Knowledge, Attitudes, and Practices of Pharmacy Professionals on Artificial Intelligence: Findings and Implications in Zambia

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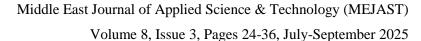
ABSTRACT

Technological advancements have significantly transformed human activities, evolving from manual labour from the Stone Age to modern times. The advanced automation of machines now enhances efficiency and reduces the time required for complex tasks. Despite the growing global integration of Artificial Intelligence (AI) in healthcare, there is still a paucity of information on the knowledge, attitudes, and practices regarding AI among pharmacy professionals in Zambia. Therefore, this study aimed to evaluate the knowledge, attitudes, and practices regarding AI among pharmacy personnel in Zambia. A cross-sectional study was conducted among 316 pharmacy professionals in Zambia between August and September 2024. Data were collected using a structured questionnaire and analyzed using the Statistical Package for Social Sciences (SPSS) version 25.0. Of the 316 participants, 108 (34.2%) were aged 20–25 years. The majority of the participants demonstrated good knowledge 202 (64.0%), 284 (90.0%) exhibited positive attitudes, and 216 (68.4%) reported good practices to AI. Statistical analysis revealed significant associations between knowledge and age ($p = 0.031$) and between practice and gender ($p = 0.002$). Most pharmacy professionals in Zambia displayed good knowledge, positive attitudes, and good AI-related practices. Knowledge was significantly associated with age, while practice was influenced by gender. Despite these promising findings, there is a need to further promote AI adoption in pharmacy to enhance patient outcomes. Additionally, educational initiatives and awareness programs should be implemented to ensure pharmacy personnel fully understand AI's role and benefits in healthcare.

Keywords: Artificial Intelligence; Pharmacy Professionals; Knowledge; Attitudes; Practices; Healthcare Technology; Digital Health; AI Adoption; Pharmacy Education; Health Informatics; AI Awareness; Zambia.

1. Background

Artificial intelligence (AI) refers to the intelligence demonstrated by machines or software, distinguishing it from human intelligence (Sheikh et al., 2023; Helm et al., 2020; Hamet and Tremblay, 2017). It is defined as the capability of a computer system to achieve human-like performance in cognitive tasks (Sheikh et al., 2023). As a branch of computer science, AI focuses on developing intelligent machines capable of learning, reasoning, and problem-solving (Davenport & Kalakota, 2019). The field of AI was formally established in 1956 (Russell & Norvig, 2003). Over the years, it has experienced cycles of rapid growth followed by stagnation, known as "AI winters" (Haigh, 2024a; Haigh, 2024b).

AI is widely utilized across multiple sectors, including government, industry, and scientific research (Rajpurkar et al., 2022; Amisha et al., 2019). Key examples include sophisticated search engines like Google, personalized recommendation systems such as those used by Amazon and Netflix, virtual assistants like Siri and Alexa, autonomous vehicles (Waymo), and creative AI applications, such as ChatGPT and AI-generated art (Russell & Norvig, 2003). AI has permeated multiple fields, from engineering to medicine, significantly impacting scientific and technological advancements (Sahu et al., 2022). It enables computers to execute tasks traditionally requiring human cognition, such as learning, language processing, perception, problem-solving, and numerical computations (Nelson et al., 2020). In healthcare, AI is transforming the community and clinical pharmacy sector ensuring

seamless and efficient services (Jarab et al., 2023; Raza et al., 2022). This technology has reportedly been used in universities among medical and pharmacy students (Mudenda et al., 2025; Hasan et al., 2024; Mudenda et al., 2024).

AI-driven technologies have been integrated into diverse professional fields, including law, finance, and industry (Babashahi et al., 2024). The medical sector has particularly benefited from AI advancements, with applications in oncology for cancer diagnosis and grading (Londhe & Bhasin, 2019), e-learning systems in education (Khumrin et al., 2017), endoscopic gastroenterology for detecting pathological lesions (Alagappan et al., 2018), and radiology for cancer imaging and interpretation (Hosny et al., 2018). While AI is becoming more embedded in healthcare, its implementation in medical training remains limited (Park et al., 2021).

On a global scale, AI is poised to revolutionize healthcare by enhancing crisis management and disease prevention (Karim et al., 2020). Many healthcare systems now use AI for patient data storage and technological advancements (Raza et al., 2022; Yu et al., 2018). In Saudi Arabia, AI is playing a pivotal role in advancing patient care initiatives (Wu et al., 2019). In Jordan, most pharmacists supported the use of ChatGPT but cautioned on the ethical, legal, accuracy of data generated, privacy, worries, bias risk, data learning issues that may arise due to the use of AI (Abu Hammour et al., 2023). Alongside this, ethical concerns and inadequate training remains among the major barriers regarding the practical implementation of AI in pharmacy practice (Alghitran et al., 2025).

In Africa, the adoption of AI is growing. Kenya piloted AI in healthcare in the mid-1980s, leading to improvements in patient interaction (Mitchell & Kan, 2019). Based on a global survey, Nigeria has leveraged AI in the pharmaceutical industry, with notable contributions such as Adebayo Alonge's 2019 award-winning AI-driven drug authentication system (Tran et al., 2019). However, documentation of AI applications in Zambia's healthcare sector remains scarce. This study aimed to assess the knowledge, attitudes, and practices of AI among pharmacy professionals in Zambia.

1.1. Study objectives

1) To assess the level of knowledge about artificial intelligence among pharmacy professionals in Zambia.

2) To determine the attitudes of pharmacy professionals towards the use and integration of AI in healthcare practice.

3) To evaluate the current practices of pharmacy professionals in utilizing artificial intelligence in their professional roles.

4) To examine the association between demographic characteristics (e.g., age, gender, education level) and the knowledge, attitudes, and practices (KAP) of pharmacy professionals regarding AI.

5) To identify potential barriers and facilitators to the adoption and implementation of AI technologies among pharmacy personnel in Zambia.

6) To generate evidence-based recommendations for policymakers and educators to promote the integration of AI in pharmacy education and practice in Zambia.

2. Materials and Methods

2.1. Study Design

This descriptive cross-sectional study was conducted among pharmacy personnel in Zambia from April to October 2024. The study was conducted in Zambia, a landlocked country in southern Africa, comprising ten provinces including Southern, Northern, Luapula, Lusaka, Central, Copperbelt, Muchinga, Northwestern, Eastern, and Western. Pharmacy personnel, responsible for dispensing and managing medications, were targeted across different fields. The study included pharmacy personnel actively practising in Zambia during the data collection period. Pharmacy personnel who were unavailable during the study period were excluded from this study.

2.2. Sample size estimation and sampling technique

The sample was estimated using Cochran's formula, as previously explained by Charan and Biswas (Charan & Biswas, 2013). With no previous study done among non-healthcare students in Zambia, we employed a conservative prevalence of 50% at a 95% CI and a 5% margin of error. This resulted in a minimum of 385 participants being included in the study, however, only 316 participants were enrolled in this study. A simple random sampling method was used, allowing all eligible pharmacy personnel to participate.

2.3. Data Collection Tool

The questionnaire was adapted from a similar study conducted in Syria on AI knowledge, attitudes, and practices (Swed et al., 2022) and modified to align with the University of Zambia's standards. To ensure broad participation, an online questionnaire was distributed through various digital platforms. It comprised four sections: **Section A:** Socio-demographic characteristics of participants; **Section B:** Knowledge of AI among pharmacy professionals; **Section C:** Attitude towards AI among pharmacy professionals; and **Section D:** AI-related practices among pharmacy professionals.

2.4. Data Analysis

The collected data were verified for accuracy, entered into Microsoft Excel, and analyzed using the IBM Statistical Package for Social Sciences (SPSS) version 25.0. Statistical significance was determined at a 95% confidence level ($p = 0.05$), and Chi-square tests were used to assess relationships between categorical variables.

2.5. Ethical Approval

Participation in the study was voluntary, and responses were anonymized using coded questionnaires. Ethical approval was obtained from the University of Zambia Health Sciences Research Ethics Committee (UNZAHSREC) under Protocol ID 20231270135 and NHRA number NHRA5937/13/08/2024. Participants were informed of the study's objectives through an information sheet and consent form. Confidentiality was maintained, and while there were no direct financial benefits for participation, the findings are a can contribution to AI knowledge dissemination among Zambian policymakers.

3. Results

3.1. Sociodemographic characteristics of study participants (N=316)

Among the 316 study participants, giving a response rate of 82.1% from a target of 385 participants, the majority (34.2%) were aged 20-25 years. The gender distribution was nearly balanced, with 162 males (51.3%) and 154 females (48.7%). Regarding professional qualifications, pharmacists comprised 80.4% (n=254), while pharmacy technologists accounted for 19.6% (n=62). Most participants were employed (63.9%), whereas 36.1% were unemployed. Detailed sociodemographic characteristics are presented in Table 1. Overall, 63.9% of the participants had good knowledge of AI, 89.9% had a positive attitude, and 68.4% exhibited good AI practices.

Table 1. Sociodemographic Characteristics of Study Participants

Variable	Attribute	Frequency (n=316)	Percentage (%)
Gender	Male	162	51.3
	Female	154	48.7
Age Group (years)	20-25	108	34.2
	26-30	85	26.9
	31-35	57	18.0
	36-40	37	11.7
	Above 41	29	9.2
Qualification	Pharmacist	254	80.4
	Pharmacy Technologist	62	19.6
Employment Status	Employed	202	63.9
	Unemployed	114	36.1

3.2. Knowledge of AI among study participants

The majority of the participants (88.0%) had heard about AI, primarily through the internet (64.6%). Other sources included friends (8.2%), ChatGPT (3.2%), school (2.5%), and phone (2.5%). However, 68.4% lacked knowledge of AI applications in pharmacy. Among those who knew about the application of AI in the field of pharmacy, most responded that AI was used for research (8.7%), drug design and discovery (8.2%), dispensing (3.2%), and disease treatment (1.6%). Notably, 73.1% had not received AI-related education during training or practice. The details of the participants' knowledge of AI are represented in Table 2.

Table 2. Knowledge of pharmacy personnel on artificial intelligence

Knowledge questions	Attribute	Frequency	Percent
Do you know what Artificial Intelligence (AI) is?	No	38	12.0
	Yes	278	88.0
If the answer is yes, what was your source of information?	Article	3	0.9
	Chat GPT	10	3.2
	Chatbots	1	0.3
	Friends	26	8.2

	Internet	204	64.6
	LinkedIn	1	0.3
	Meta	6	1.9
	NA	47	14.9
	Phone	8	2.5
	School	8	2.5
	Scientific conference	1	0.3
	Work	1	0.3
Do you know about the application of AI in the pharmacy field?	No	216	68.4
	Yes	100	31.6
If yes, specify	Clinical information	1	0.3
	Dispensing	10	3.2
	Doing the work of pharmacy personnel	1	0.3
	Drug design and discovery	26	8.6
	Helps in finding information relating to pharmacy	1	0.3
	In warehousing	1	0.3
	Inventory management	1	0.3
	It involved machine learning, computer vision, and robotics	1	0.3
	Management of pharmaceuticals at the district level	1	0.3
	NA	236	74.7
	Pharmaceutical	1	0.3
	Research	28	8.7
	Supply chain	1	0.3
	Tele pharmacy	1	0.3
	Treatment of diseases	5	1.6
	Use in stock management	1	0.3
Have you been told about AI during training or practice?	No	231	73.1
	Yes	85	26.9

3.3. Attitudes of participants towards AI

Most participants (81.6%) considered AI essential in their workplaces, while 80.1% did not believe AI would replace pharmacy personnel. Additionally, 87.7% agreed AI could enhance pharmacy services if widely adopted. AI was deemed useful in dispensing (64.2%) and managing expiries/new stock (72.2%). Furthermore, 81.6% felt AI would not burden the profession. Detailed responses are in Table 3.

Table 3. Attitude of Participants on Artificial Intelligence

Attitude questions	Attribute	Frequency	Percentage
Do you think AI is essential at your workplace?	No	58	18.4
	Yes	258	81.6
Do you believe or think that AI will replace pharmacy personnel in their workplaces?	No	253	80.1
	Yes	63	19.9
Do you think AI will render more help to pharmacy personnel if it's to be used widely?	No	39	12.3
	Yes	277	87.7
Do you think AI is essential in the field of dispensing?	No	113	35.8
	Yes	203	64.2
Do you think AI is essential in recording expiries and new stock received?	No	88	27.8
	Yes	228	72.2
According to you, do you think AI would be a burden to the profession?	No	258	81.6
	Yes	58	18.4

3.4. Practices of Participants Regarding AI

Exactly half (50.0%) of the participants had applied AI in their practice. A majority (59.8%) believed AI integration would not lead to frequent errors, whereas 40.2% thought otherwise. Participants reported using AI mainly in research (16.5%), dispensing (7.6%), and school-related activities (14.9%). Additionally, 76.6% expressed a willingness to support AI programs in the future. Table 4 outlines participants' AI-related practices.

Table 4. The practice of participants on Artificial Intelligence

Practice questions	Attribute	Frequency	Percentage
Have you applied or used AI in your practice?	No	158	50.0
	Yes	158	50.0
Do you think AI can bring about a lot of errors when fully incorporated into the system?	No	189	59.8
	Yes	127	40.2
If yes, was it easy to use AI	No	176	55.7
	Yes		44.3
Which area did you use AI in?	Batch recognition	1	0.3
	Customer service and Framework preparation for a long-term contract.	1	0.3

		Dispensing	24	7.6
		Dosage	1	0.3
		Drug interaction	5	1.6
		Logistics	4	1.3
		None	169	53.5
		Phone	1	0.3
		Practice	1	0.3
		Research	52	16.5
		School	47	14.9
		Treatment of certain diseases	7	2.2
		Work	3	0.9
Would you like to support AI programs in the future?		No	74	23.4
		Yes	242	76.6

3.5. Relationship between Participant's Sociodemographic Characteristics and Knowledge of AI

There was a relationship between the age of participants and their knowledge of AI ($p = 0.031$), indicating that younger participants (40.1%) had higher knowledge compared to other age groups. There was a relationship between the participant's gender and practices regarding AI ($p=0.002$), as shown by most males who had used AI compared to females. Table 5 presents these findings.

Table 5. Shows the association between participants' sociodemographic characteristics and their level of Knowledge of AI

Variable	Characteristics	Attributes	Good n (%)	Poor n (%)	*p-value*
Knowledge	Gender	Male	110(54.5)	52(45.6)	0.082
		Female	92(45.5)	62(54.4)	
	Age (years)	20-25	81(40.1)	27(23.7)	0.031
		26-30	45(22.3)	40(35.1)	
		31-35	36(17.8)	21(18.4)	
		36-40	23(11.4)	14(12.3)	
		Above 41	17(8.41)	12(10.5)	
Attitude	Gender	Male	150(53.5)	12(37.5)	0.072
		Female	134(47.2)	20(62.5)	
Practices	Gender	Male	123(56.9)	39(39)	0.002
		Female	93(43.1)	61(61)	

4. Discussion

To our knowledge, this is the first study in Zambia to assess the knowledge, attitudes, and practices regarding AI among pharmacy professionals. A total of 316 participants were included, with the majority (34.2%) aged 20–25 years, while the least represented group was those above 41 years (9.2%). A comparable study conducted in Dakshina Kannada, India, identified the highest proportion of participants in the 25–34 age group (24.9%) (Bhat, Nayak, & Shabaraya, 2024). A similar study performed in Pakistan revealed that 17.6% of pharmacists were aged 20-25 years (Nesar et al., 2024). Likewise, research in the Middle East and North Africa (MENA) region reported that the youngest age group had the highest representation (Allam et al., 2023).

In terms of employment status, 63.9% of participants were employed, while 36.1% were unemployed. The majority were pharmacists (80.4%), with pharmacy technologists making up 19.6%. Gender distribution was nearly equal, with males accounting for 51.3% and females 48.7%. A study in Dakshina Kannada similarly reported a higher male representation (69.7%) (Bhat, Nayak, & Shabaraya, 2024). However, in contrast, a study in the MENA region showed female dominance (70.3%) in the pharmaceutical sector (Mousavi Baigi et al., 2023). These demographic trends may have influenced the participants' knowledge, perspectives, and interactions with AI.

In this study, most participants (88.0%) had heard of artificial intelligence (AI), with the internet being the primary source of information (64.6%), followed by friends, ChatGPT, and academic institutions. These findings are consistent with a study conducted in Dakshina Kannada, where 89.6% of pharmacists were aware of AI, with online media cited as the most common source (29.9%) (Bhat, Nayak, & Shabaraya, 2024).

Despite the high level of awareness, only 31.6% of participants in our study were familiar with AI applications in the pharmacy profession. A study conducted in Jordan, Palestine, Lebanon, Egypt, Saudi Arabia, and Libya found moderate knowledge of AI among pharmacy students and faculty (Hasan et al., 2024).

In our study, a statistically significant correlation was observed between age and AI knowledge ($p = 0.031$), with younger participants exhibiting better understanding. This may be attributed to their increased exposure to digital technologies, online learning platforms, and AI-driven tools in both academic and everyday contexts. In contrast, older participants may have had fewer opportunities for AI-related training, highlighting a generational gap in AI literacy.

These findings suggest the need for targeted education and upskilling initiatives, particularly for older and mid-career healthcare professionals to ensure equitable integration of AI in pharmacy and healthcare practice. This is similar to findings from previous studies in which authors recognised the importance of providing educational and training programs to improve pharmacists' knowledge of AI (Taha et al., 2024; Jarab et al., 2023).

Our study found that the majority of participants (81.6%) believed AI was essential in the workplace, while 80.1% disagreed with the notion that AI would replace pharmacy personnel. This contrasts with findings from a study in Pakistan, where 59.5% of healthcare professionals believed AI could replace some jobs (Habib et al., 2024). Additionally, 81.4% of participants in our study did not perceive AI as a burden to the pharmacy profession. Similar sentiments were reflected in a study from Dakshina Kannada, where 44.8% of participants believed that AI would benefit the pharmacy profession (Bhat, Nayak, & Shabaraya, 2024).

Overall, 89.9% of our participants exhibited a positive attitude toward AI. Our findings are similar to previous studies found among community pharmacists in which most participants had positive attitudes towards AI (Sendekie et al., 2024; Jarab et al., 2023). This aligns with a multi-country study involving pharmacy students and faculty from Jordan, Palestine, Lebanon, Egypt, Saudi Arabia, and Libya, where participants recognized the potential benefits of AI but expressed concerns about patient safety and job security (Hasan et al., 2024).

These findings emphasize the growing acceptance of AI among pharmacy professionals in Zambia and underscore the importance of integrating AI literacy into pharmacy education and workforce development to harness its full potential while addressing associated concerns. Similar findings were reported in Jordan indicating a need to leverage AI in the profession of pharmacy (Abu-Farha et al., 2024). A study in Ethiopia also found high willingness and perceptions of community pharmacists to use AI in their practice (Sendekie et al., 2024).

In this study, half (50%) of the participants reported using AI in their workplace, primarily for dosage calculations, dispensing, and batch recognition. A similar study found that participants believed that AI can boost up the efficiency of healthcare providers, reduce their workload, save time and minimize medical errors (Yousif et al., 2024). In contrast, a study conducted in Dakshina Kannada found that only 15% of pharmacists utilized AI tools at work (Bhat, Nayak, & Shabaraya, 2024). Overall, 68.4% of participants in our study demonstrated good AI practices, while 31.6% exhibited poor practices. The gaps in practices observed in our study and similar studies call for strengthened training and improvement in curricula regarding the use of AI in the healthcare system (Mousavi Baigi et al., 2023). These findings highlight a growing acceptance and integration of AI in pharmacy practice in Zambia, but also point to the need for structured training and capacity building to close existing knowledge and practice gaps, especially as AI continues to reshape healthcare delivery.

4.1. Limitations

The study faced challenges with participant recruitment, as some pharmacy personnel were unwilling to participate, and others discouraged their colleagues from taking part.

5. Conclusion

This study highlights growing awareness and positive attitudes toward artificial intelligence (AI) among pharmacy personnel in Zambia, with 88% having heard of AI and 89.9% expressing favourable perceptions. While half of the participants reported using AI in their practice and 68.4% demonstrated good AI-related practices, only 31.6% had adequate knowledge of AI applications in pharmacy. These findings underscore the need to integrate AI education into pharmacy curricula and provide targeted training to bridge existing knowledge and practice gaps. Strengthening AI capacity among pharmacy professionals is essential to fully harness its potential in enhancing pharmaceutical services and healthcare delivery.

5.1. Recommendations

1) Introduce AI-focused academic programs in pharmacy schools and continuing education platforms that are specifically tailored to the needs and roles of pharmacy personnel in Zambia. This will build foundational and advanced competencies in AI among future and current practitioners.

2) Integrate practical AI tools and simulations into pharmaceutical practice settings to enhance pharmacists' hands-on experience with technologies such as automated dispensing systems, AI-supported clinical decision tools, and digital health platforms.

3) Implement structured Continuous Professional Development (CPD) programs focused on AI literacy, including its applications, ethical considerations, and potential impact on patient care, to ensure pharmacy professionals remain current with evolving technological trends.

4) Promote collaborative research and innovation between pharmacy institutions, government bodies, and tech developers to foster context-specific AI solutions that address Zambia's healthcare and pharmaceutical challenges.

5) Develop national guidelines and policies that support the safe, ethical, and effective adoption of AI in pharmaceutical services, ensuring alignment with Zambia's broader digital health strategy and global best practices.

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