Harnessing the potential of ChatGPT in pharmacy management: a concise review

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Abstract

ChatGPT is one of the promising AI-based language models which has the potential to contribute to pharmacy settings in many aspects. This paper focuses on the possible aspects of pharmacy management where ChatGPT can contribute, the prevalence of its use in Saudi Arabia as a practical insight, case studies showing the potential of ChatGPT in answering health-related enquiries, its benefits, challenges, and future prospects of it. Helping clients, verifying medication, examining for potential reactions to drugs, identifying potential interaction between drugs, providing recommendation for suitable alternative medication therapies, assisting healthcare workers and supporting the search for novel medication are the biggest roles that are cited. The study highlights several benefits of using ChatGPT, including greater medical supervision, fewer drug errors, greater power over existing equipment, and support to study about the medicine sector. However, concerns about security, reliability, privacy, over-reliance on AI, and lack of natural judgement must be addressed by careful implementation under human review. The study also provided insight of practical application of ChatGPT in pharmacy education and possible ways of implementing ChatGPT in getting improved care and optimized operation. The future prospect of ChatGPT is promising but requires increased precision, integration of it into education programs, progressing of patient treatment and interaction, and facilitating novel research abilities. In general, the review suggests that ChatGPT has the potential to improve and modernize pharmacy processes but cautious implementation of this developing AI technology, combined with human knowledge is important to improve healthcare in the pharmaceutical field.

Keywords

ChatGPT, pharmacy practice, artificial intelligence, workflow automation, patient counseling, medication safety

Introduction

The use, expense, and range of pharmacy research are expanding. Innovative management strategies are required due to the distinctive character of various disorders managed by specialized medications, such as cancer and rheumatoid arthritis [1]. Pharmacies and chemists are only one example of the several healthcare professions that exist to cure sickness and encourage better health. Although the main objective is to enhance patient medical results and standard of daily life, drugstores remain active businesses and need to be handled effectively in order to keep their clientele, provide therapeutic services, be successful, and develop over time [2, 3].

A natural language processing (NLP) system called ChatGPT was created by OpenAI. By comprehending the context of a discussion and producing suitable responses, it is intended to produce dialogues that are human-like. A deep learning model named GPT-3, which was trained on a sizable dataset of chats, forms the foundation of ChatGPT [4]. By giving the helpers greater and more precise assistance, ChatGPT may be used to raise the quality of the preceding services. These assistants can offer individualized suggestions and counsel, such as meal plans or medication reminders, to aid patients in managing their medical problems [5]. Hariri [5] and Zhai [6] conducted that intelligent tutoring systems that can give students individualized learning experiences have been developed using ChatGPT. These systems are able to recognize the various learning preferences of students and modify the lesson plan and instructional techniques to better suit their requirements [5, 7]. Additionally, chatbots that can respond to consumer questions and assistance requests have been created using ChatGPT. These chatbots can comprehend text written in natural language and offer tailored replies, enhancing the general customer experience and lightening the burden of customer support representatives. High-quality content for websites, social media platforms, and advertising campaigns has been produced using ChatGPT. The ability of translating text between languages has been created using ChatGPT and delivering translations that are appropriate for the situation helps individuals from various cultures and backgrounds communicate more effectively. Engineers in the field of computing and programming aficionados can also benefit from ChatGPT [5].

By producing simple descriptions of pharmacology, pharmacokinetics, and interactions among drugs, offering examples and case studies, creating slides and assessments, and referring to pertinent resources, ChatGPT can help with pharmacy education. By creating virtual patient contacts, offering feedback on interaction and counselling approaches, and producing natural language replies to frequent patient inquiries and circumstances, ChatGPT can help with the growth of patient counselling and drug handling abilities (Figure 1). The dangers to confidentiality and safety, the reliability and precision of created material, the potential for dependence on science and technology, the inability to recognize bias or mistakes, and the potential for diminished imagination and critical thinking are some issues and difficulties that could arise from using ChatGPT in the field of pharmacy. It is critical to incorporate human supervision and input, set ethical standards for employment, guarantee security and privacy measures have been put place, and routinely check for any discrimination or mistakes in order to solve ChatGPT's shortcomings in educating pharmacists and maintain safeguards for patients and privacy [8]. This concise review shows the probable applications, shortcomings, and use cases of ChatGPT management along with the probable future of the technology in the future.

Methodology

Search design and data source

The search strategy for this review was designed to capture relevant literature on the application of ChatGPT and similar large language models in pharmacy management. Primary searches were conducted in PubMed, Scopus, and Web of Science databases, using a combination of MeSH terms and keywords related to artificial intelligence (AI), language models, and pharmacy practice. The search string included: ("ChatGPT" OR "GPT-3" OR "large language model*" OR "artificial intelligence") AND ("pharmacy management" OR "pharmacy administration" OR "pharmacy practice" OR "pharmaceutical services"). To
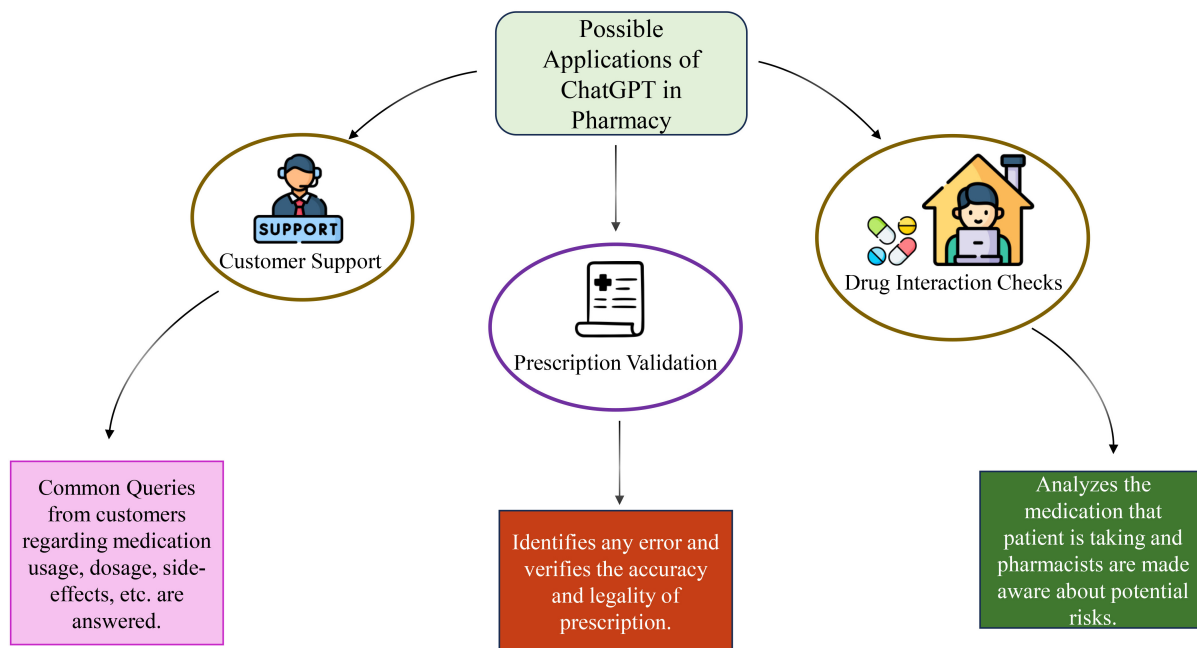
Figure 1. ChatGPT potential in pharmacy management. Icons made by Freepik from www.flaticon.com

ensure comprehensive coverage, additional sources were consulted, including Google Scholar for gray literature, and relevant conference proceedings from major pharmacy and health informatics conferences.

Inclusion and exclusion criteria

To ensure the relevance and quality of the included studies, specific inclusion and exclusion criteria were established. Studies were included if they (Table 1): (1) focused on the application of ChatGPT or similar large language models in pharmacy management or practice; (2) were published in English between 2020 and present; (3) were original research articles, systematic reviews, meta-analyses, or case studies; and (4) reported on outcomes such as efficiency, cost-effectiveness, error reduction, or patient satisfaction in pharmacy settings. Exclusion criteria encompassed (Table 1): (1) studies not specifically related to pharmacy or ChatGPT; (2) opinion pieces, editorials, or letters to the editor; (3) publications focusing on AI technologies other than large language models; (4) studies conducted in non-pharmacy healthcare settings; and (5) purely theoretical discussions without clear outcomes. Additionally, only peer-reviewed publications with full-text availability were considered. This careful selection process aimed to capture the most relevant and high-quality evidence on the potential of ChatGPT in pharmacy management while excluding tangential or less rigorous sources.

Table 1. Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Publication type	Original research articles, systematic reviews, meta-analyses, case studies	Opinion pieces, editorials, letters to the editor
Language	English	Non-English publications
Publication date	2020–present	Publications before 2020
Study focus	Applications of ChatGPT or similar AI in pharmacy management	AI applications not specific to pharmacy or ChatGPT not mentioned
Setting	Pharmacy settings (community, hospital, clinical)	Non-pharmacy healthcare settings
AI technology	ChatGPT, GPT-3, GPT-4, or similar large language models	Other AI technologies not related to language models
Outcomes	Efficiency, cost-effectiveness, error reduction, patient satisfaction	Studies without clear outcomes or purely theoretical discussions
Accessibility	Full-text available	Abstract only
Peer review	Peer-reviewed publications	Non-peer-reviewed sources
Sample size	N/A (dependent on study design)	Case reports with single subject

Applications of ChatGPT in pharmacy

By interpreting natural language rapidly and effectively, ChatGPT can improve healthcare duties including helping patients and medical record maintenance. By reducing manual entry of data into computerized medical records, it can speed up interaction among doctors and nurses, increase reliability, and reduce time. With the use of ChatGPT technology, patients could get one-on-one assistance from simulated assistants, which improves their experience by cutting down on the period it takes for doctors to respond and giving them additional time to handle complicated situations [9].

The potential of using ChatGPT-4 language model-based AI to provide younger doctors with medical guidance in medical situations. The research found that ChatGPT-4 performed exceptionally well at giving accurate and logical medical counsel. These researchers think that AI models like ChatGPT-4 might alter the medical curriculum and help to ease the limitations on clinical exposure. They do acknowledge that ChatGPT-4 has limitations when interacting with extremely particular industries by developing genuine patients case studies, increasing medical educational materials with clarification, examples, and illustrations [10]. Also analyzing medical literature publications, language models can improve medical students testing and the capacity to solve problems while utilizing time as well as keeping them up updated by the most recent findings in their area of expertise [11].

AI has shown promising results in promoting drug adherence and monitoring faithfulness. However, evaluating adherence to medicines remains challenging. Common strategies include self-reporting, digital regulations, and other qualitative and quantitative methods. However, there is a weak-to-moderate association between self-reported measurements and computerized measurements and medication refills. Machine learning methods, particularly in machine learning, could improve the trustworthiness and accuracy of adherence metrics [12, 13]. AI can aid integrated medical systems, data exchange, and patient self-care through multidisciplinary studies systems, computational medical graphs, and electronic medical records (Table 2). It can also help medical information managers organize and harvest information from unorganized electronic medical documents using NLP and computational AI techniques. AI-assisted innovation can optimize instructions, prioritize prescriptions, and reduce pharmaceutical errors, such as pharmaceutical reconciliation, which is often used to reduce mistakes [13, 14].

Table 2. Summary of some of the possible applications of ChatGPT in pharmacy

Application	Description	Example	References
Customer support	ChatGPT can answer common queries from customers about their medications, such as dosage, side effects, availability, etc.	Customer: How often should I take this antibiotic? ChatGPT: You should take one tablet every 12 hours for 7 days.	[20]
Drug interaction checks	ChatGPT can analyze the medications that a patient is taking and alert the pharmacist to any potential risks of adverse drug reactions.	Pharmacist: What other medications are you taking? Patient: I'm taking aspirin for my headache. ChatGPT: Aspirin may interact with your antibiotic and increase the risk of bleeding. You should consult your doctor before taking aspirin.	[15]
Prescription validation	ChatGPT can verify the accuracy and legality of prescriptions, identifying any errors or inconsistencies.	Prescription: Amoxicillin 500 mg, 1 tablet twice daily for 10 days. ChatGPT: This prescription is valid and matches the standard dosage for amoxicillin.	[21]

ChatGPT, an AI-based technology, can predict and clarify medication interactions, aiding those without immediate healthcare communication. However, it may not provide comprehensive assistance, and further work is needed to improve its accuracy and enhance its utility for patients. A study assessed ChatGPT's ability to predict and explain drug-drug interactions (DDIs), revealing that 39 out of 40 cases had valid solutions. However, half of the scenarios had unclear solutions. The study used pharmaceutical perspectives to assess the precision, with a layman's perspective stating that the data is accurate and can help patients identify DDIs [15]. The ChatGPT-4 application highlights the potential to improve patient treatment by illuminating the medical settings for allergy-related symptoms. It has many limitations that can make it unable to provide accurate or comprehensive information. Despite these limitations, AI

chatbots had the ability to fundamentally alter the field of allergic diseases by increasing patient involvement, improving diagnostic accuracy, personalizing treatment, and applying research findings into clinical practice (Table 2). AI chatbots in clinics face challenges and further research is needed to understand their potential uses and potential hazards. While AI can improve patient care and maintain medical expertise, it also requires continuous cooperation between AI creators and allergy experts, requiring further research and understanding of potential risks [16].

AI should be used alongside human supervision and integrated into any system, not as a stand-in. However, some businesses are utilizing AI in inventory management, and its results are promising. AI may significantly influence demand prediction due to the availability of accurate information on the web and the interplay of corporate computers and smart devices, leading to a shift from traditional inventory control methods. Such as Amazon integrates AI and stock management into its forecasting process to compete with other online retailers, requiring administrators to rethink inventory management procedures [17, 18]. AI gathers information from various databases about the disease, aiding scientists in making decisions for new and current treatments. It also expedites clinical trials by identifying suitable individuals. AI can optimize physician interactions, provide affordable medical care, enhance practical statistics, guide daily habits, integrate eating and physical activity, and ensure care plan compliance [19–21].

Benefits and advantages of ChatGPT in pharmacy practice

ChatGPT showcases remarkable capabilities in examining pharmaceutical interrelations, notifying pharmacists about conceivable perilous situations, diminishing the likelihood of deleterious drug interactions, curbing diagnostic errors, and enhancing patient well-being [22, 23]. Moreover, ChatGPT possesses the capability to facilitate in autonomously verifying prescriptions, as well as guaranteeing adherence to lawful and regulatory obligations. Adequate inventory control is crucial to ensure the seamless functioning of a pharmaceutical establishment. By capitalizing on the potential of ChatGPT, apothecaries can monitor and supervise their stock inventory with enhanced proficiency, thereby optimizing the quantity of supplies and averting any scarcity of medications. Facilitate a resilient association between the pharmacy's software and ChatGPT API, enabling the AI to retrieve pertinent patient information, including prescribed drug timetables and communication specifics. Craft tailor-made scripts or applications that utilize ChatGPT to generate personalized notification messages based on an individual's specific medication schedule. Integrate the ChatGPT-generated messages into the pharmacy's pre-existing communication channels, such as email or SMS services, to methodically send patient notifications [23] (Table 3). ChatGPT has the potential to fulfill the societal objective of eliminating linguistic obstacles, thereby enabling a broader population to create exceptional healthcare literature [24, 25]. To delve deeper, the survey witnessed the utmost consensus (77.2%) via the proclamation that pharmacists could derive immense advantages by employing ChatGPT [22]. The realm of AI wields the adeptness to discern individuals predisposed to re-entry, thereby enabling tailored interventions that amplify the flourishing and outcomes of patients. AI possesses an astonishing capacity to provide instant and precise revelations to adept surgeons, assisting them in evading errors and complexities. The implementation of AI empowers healthcare experts to focus predominantly on delivering exceptional patient care, enhancing safety protocols, and optimizing the overall execution of healthcare provisions [22].

Challenges and considerations in implementing ChatGPT

Just like any sophisticated deep learning system, ChatGPT raises possible apprehensions regarding security. One primary issue revolves around the peril of adversary assaults, wherein a malevolent perpetrator endeavor's to manipulate the system by introducing detrimental inputs that generate inaccurate or adverse outcomes. One additional concern revolves around the probability of ChatGPT being exploited to spread untruths or propaganda, especially if it becomes integrated into platforms with extensive influence, like social media networks. Furthermore, the ChatGPT's aptitude in generating text resembling human communication heightens the danger of deception and theft of individual identities [4] (Table 3).

Table 3. Summary of the benefits and challenges of ChatGPT in pharmacy practice

Aspect	Description	References
Benefits		
Drug safety	Examines pharmaceutical interrelations, notifies about potential hazards, reduces likelihood of harmful drug interactions	[22, 23]
Error reduction	Curbs diagnostic errors, assists in autonomous prescription verification	[22, 23]
Patient care	Enhances patient well-being, generates personalized notification messages	[22, 23]
Compliance	Ensures adherence to legal and regulatory obligations	[22, 23]
Inventory management	Improves stock control and supply optimization	[23]
Communication	Eliminates language barriers in healthcare literature	[24, 25]
Predictive analytics	Identifies individuals prone to readmission for targeted interventions	[22]
Surgical support	Provides instant, accurate insights to skilled surgeons	[22]
Healthcare efficiency	Allows professionals to focus more on patient care	[22]
Clinical decision-making	Enhances decision-making through AI algorithms and machine learning	[28]
Challenges		
Security	Risk of adversarial attacks	[4]
Misinformation	Potential for spreading false information or propaganda	[4]
Identity theft	Risk of deception due to human-like text generation	[4]
Data quality	Dependence on accuracy and quality of training data, potential for bias	[26]
Privacy	Concerns about extensive use of patient data for AI training	[28]

The dependability of this system is intricately connected to the precision and excellence of its training data, the particularities of which are veiled in confidentiality and probably put importance on a limited concentration in the domain of medical care and communal wellbeing. This clandestine information could potentially encompass inaccuracies, fostering the assimilation of flawed data, lopsided content, and prejudices throughout the training process [26]. ChatGPT offers tailored recommendations for educators by analysing data on pedagogical principles and students' academic achievements. Should you venture on the quest of acquiring knowledge in an unfamiliar linguistic system, you are presented with the extraordinary chance to exploit the immense capabilities of ChatGPT to skilfully obtain personalized recommendations for enhancing your vocabulary, expression, and enunciation. ChatGPT possesses the ability to provide students with superior support in readying themselves for evaluations by conducting in-depth scrutiny of data concerning their previous achievements and favoured methods of learning [27] (Table 3). The integration of AI technologies equips pharmacists with advanced tools and sophisticated systems that empower them to formulate precise and knowledge-driven clinical judgments. By employing AI algorithms and machine learning techniques, pharmacologists can swiftly scrutinize extensive quantities of patient data, encompassing medical documentation, laboratory findings, and drug histories. This enables them to discern potential interactions among pharmaceuticals, assess the safety and efficacy of treatments, and provide astute recommendations tailored to individual patients. Securing the overt endorsement of patients plays a crucial part in alleviating concerns regarding the privacy of information, as healthcare establishments may extensively utilize patient data for the education of advanced computer systems, lacking the procurement of adequate authorization from every individual (Table 3) [28].

Some stories of implementing ChatGPT and AI in pharmacy management

ChatGPT is a powerful language model that can generate text responses based on prompts. It can be used for various purposes in the pharmacy sector, such as providing customer support, checking drug interactions, validating prescriptions, and advancing drug discovery (see Table 4).

Waterloo's School of Pharmacy has been using a generative AI platform since early–2018 to enhance experiential learning for pharmacy professionals and students. The platform uses ChatGPT to create realistic patient scenarios for warfarin management, a complex and critical task for pharmacists. The platform allows learners to interact with ChatGPT patients and receive feedback on their decisions [29].

Table 4. Use stories of ChatGPT in pharmacy

Title	Country	Outcome	Duration	References
ChatGPT in pharmacy practice: a cross-sectional exploration of Jordanian pharmacists' perception, practice, and concerns	Jordan	Identified benefits and challenges of ChatGPT in pharmacy practice	2 months	[21]
Effectiveness of ChatGPT in clinical pharmacy and the role of artificial intelligence in medication therapy management	USA	ChatGPT 4.0 accurately solved 39 out of 39 (100%) patient cases in medication therapy management (MTM). It successfully identified drug interactions, provided therapy recommendations, and formulated general management plans, but did not recommend specific dosages. The study suggests that ChatGPT can assist pharmacists in formulating MTM plans to improve overall efficiency and enhance patient safety. The future of the pharmacy profession may depend on integrating AI models like ChatGPT to improve patient care.	N/A	[30]

The main outcome of the article "Effectiveness of ChatGPT in clinical pharmacy and the role of artificial intelligence in medication therapy management" [30] is that ChatGPT 4.0 accurately solved 39 out of 39 (100%) patient cases in medication therapy management (MTM). It successfully identified drug interactions, provided therapy recommendations, and formulated general management plans, but did not recommend specific dosages. The study suggests that ChatGPT can assist pharmacists in formulating MTM plans to improve overall efficiency and enhance patient safety. The future of the pharmacy profession may depend on integrating AI models like ChatGPT to improve patient care.

Brisk Logic, a software development company, has been emerging ChatGPT practice for drug recognition and progress. ChatGPT can create an advanced, specific mixture based on the correct properties or objects, such as blocking a particular enzyme or being compulsory to a separate effector. ChatGPT can also evaluate the chemical form and pharmaceutical activity of existing medicines and propose developments or options.

Future development of ChatGPT in pharmacy management

Certain changes are required to fully realise ChatGPT's promise in pharmacy management. One important focus is to increase the accuracy of pharmaceutical guidance. The discussion of AI in health systems concludes by addressing many implementation challenges with AI both within and outside the health industry. Data protection, societal difficulties, ethical issues, hacking issues, and developer issues were some of the challenges to successfully applying AI in the medical industry [31].

Moreover, research into AI governance and regulatory frameworks is critical for understanding their impact on innovation, healthcare costs, access to treatment, and health inequities. Decentralized data management techniques, such as Federated Learning, can improve data security and scalability in healthcare AI. Exploring synthetic health data generation techniques and analyzing their applications can provide a broad training dataset for constructing strong AI models in healthcare [32].

Future directions and opportunities

The effectiveness of ChatGPT and other NLP technologies in pharmacy management may be further explored and built upon in future studies. Researchers may be motivated to create new procedures based on the study's findings in order to improve ChatGPT's predictiveness and accuracy while handling medication administration [33]. More detailed and follow-up inquiries are required as ChatGPT's accuracy in producing accurate answers often decreases with case complexity. Nevertheless, it was effective in pointing out possible combinations that would exacerbate a patient's symptoms and offered suitable treatment strategies. The majority of drug-drug, drug-substance, and drug-disease interactions were covered with full precision in every case. ChatGPT has the ability and accuracy to solve clinical patient cases with different complexity levels [34]. It demonstrated its potential to optimize clinical workflow, leading to cost savings and improved healthcare delivery efficiency. ChatGPT's capacity to generate effective discharge

summaries can reduce documentation load in the healthcare industry. It also has the potential to revolutionize healthcare delivery by improving diagnostics, predicting illness risk and outcome, and discovering new drugs, among other translational research fields [33].

Additionally, there is the potential for enhanced health literacy and tailored care through the public's easy access to clear health information. ChatGPT comments illustrating the need of consulting healthcare practitioners and other trustworthy sources in particular scenarios served as an example of its value [35]. ChatGPT has the potential to revolutionize healthcare by improving diagnostics, predicting illness risk and outcome, and discovering new drugs [36, 37]. It has shown moderate accuracy in breast cancer screening and discomfort assessment, suggesting potential for radiology decision-making [38]. ChatGPT can increase health literacy and advance personalized treatment by making health information accessible to the general population [39]. However, consulting healthcare professionals and trustworthy sources is essential in specific circumstances, emphasizing the importance of trust in healthcare [40].

A number of recent studies have emphasized the possible advantages of using ChatGPT in pharmacy education. Students who struggle to grasp pharmaceutical and medical ideas might benefit from ChatGPT's simpler explanations of complicated subjects and medical jargon. Additionally, it can provide interactive platforms for the development of facial expression and emotional communication—two abilities that are crucial for patient counseling [8]. By integrating AI-based technologies, learning outcomes, health literacy, and evidence-based practice may all be improved. In addition to collecting data on health-related subjects including patient satisfaction, healthcare use, and health habits, ChatGPT may also be used to educate patients, healthcare practitioners, and researchers about a variety of medical disorders [41]. All things considered, ChatGPT can lead to better medical results. Patients can engage in research projects using ChatGPT by offering their opinions, involvement, and suggestions for study topics. This database takes into account the requirements and concerns of patients, makes use of recent illness prevalence, and guarantees patient-centered investigations [42].

Participants in the current survey showed a keen interest in using AI to the pharmaceutical industry. According to a Saudi Arabian research [43], 87% of pharmacists expressed a strong readiness to employ telepharmacy technology. Comparatively, in earlier research carried out in China and Pakistan [44], doctors and medical students also indicated a strong desire to use AI in the field of medicine [45]. Participants in the current study showed the greatest desire to use AI (82.3%) to connect with healthcare providers from home and receive primary care. This makes sense because finding the most inexpensive healthcare solutions and easing contact with healthcare professionals are two of AI's most beneficial applications [46].

The majority of pharmacists, according to the survey, are enthusiastic about using AI in the pharmaceutical industry, demonstrating a favorable attitude toward AI. However, the absence of technology and software specifically dedicated to AI, the requirement for human supervision, and the high operating expenses are obstacles to its application. Healthcare authorities must provide financial assistance in order to guarantee that AI technology is accessible in community pharmacy settings. Experienced pharmacists are more willing to use AI, maybe because they are aware of how labor- and time-intensive some activities might be. Their opinion of AI technology may change as a result, and they may be more inclined to employ it in the future [47].

Conclusions

ChatGPT can be applied in pharmacy for customer support, drug interaction checks, prescription validation, drug discovery, and more. It can enhance efficiency and accuracy in many pharmacy workflows. Benefits of ChatGPT include improving patient counseling, reducing medication errors, optimizing inventory management, and generating personalized notifications. It can also aid pharmacy education. However, there are valid concerns about security, reliability, privacy, dependence on AI, and lack of human discretion. Careful implementation with human oversight is crucial. Future opportunities lie in improving ChatGPT's accuracy, incorporating it into pharmacy curricula, enhancing patient care and engagement, and advancing research through its generative capabilities.

Overall, ChatGPT is a promising AI technology that can transform certain aspects of pharmacy management if thoughtfully implemented. More research and guidelines are needed to realize its full potential while addressing ethical concerns. A balanced, evidence-based approach is key.

In summary, ChatGPT offers exciting new capabilities but also raises important considerations for the pharmacy field. Further exploration of its responsible integration can pave the way for improved pharmaceutical care and outcomes.

Abbreviations

AI: artificial intelligence

NLP: natural language processing

Declarations

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Author contributions

AAN: Conceptualization, Writing—original draft. MDIAF and SMM: Writing—review & editing. TST: Writing—original draft, Data curation. AAS: Validation, Writing—review & editing, Software. All authors read and approved the submitted version.

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The author declares that there are no conflicts of interest.

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