam et al., 2024: pp. 1-14). These sociodemographic characteristics show a relationship with the sociodemographic characteristics of this study and might have influenced the knowledge and attitude of participants.

The present study found high awareness of AI among pharmacy students. Our findings are in line with those reported in other studies in which high awareness regarding AI was recorded (Syed & Basil A. Al-Rawi, 2023; Hasan et al., 2024; Orok et al., 2024). In this study, it was found that most participants had inadequate knowledge of AI despite the majority having heard of AI and being aware of ChatGPT. The low knowledge of AI among pharmacy students was due to low scores in the application of AI and not learning AI in school. Additionally, a lack of knowledge concerning AI was noticed in most female pharmacy students (122, 79.22%). Moderate knowledge of AI among university students was reported in some studies (Hasan et al., 2024; Al-Qerem et al., 2023). A Nigerian study found good knowledge of AI among most pharmacy students (Orok et al., 2024). The findings in our study corroborate the results of a study in Nigeria that reported inadequate knowledge of AI among radiology students (Akinmoladun, Smart, & Atalabi, 2022: pp. 112-117). Another study which was done in Syria observed that 70% of students had a basic concept of AI, 65.3% had inadequate knowledge about machine learning (ML) and deep learning (DL), and only 23.7% had good knowledge about its applications (Swed et al., 2022) Another study carried out in the Middle East and North Africa (MENA) region found that a considerable proportion of the participants had inadequate knowledge of the fundamental computational principles of AI (36 5, 41.7%) (Johnson et al., 2021: pp. 86-93). Arab medical students had inadequate knowledge of AI because they never learned it in class (Allam et al., 2024: pp. 1-14). The findings reported in our study and similar studies indicate the need to introduce AI in university training to prepare students for its application during their work practice, similar to what was reported in other studies (Al-Qerem et al., 2023; Hasan et al., 2024; Hasan Sapci & Aylin Sapci, 2020; Sallam et al., 2023; Shahzad, Xu, & Javed, 2024; Sallam, Al-Farajat, & Egger, 2024: pp. 95-108).

The present study found that most students had negative attitudes towards AI. Having a negative attitude towards AI was reported more among female participants (120, 79.22%). In Nigeria, the majority of pharmacy students reported having positive attitudes towards AI (Orok et al., 2024). An international multinational study also found that most pharmacy students had positive attitudes towards AI

(Busch et al., 2024: pp. 649-661). Our findings are in contrast to those reported in Canada, in which most participants reported having positive attitudes (1595, 74.5%) towards the emerging role of AI in their respective fields (Teng et al., 2022). Another study was found in the Middle East and North Africa (MENA), where the majority of participants had positive attitudes toward AI (593, 67.8%) and believed that AI would improve and revolutionize clinical pharmacy practice (Hasan et al., 2024). In Saudi Arabia, most pharmacy students reported having positive attitudes toward AI (Syed & Basil A. Al-Rawi, 2023). Similar to our study, concerns about the impact of AI on job security and patient safety have been reported, and students have viewed AI as a competitor that will take over their jobs in the future (Hasan et al., 2024). These findings are in contrast to those reported in Australia, where the majority of medical students felt that AI would not take their future jobs (Stewart et al., 2023). Another study found that pharmacy students and staff were worried that AI might take over their jobs and were also concerned with patient safety (Hasan et al., 2024).

In this study, most of the students had a suboptimal practice towards AI. The present study found that most third-year students (73, 60.33%) exhibited suboptimal practices towards AI compared to students in other years of study. Additionally, the practice was also linked with residence, in which most students who resided in rural areas (114, 49.14%) exhibited bad practices towards AI. A previous study highlighted inadequate practice regarding AI, citing a lack of skills and noting that participants had no prior experience using and working with AI (Mousavi Baigi et al., 2023). In another study, most participants indicated they would be considered using a clinical workflow where a patient's diagnostic information is analyzed by AI and then reviewed by a specialized pharmacist (Hasan et al., 2024). This is in contrast to the current study, where a small number expressed their willingness to use this workflow. In contrast to this study, a significant proportion of Palestinian pharmacy students in the West Bank of Palestine demonstrated greater confidence in utilizing AI programs for drafting research articles (Mosleh et al., 2023: pp. 1391-1400). The incorporation of AI in pharmacy practice still remains low, with many gaps in understanding AI and adopting it in real practice (Hasan et al., 2024; Aziz et al., 2024). There are also still debates on the use of AI in pharmacy writing and research that need urgent attention and guidance (Weidmann, 2024: pp. 751-754; Mortlock & Lucas, 2024). Nevertheless, the pharmacy fraternity needs to remain proactive and at the centre of discussions regarding AI, its revolutionizing of the industry, and how it affects the future of pharmacy practice (Cain, Malcom, & Aungst, 2023; Khan et al., 2023: pp. 32-40; Chalasani et al., 2023).

We recommend the incorporation of AI into pharmacy curricula by implementing fundamental courses on AI principles and healthcare applications, highlighting practical examples. The integration of AI into the pharmacy curricula should include theoretical and practical topics on the use of AI in drug discovery and development, research, and development, clinical trial optimization,

personalized medicine, automated dispensing, medication management, pharmacovigilance, virtual assistants, inventory management, workflow optimization, disease diagnosis, medication adherence apps, personalized health advice, and addressing antimicrobial resistance (AMR). Additionally, it will be critical to enhance practical comprehension via experiential seminars and encounters with AI tools, promoting AI-centric projects. There is a need to encourage transdisciplinary courses in computer science by inviting specialists to examine AI's influence on pharmacy practice. We need to provide ongoing education for chemists to enhance AI competencies, promoting lifetime learning and flexibility to technological progress. However, there is a need to confront the adverse perceptions by conducting lectures on the ethical and societal implications of AI, emphasizing successful case studies. There is also a need to conduct qualitative studies to understand the reasons for inadequate knowledge, negative attitudes, and poor practices towards AI among pharmacy students.

Limitations of the Study

We are aware that our study had some limitations. Being a cross-sectional study, we believe that recall bias could have occurred in which students may not have accurately remembered their past interactions or experiences with AI tools, thus affecting the authenticity of their responses. The study's focus on a single institution may restrict the generalisability of the results to other pharmacy institutions in Zambia. Additionally, the findings suggest that integrating AI education into pharmacy curricula is still lacking, which may hinder students' readiness to adopt AI in their professional practice. The findings also indicate that exposure to AI concepts among pharmacy students has been relatively low, suggesting a potential gap in both educational and institutional support.

5. Conclusion

This study revealed that most pharmacy students exhibited inadequate knowledge of AI and had a limited understanding of and formal education on its deeper concepts. The study also found that most pharmacy students had negative attitudes and suboptimal practices towards the applications of AI, demonstrating the need for more education and exposure to its use in the pharmacy profession. Additional efforts are needed to enhance students' knowledge of AI, particularly its significance and advantages within the healthcare system. In the future, there is a need to expand the study to include remote and rural areas across the country. This will ensure the collection of more comprehensive data that better represents the broader population of pharmacy students, providing deeper insights into their perception of KAP related to AI. Integrating AI-related workshops, seminars, and online courses into the pharmacy curricula can increase students' awareness and understanding of AI applications in healthcare. Finally, there is a need to incorporate a hybrid data collection method that combines both physical and digital surveys in future studies, allowing students from different locations, including

those with limited physical access, to participate, thus broadening the study's reach.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Akinmoladun, J. A., Smart, A. E., & Atalabi, O. M. (2022). Knowledge, Attitude, and Perception of Radiologists about Artificial Intelligence in Nigeria. *West African Journal of Radiology, 29,* 112-117. https://doi.org/10.4103/wajr.wajr_42_21

Albayati, H. (2024). Investigating Undergraduate Students' Perceptions and Awareness of Using ChatGPT as a Regular Assistance Tool: A User Acceptance Perspective Study. *Computers and Education: Artificial Intelligence, 6,* Article 100203. https://doi.org/10.1016/j.caeai.2024.100203

Allam, A. H., Eltewacy, N. K., Alabdallat, Y. J., Owais, T. A., Salman, S., Ebada, M. A. et al. (2024). Knowledge, Attitude, and Perception of Arab Medical Students towards Artificial Intelligence in Medicine and Radiology: A Multi-National Cross-Sectional Study. *European Radiology, 34,* 1-14. https://doi.org/10.1007/s00330-023-10509-2

Al-Qerem, W., Eberhardt, J., Jarab, A., Al Bawab, A. Q., Hammad, A., Alasmari, F. et al. (2023). Exploring Knowledge, Attitudes, and Practices towards Artificial Intelligence among Health Professions' Students in Jordan. *BMC Medical Informatics and Decision Making, 23,* Article No. 288. https://doi.org/10.1186/s12911-023-02403-0

Aziz, M. H. A., Rowe, C., Southwood, R., Nogid, A., Berman, S., & Gustafson, K. (2024). A Scoping Review of Artificial Intelligence within Pharmacy Education. *American Journal of Pharmaceutical Education, 88,* Article 100615. https://doi.org/10.1016/j.ajpe.2023.100615

Busch, F., Hoffmann, L., Truhn, D., Palaian, S., Alomar, M., Shpati, K. et al. (2024). International Pharmacy Students' Perceptions towards Artificial Intelligence in Medicine—A Multinational, Multicentre Cross-Sectional Study. *British Journal of Clinical Pharmacology, 90,* 649-661. https://doi.org/10.1111/bcp.15911

Cain, J., Malcom, D. R., & Aungst, T. D. (2023). The Role of Artificial Intelligence in the Future of Pharmacy Education. *American Journal of Pharmaceutical Education, 87,* Article 100135. https://doi.org/10.1016/j.ajpe.2023.100135

Caucheteux, C., Hodgkins, L., Batifol, V., Fouché, L., & Romero, M. (2024). Students' Perspective on the Use of Artificial Intelligence in Education. In A. Urmeneta, & M. Romero (Eds.), *Creative Applications of Artificial Intelligence in Education* (pp. 101-113). Springer. https://doi.org/10.1007/978-3-031-55272-4_8

Chalasani, S. H., Syed, J., Ramesh, M., Patil, V., & Pramod Kumar, T. M. (2023). Artificial Intelligence in the Field of Pharmacy Practice: A Literature Review. *Exploratory Research in Clinical and Social Pharmacy, 12,* Article 100346. https://doi.org/10.1016/j.rcsop.2023.100346

Chan, C. K. Y., & Hu, W. (2023). Students' Voices on Generative AI: Perceptions, Benefits, and Challenges in Higher Education. *International Journal of Educational Technology in Higher Education, 20,* Article No. 43. https://doi.org/10.1186/s41239-023-00411-8

Hasan Sapci, A., & Aylin Sapci, H. (2020). Artificial Intelligence Education and Tools for Medical and Health Informatics Students: Systematic Review. *JMIR Medical Education, 6,* e19285. https://doi.org/10.2196/19285

Hasan, H. E., Jaber, D., Al Tabbah, S., Lawand, N., Habib, H. A., & Farahat, N. M. (2024). Knowledge, Attitude and Practice among Pharmacy Students and Faculty Members

towards Artificial Intelligence in Pharmacy Practice: A Multinational Cross-Sectional Study. *PLOS ONE, 19,* e0296884. https://doi.org/10.1371/journal.pone.0296884

Ibrahim, H., Liu, F., Asim, R., Battu, B., Benabderrahmane, S., Alhafni, B. et al. (2023). Perception, Performance, and Detectability of Conversational Artificial Intelligence across 32 University Courses. *Scientific Reports, 13,* Article No. 12187. https://doi.org/10.1038/s41598-023-38964-3

Jackson, P., Ponath Sukumaran, G., Babu, C., Tony, M. C., Jack, D. S., Reshma, V. R. et al. (2024). Artificial Intelligence in Medical Education-Perception among Medical Students. *BMC Medical Education, 24,* Article No. 804. https://doi.org/10.1186/s12909-024-05760-0

Jaiteh, J., Hasan, M., Karim, A., Mamun, M. A. A., & Khan, M. S. H. (2024). Students' Perceptions of Using Artificial Intelligence in Tertiary Education. In T. Cochrane, V. Narayan, E. Bone, C. Deneen, M. Saligari, K. Tregloan, & R. Vanderburg (Eds.), *Navigating the Terrain: Emerging Frontiers in Learning Spaces, Pedagogies, and Technologies* (pp. 506-511). ASCILITE Publications. https://doi.org/10.14742/apubs.2024.1233

Jaldi, A. (2023). *Artificial Intelligence Revolution in Africa: Economic Opportunities and Legal Challenges*. https://www.policycenter.ma/publications/artificial-intelligence-revolution-africa-economic-opportunities-and-legal-challenges

Jebreen, K., Radwan, E., Kammoun-Rebai, W., Alattar, E., Radwan, A., Safi, W. et al. (2024). Perceptions of Undergraduate Medical Students on Artificial Intelligence in Medicine: Mixed-Methods Survey Study from Palestine. *BMC Medical Education, 24,* Article No. 507. https://doi.org/10.1186/s12909-024-05465-4

Johnson, K. B., Wei, W., Weeraratne, D., Frisse, M. E., Misulis, K., Rhee, K. et al. (2021). Precision Medicine, AI, and the Future of Personalized Health Care. *Clinical and Translational Science, 14,* 86-93. https://doi.org/10.1111/cts.12884

Joskow, J., & Yamane, T. (1965). Statistics, an Introductory Analysis. *Journal of the American Statistical Association, 60,* 678-680. https://doi.org/10.2307/2282703

Khan, O., Parvez, M., Kumari, P., Parvez, S., & Ahmad, S. (2023). The Future of Pharmacy: How AI Is Revolutionizing the Industry. *Intelligent Pharmacy, 1,* 32-40. https://doi.org/10.1016/j.ipha.2023.04.008

Lubowitz, J. H. (2023). ChatGPT, an Artificial Intelligence Chatbot, Is Impacting Medical Literature. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 39,* 1121-1122. https://doi.org/10.1016/j.arthro.2023.01.015

Marrone, R., Zamecnik, A., Joksimovic, S., Johnson, J., & De Laat, M. (2024). Understanding Student Perceptions of Artificial Intelligence as a Teammate. *Technology, Knowledge and Learning*. https://doi.org/10.1007/s10758-024-09780-z

Menke, J., Homberg, S., & Koch, O. (2023). Introduction to Artificial Intelligence and Deep Learning Using Interactive Electronic Programming Notebooks. *Archiv der Pharmazie, 356,* Article 2200628. https://doi.org/10.1002/ardp.202200628

Mortlock, R., & Lucas, C. (2024). Generative Artificial Intelligence (Gen-AI) in Pharmacy Education: Utilization and Implications for Academic Integrity: A Scoping Review. *Exploratory Research in Clinical and Social Pharmacy, 15,* Article 100481. https://doi.org/10.1016/j.rcsop.2024.100481

Mosleh, R., Jarrar, Q., Jarrar, Y., Tazkarji, M., & Hawash, M. (2023). Medicine and Pharmacy Students' Knowledge, Attitudes, and Practice Regarding Artificial Intelligence Programs: Jordan and West Bank of Palestine. *Advances in Medical Education and Practice, 14,* 1391-1400. https://doi.org/10.2147/amep.s433255

Mousavi Baigi, S. F., Sarbaz, M., Ghaddaripouri, K., Ghaddaripouri, M., Mousavi, A. S., & Kimiafar, K. (2023). Attitudes, Knowledge, and Skills towards Artificial Intelligence among Healthcare Students: A Systematic Review. *Health Science Reports, 6,* e1138. https://doi.org/10.1002/hsr2.1138

Mudenda, S., & Mohamed, S. (2024). Leveraging Artificial Intelligence and Machine Learning in Predicting and Managing Pandemics: Lessons Learnt and Future Implications in the Healthcare Sector. *Scholars Academic Journal of Biosciences, 12,* 16-21. https://doi.org/10.36347/sajb.2024.v12i01.003

Mudenda, S., Daka, V., Mufwambi, W., Matafwali, S. K., Chabalenge, B., Skosana, P. et al. (2023). Student's Perspectives, Satisfaction and Experiences with Online and Classroom Learning during the COVID-19 Pandemic: Findings and Implications on Blended Learning. *SAGE Open Medicine, 11,* 1-12. https://doi.org/10.1177/20503121231218904

Orok, E., Okaramee, C., Egboro, B., Egbochukwu, E., Bello, K., Etukudo, S. et al. (2024). Pharmacy Students' Perception and Knowledge of Chat-Based Artificial Intelligence Tools at a Nigerian University. *BMC Medical Education, 24,* Article No. 1237. https://doi.org/10.1186/s12909-024-06255-8

Peres, R., Schreier, M., Schweidel, D., & Sorescu, A. (2023). On ChatGPT and Beyond: How Generative Artificial Intelligence May Affect Research, Teaching, and Practice. *International Journal of Research in Marketing, 40,* 269-275. https://doi.org/10.1016/j.ijresmar.2023.03.001

Sallam, M., Al-Farajat, A., & Egger, J. (2024). Envisioning the Future of ChatGPT in Healthcare: Insights and Recommendations from a Systematic Identification of Influential Research and a Call for Papers. *Jordan Medical Journal, 58,* 95-108. https://doi.org/10.35516/jmj.v58i1.2285

Sallam, M., Salim, N., Barakat, M., & Al-Tammemi, A. (2023). ChatGPT Applications in Medical, Dental, Pharmacy, and Public Health Education: A Descriptive Study Highlighting the Advantages and Limitations. *Narra J, 3,* e103. https://doi.org/10.52225/narra.v3i1.103

Seo, K., Tang, J., Roll, I., Fels, S., & Yoon, D. (2021). The Impact of Artificial Intelligence on Learner-Instructor Interaction in Online Learning. *International Journal of Educational Technology in Higher Education, 18,* Article No. 54. https://doi.org/10.1186/s41239-021-00292-9

Shahzad, M. F., Xu, S., & Javed, I. (2024). ChatGPT Awareness, Acceptance, and Adoption in Higher Education: The Role of Trust as a Cornerstone. *International Journal of Educational Technology in Higher Education, 21,* Article No. 46. https://doi.org/10.1186/s41239-024-00478-x

Stewart, J., Lu, J., Gahungu, N., Goudie, A., Fegan, P. G., Bennamoun, M. et al. (2023). Western Australian Medical Students' Attitudes towards Artificial Intelligence in Healthcare. *PLOS ONE, 18,* e0290642. https://doi.org/10.1371/journal.pone.0290642

Swed, S., Alibrahim, H., Elkalagi, N. K. H., Nasif, M. N., Rais, M. A., Nashwan, A. J. et al. (2022). Knowledge, Attitude, and Practice of Artificial Intelligence among Doctors and Medical Students in Syria: A Cross-Sectional Online Survey. *Frontiers in Artificial Intelligence, 5,* Article 1011524. https://doi.org/10.3389/frai.2022.1011524

Syed, W., & Basil A. Al-Rawi, M. (2023). Assessment of Awareness, Perceptions, and Opinions towards Artificial Intelligence among Healthcare Students in Riyadh, Saudi Arabia. *Medicina, 59,* Article 828. https://doi.org/10.3390/medicina59050828

Teng, M., Singla, R., Yau, O., Lamoureux, D., Gupta, A., Hu, Z. et al. (2022). Health Care Students' Perspectives on Artificial Intelligence: Countrywide Survey in Canada. *JMIR Medical Education, 8,* e33390. https://doi.org/10.2196/33390

Weidmann, A. E. (2024). Artificial Intelligence in Academic Writing and Clinical Pharmacy Education: Consequences and Opportunities. *International Journal of Clinical Pharmacy, 46,* 751-754. https://doi.org/10.1007/s11096-024-01705-1

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic Review of Research on Artificial Intelligence Applications in Higher Education—Where Are the Educators? *International Journal of Educational Technology in Higher Education, 16,* Article No. 39. https://doi.org/10.1186/s41239-019-0171-0