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Psychometric Properties and Assessment of Knowledge, Attitude, and Practice towards

ChatGPT in Pharmacy Practice and Education: A Study Protocol

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Psychometric Properties and Assessment of Knowledge, Attitude, and Practice towards ChatGPT in Pharmacy Practice and Education: A Study Protocol

Abstract

ChatGPT represents an advanced conversational artificial intelligence (AI), providing a powerful tool for generating human-like responses that could change pharmacy prospects. This protocol aims to describe the development, validation, and utilization of a tool to assess the knowledge, attitudes, and practices towards ChatGPT (KAP-C) in pharmacy practice and education. The development and validation process of the KAP-C tool will include a comprehensive literature search to identify relevant constructs, content validation by a panel of experts for items relevancy using content validity index (CVI) and face validation by sample participants for items clarity using face validity index (FVI), readability and difficulty index using Flesch-Kincaid Readability Test, Gunning Fog Index, or Simple Measure of Gobbledygook (SMOG), assessment of reliability using internal consistency (Cronbach's alpha), and exploratory factor analysis (EFA) to determine the underlying factor structure (eigenvalues, scree plot analysis, factor loadings, and varimax). The second phase uses the validated KAP-C tool to survey pharmacists and pharmacy students in selected low-and middle-income countries (LMIC) (Nigeria, Pakistan, and Yemen). The final data will be analyzed descriptively using frequencies, percentages, mean (standard deviation) or median (interquartile range), and inferential statistics like Chi-square or regression. ChatGPT holds the potential to revolutionize pharmacy practice and education. This study will highlight the psychometric properties of the KAP-C tool that assesses the knowledge, attitude and practice towards ChatGPT in pharmacy practice and education. The findings will contribute to the potential ethical integration of ChatGPT in pharmacy practice and education and provide valuable evidence for leveraging AI advancements in pharmacy.

Keywords: Knowledge, Attitude, Practice, ChatGPT, Artificial intelligence, Pharmacy

Introduction

The emergence of artificial intelligence (AI) and natural language processing (NLP) has brought significant transformation in numerous industries, including healthcare and education.^{1,2} ChatGPT, a powerful generative pre-trained transformer language model developed by OpenAI in November 2022, has emerged as a promising technology that can potentially transform the healthcare sector, including pharmacy, by providing relevant medical information and assistance to practitioners, students, and researchers in an interactive conversational manner.³

The pharmacy sector has a long history of computerized technologies.⁴ The sector is expected to undergo significant changes with the emergence of AI.⁵ AI technology has already significantly impacted healthcare by increasing efficiency, streamlining procedures, and facilitating data storage and management. The pharmacy sector shows increased interest in using AI in drug discovery, dosage form design, polypharmacy, and hospital pharmacy fields.^{5,6} Therefore, ChatGPT has the potential to be an efficient one-stop center for pharmacists and pharmacy students seeking drug information and clinical reference, with exceptional natural language processing.

The application of ChatGPT in the health industry can optimize patient profiling and evidence-based care and improve patient education and clinical decision-making resulting in cost savings and enhanced individualized medicine.^{7,8} The integration of ChatGPT into education, specifically in healthcare fields such as pharmacy, represents a significant shift in how we approach teaching and learning. It necessitates reevaluating traditional assessment methods and presents new prospects for fostering critical thinking and problem-solving abilities.^{7,8} ChatGPT has recently been shown to achieve an accuracy rate of 60% or higher for all three United States Medical

Licensing Exams (USMLE),⁹ indicating that AI language models could guide health education and clinical decision-making.

Prioritizing accuracy and trust in developing chatbots such as ChatGPT is essential. Therefore, assessing the prevailing knowledge and application of ChatGPT in practice is a crucial step in evaluating its capabilities. Despite the potential benefits of ChatGPT in various areas of the health sector, no study assessed the knowledge, attitude, and practice (KAP) towards ChatGPT among pharmacists and pharmacy students, particularly in low- and middle-income countries (LMIC), such as Nigeria (West Africa), Pakistan (South Asia), and Yemen (Middle East). These countries typically have lower incomes, economic development, social and technological developments.¹⁰ In addition, they may have differences in the adoption of ChatGPT due to cultures, potentially affecting its effectiveness in pharmacy practice and education.¹¹ This could inform the development of best practices for integrating ChatGPT into pharmacy practice and education in the LCMI for reference to other economies.

Most questionnaire-based surveys are typically presented with a pre-tested or piloted tool or a single-administration test score reliability coefficient like Cronbach's alpha to determine internal consistency,^{12,13} or not specific to the pharmacy profession.^{14,15} To ensure an accurate assessment of the tool's reliability and construct validity, it's crucial to adopt rigorous methodological approaches. Consequently, an exhaustive evaluation of the psychometric properties of a new tool that measures knowledge, attitudes, and practices towards ChatGPT (KAP-C) related to the pharmacy profession is needed.

This protocol aims to describe the development, validation, and utilization of a tool to assess the knowledge, attitudes, and practices towards ChatGPT (KAP-C) in pharmacy practice and education among pharmacists and pharmacy students in LMICs. The specific objectives include

highlighting the steps to develop and validate the KAP-C tool, determining the prevalence of ChatGPT usage and its associated KAP, comparing the ChatGPT application and its associated KAP between pharmacists and pharmacy students, comparing ChatGPT application and its associated KAP among Nigeria, Pakistan, and Yemen, identifying predictors of ChatGPT application and its associated KAP, and identifying barriers and facilitators of ChatGPT application in pharmacy practice and education.

Methods

The present study will be conducted in two phases. Phase I involves developing and validating the tool that assesses knowledge, attitude, and practices towards ChatGPT (KAP-C) in pharmacy practice and education. While phase II consists of the assessment of the baseline KAP towards the ChatGPT using the validated KAP-C tool among pharmacists and pharmacy students.

Phase I (development and validation of the KAP-C tool)

Study design

The study will be an online cross-sectional survey to develop and validate the KAP-C tool. The validation is divided into four-five steps: content validity, face validity, readability and difficulty index, and exploratory factor analysis.

Questionnaire development

The KAP-C tool will be developed based on a relevant literature review and discussion with experts in pharmacy practice, pharmacy education, and artificial intelligence. The final tool will be reviewed by experts and validated using standard validation procedures. Experts will perform content validation to determine the relevance of the tool items to the measured domains, and face

validation will be performed by a sample of target participants (pharmacists and pharmacy students) to assess the clarity of the tool items for the measured domains. The tool will then be tested for reliability on samples of the target group (pharmacists and pharmacy students). The internal consistency reliability of the survey tool will be calculated using Cronbach's alpha. The steps followed are detailed in the next section of the paper.

Forward and back translation

The process of scale translation will adhere to the established norms for questionnaire translation and cross-cultural adaptation.^{16,17} To start, the translation will be performed by two experts in pharmacy practice and education who are proficient in English and Arabic. Their expertise in the field will ensure a comprehensive understanding of the discipline's terminology. This will result in two Arabic versions of the ChatGPT KAP questionnaire. Subsequently, a seasoned researcher, who is native to Arabic, will cross-examine the two Arabic translations against the original English text. After a meticulous evaluation and revision, the two Arabic translations will be amalgamated into a singular, final Arabic version of the scale. Finally, a separate translator will retranslate the Arabic questionnaire back to English.

Psychometric tests (validations)

Based on the results of these validation steps below, necessary revisions to the questionnaire will be made to form the final validated tool that assesses KAP towards ChatGPT in pharmacy practice and education. The following steps will be followed to validate the study questionnaire:

Establish content validity

Content validity will be confirmed based on reported recommendations.¹⁸ To ensure each item in the tool is relevant to the measure of KAP related to ChatGPT in pharmacy practice and education,

a panel of at least ten experts with qualifications and experience in pharmacy practice and education will be constituted. The experts for content validation will be selected based on their expertise and experience in pharmacy practice, education, and AI. The criteria for selection include relevance, experience, and diversity. Experts from each participating country (Nigeria, Pakistan, and Yemen) will be included to ensure the tool's cultural relevance and contextual appropriateness. The panel will be asked to evaluate and assess each component in the tool using a 4-point Likert scale (1 - not relevant, 2 - requires major revision, 3 - requires minor revision, and 4 - very relevant). The questionnaire will be appropriately adjusted according to the suggestions provided by the experts. The relevance rating will subsequently be converted to 1 (for a relevance score of 3 or 4) or 0 (for a relevance score of 1 or 2).

The experts' relevancy ratings will be used to compute the content validity index (CVI). The item-level content validity index (I-CVI) for individual items and the scale-level content validity index (S-CVI) for the overall scale will be calculated. To determine the S-CVI, two methods will be employed: the averaging calculation method (S-CVI/Ave) and the universal agreement calculation method (S-CVI/UA). S-CVI/Ave is calculated by dividing the total I-CVI value by the total number of items, while S-CVI/UA is calculated by dividing the number of items with 100% agreement by the total number of items. An acceptable index value of 0.80 or higher will indicate valid and relevant content for the items.¹⁹

Establish face validity

Face validity will be ensured based on previous recommendations.^{20,21} A representative sample of pharmacists and pharmacy students among the target participants will be invited to evaluate the questionnaire and offer feedback on the clarity and comprehensibility of the items related to the measured domains. The questionnaire will be modified based on their suggestions, focusing on

using simpler language and ensuring appropriateness in assessing KAP towards ChatGPT in pharmacy practice and education.

At least 12 participants from the target group will be selected for the face validation test. They will be asked to rate the items on a 4-point Likert scale, where 1 indicates that the item is very unclear and not understandable, 2 suggests that the item needs major revision, 3 indicates the item needs minor revision, and 4 indicates that the item is very clear and understandable. Ratings of 3 and 4 will be considered 1 (clear and understandable), while ratings of 1 and 2 will be considered 0 (not clear and understandable).

The face validity index (FVI) will be calculated by determining the average score of the scale based on the clarity ratings provided by the participants. The item-level face validity index (I-FVI) will be calculated for each item, and the scale-level face validity index (S-FVI) will be calculated for the overall scale. Two methods will be used to calculate the S-FVI: the averaging calculation method (S-FVI/Ave), obtained by dividing the total I-FVI value by the total number of items, and the universal agreement calculation method (S-FVI/UA), calculated by dividing the number of items with 100% agreement by the total number of items. An index value of 0.80 or higher will be considered acceptable, indicating the validity and clarity of the item content.²²

Readability and difficulty index

To evaluate the readability of the tool and ensure its comprehensibility for the majority of the intended audience, we will utilize the Simple Measure of Gobbledygook (SMOG). The SMOG grade estimates the years of education required to understand a given piece of writing. In this study, a SMOG grade of six or higher will be deemed acceptable, aligning with the level of education typically attained by healthcare practitioners.²³

To determine the difficulty index of the tool, items that appear ambiguous to the participants will be identified by calculating the percentage of correct responses for each item. Any item with a knowledge score below 50% will be regarded as difficult and undergo rewording to enhance clarity.²⁴

Establish construct validity

Construct validity will be determined using two-parameter logistic item response theory (2-PL IRT) and exploratory factor analysis (EFA). The appropriate sample size for the EFA will be determined by the ratio of questionnaire items to respondents, commonly 1:5 to 1:10.²⁵⁻²⁷

Given that the knowledge section of the tool is unidimensional, with responses limited to either correct or incorrect, it will be assessed using the two-parameter logistic item response theory (2-PL IRT). The evaluation of knowledge items will rely on the difficulty and discrimination indexes. The difficulty index reflects the proportion of respondents who answered the item correctly. An acceptable difficulty index falls within the range of -3 to 3. The discrimination index measures how well the performance of the "overall best" respondents compares to the "overall worst" respondents on a specific item. An acceptable discrimination index is typically between 0.35 and 2.5.²⁶

The EFA method will establish factors for the attitude and practice section. To ensure sampling adequacy, a Kaiser-Meyer-Olkin (KMO) value equal to or greater than 0.6 and a significant result from Bartlett's test for sphericity ($p < 0.05$) will be sought. Factors with eigenvalues of 1 or higher will be deemed significant for factor extraction. The extracted factors will be subjected to orthogonal rotation, utilizing the varimax procedure or an alternative method. A factor loading of

0.40 or higher will be considered acceptable in determining the relationship of each item to its respective factor.²⁷

Establish reliability

To assess the reliability of the tool, we will perform an item-scale correlation analysis to measure the extent of correlation between each item and its respective subscale. Pearson correlation coefficient values of 0.4 or higher will be considered satisfactory.²⁷ Additionally, Cronbach's alpha coefficient will be examined to assess the internal consistency of the questionnaire. A reliability coefficient of 0.70 or higher will indicate good internal consistency for the instrument.^{26,27}

Proposed KAP-C tool

The proposed KAP-C tool will consist of four sections (A to D). Section A: socio-demographics (12 items); Section B: Knowledge (12 items); Section C: Attitude (12 items); Section D: Practice (14 items). The complete questionnaire can be found in the Supplementary Information (SI).

Phase II (Assessment of KAP towards ChatGPT)

The second phase of the study will involve the utilization of the validated KAP-C questionnaire to assess the baseline knowledge, attitude, and practice towards the ChatGPT in pharmacy practice and education pharmacists and pharmacy students in Nigeria, Pakistan, and Yemen.

Study design

This online cross-sectional survey will be conducted using a validated self-administered questionnaire created using Google Forms (www.google.com/forms) to assess the knowledge, attitudes, and practices towards the ChatGPT among pharmacists and pharmacy students. The study will be conducted from July to August 2023. The survey will be conducted and reported following the "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE)²⁸ and "Checklist for Reporting Results of Internet E-Surveys" (CHERRIES)²⁹ guidelines.

Study participants and setting

The study will be conducted among pharmacists and pharmacy students in three low- and middle-income countries (Nigeria, Pakistan, and Yemen). Participants will be pharmacists from the public and private sectors (such as community, hospital, educational, administrative, and security practices) and pharmacy students enrolled in pharmacy programs in the respective countries. Nigeria, Pakistan, and Yemen are located in West Africa, South Asia, and the Middle East, respectively.³⁰

Nigeria, with a population exceeding 200 million, is the most populous country in Africa and the seventh globally. It is a diverse nation comprising over 250 ethnic groups and languages.³¹ The regulation of pharmacy practice and education in Nigeria is overseen by the Pharmacists Council of Nigeria (PCN). To become a pharmacist in Nigeria, the minimum required degree is a Bachelor of Pharmacy (BPharm) or Doctor of Pharmacy (PharmD).³² However, the uneven distribution of pharmacy schools and pharmacists throughout the country has resulted in workforce shortages, posing challenges to accessing quality medicines and pharmaceutical expertise.^{33,34} Nigeria's healthcare system faces multiple obstacles, including insufficient funding, inadequate infrastructure, and a scarcity of medical professionals.^{35,36}

Pakistan, with a population of over 220 million, ranks as the fifth most populous country globally and has a diverse population comprising numerous ethnic and linguistic groups.³⁷ The Pharmacy Council of Pakistan (PCP) serves as the professional body responsible for accrediting pharmacy education and regulating the pharmacy profession in the country. The PharmD degree is the minimum requirement in Pakistan for becoming a pharmacist.³⁸ Although the pharmacy education sector has not significantly contributed to the national healthcare system in Pakistan, the country possesses a dynamic pharmaceutical sector that ranks as the 10th largest in the Asia-Pacific region.^{39,39,40} This sector meets 70% of the country's medicinal demands. Nevertheless, a major challenge persists in the form of an inadequate number of qualified staff, particularly in pharmacy practice.⁴¹

Yemen has a population of approximately 30 million people. It is currently facing a severe humanitarian crisis characterized by conflict, displacement, and shortages of essential supplies, which significantly impact the delivery of healthcare services.^{42,43} Yemen's healthcare system is vulnerable, with limited access to healthcare services, particularly in rural areas.^{43,44} The country has a small pharmaceutical industry, but it does have a notable number of licensed pharmacists and pharmacy schools.^{45,46}

Data collection

The validated KAP-C tool will collect data from pharmacists and pharmacy students in Nigeria, Pakistan, and Yemen. The data to be collected will include the participants' sociodemographic characteristics, knowledge, attitudes, and practices regarding using ChatGPT in pharmacy practice and education. The hyperlink to the questionnaire will be disseminated via social media platforms (WhatsApp, Facebook, Telegram, Twitter, and LinkedIn) and emails of the target participants. Participants will be recruited using convenience and snowball sampling techniques, where invitees

will be asked to forward the invitations to their pharmacy partners and networks. This technique is intended to ensure broader coverage of data collection. Occasionally reminders will be sent to improve the response rate. Only those participants with complete and valid answers will be included in the final analysis.

Data collection tool

A pre-validated online self-administered questionnaire called the KAP-C tool will be used. The proposed tool will have four sections (A - D). Section A: Sociodemographic information (e.g., age, gender, academic level, and practice setting); Section B: Knowledge about ChatGPT (e.g., awareness, applications, and sources of information); Section C: Attitudes towards ChatGPT (e.g., perceived benefits, concerns, and willingness to use); and Section D: Practices towards ChatGPT (frequency of use, reasons for use, and areas of application).

The responses received will be scored as follows. For the knowledge, the correct answer was coded as 1, and the wrong or 'not sure' answer was coded as 0. For the attitude, the twelve questions on a 5-point Likert scale will be coded as 1=strongly disagree, 2= disagree, 3=neutral, 4=agree, and 5=strongly agree. For the practice, the twelve questions on a 5-point Likert scale will be coded as 1=never, 2=rarely, 3=sometimes, 4=often, and 5=always.

Sample size estimation

The sample size will be calculated using Raosoft® (Sample Size Calculator; Raosoft Inc.),⁴⁷, with the following assumptions: 5% margin of error, 95% confidence interval, and 50% response distribution. The calculated sample size for this study based on the number of pharmacists and pharmacy students for each study setting (Nigeria, Pakistan, and Nigeria) would be 350 - 380 participants.

For Nigeria, using the estimated total number of pharmacists (n=21,892)⁴⁸ and pharmacy students (n=15,000),⁴⁹ the minimum sample size is estimated at 378 and 375, respectively. For Pakistan, using the estimated total number of pharmacists (n= 32,511) and pharmacy students (n=12,175)⁵⁰, the minimum sample size is estimated at 380 and 373, respectively. For Yemen, using the estimated total number of pharmacists (n=18,000)⁵¹ and pharmacy students (n=4,000)⁵², the minimum sample size is estimated at 378 and 351, respectively.

Data analysis

Google Forms responses will be downloaded into a Microsoft Excel spreadsheet and then imported into IBM SPSS Statistics for Windows, version 28.0 (IBM Corp., Armonk, NY, USA.) for data analysis. A normality test will be performed on the continuous numeric variables using the histogram and the Kolmogorov-Smirnov test.

The content and face validity will be analyzed using the CVI and FVI. Readability and difficulty index analysis will be conducted using the Flesch-Kincaid Readability Test, Gunning Fog Index, or Simple Measure of Gobbledygook (SMOG). Reliability will be assessed using the internal consistency of Cronbach's alpha. At the same time, the EFA will be evaluated based on eigenvalues, scree plot analysis, factor loadings, and varimax or oblimin rotation.

Descriptive statistics will summarize participants' responses on socio-demographics, knowledge, attitudes, and practices towards ChatGPT. Categorical variables are represented as frequencies and percentages, and continuous variables will be presented as means (standard deviation) or medians (interquartile range), as appropriate.

Inferential statistics compare differences and identify associations between variables or groups. Chi-square or Fisher's exact test will be used to assess the relationship between categorical

variables. In contrast, the Students t-test, Mann-Whitney U test, Analysis of variance (ANOVA), or Kruskal-Wallis tests will be used to assess the differences of continuous data among two or more groups, depending on the normality. To determine the factors associated with using the ChatGPT, a simple logistic regression is performed to screen all independent variables for inclusion in the Multivariable logistic regression (MLR) analysis. Multicollinearity and interaction between the variables will be checked. Model fit assumptions are checked using Hosmer-Lemeshow tests and the area under the curve (AUC). The final model will have adjusted odds ratios (aOR), 95% confidence intervals (CI), and corresponding *p*-values. Overall, a two-sided $p < 0.05$ will be considered statistically significant.

Ethical statement

The study will follow the 1964 Declaration of Helsinki guidelines and subsequent amendments. Ethical approval is sought from the College of Health Sciences Research Ethics Committee, Bayero University Kano, Nigeria, the Institutional Bioethics Committee, University of Sindh, Pakistan, and the Ethical Committee of Medical Research at the University of Science and Technology, Yemen. Participants will receive detailed information about the objectives of the study, the survey, and the investigators. All participants must approve an online informed consent prompt before participating in the study. The study data's anonymity, confidentiality, and privacy will be guaranteed and protected throughout the study.

Expected Results

The protocol is expected to describe the psychometric properties of the tool to assess the knowledge, attitudes, and practices towards ChatGPT (KAP-C) in pharmacy practice and education in low-and middle-income countries (Nigeria, Pakistan, and Yemen). The psychometric

study will provide data confirming the validity of the KAP-C tool based on the scores from content validity, face validity, construct validity, reliability and readability analyses. The KAP-C tool should demonstrate a good content validity index (CVI > 0.78), face validity index (FVI > 0.8), adequate reliability with high internal consistency (Cronbach's alpha > 0.8), and construct validity (factor loadings > 0.5).^{19,22}

The validated KAP-C tool will consist of three domains: knowledge (7 items), attitudes (11 items), and practices (10 items). The knowledge domain assessed the respondents' familiarity with ChatGPT and its features, the attitudes domain evaluated the respondents' opinions and perceptions of ChatGPT and its benefits and risks, and the practices domain assessed the respondents' frequency and purpose of using ChatGPT.

The survey results will reveal the prevalence of ChatGPT usage and its associated baseline KAP indices among pharmacists and pharmacy students. It will also identify the differences in ChatGPT application and KAP between the study participants and among the included countries (Nigeria, Pakistan, and Yemen). The study will also identify the predictors of ChatGPT application and its associated KAP in pharmacy practice and education. Additionally, it will explore the barriers and facilitators of ChatGPT application in the pharmacy profession.

The mean scores of the KAP-C domains could vary significantly among the participants and the three countries. This may reflect the differences in the availability and quality of internet infrastructure, digital literacy, cultural norms, and regulatory policies among the countries. In addition, the findings may indicate that students are more exposed to ChatGPT through their education or social media but are less convinced of its usefulness or trustworthiness in their future profession.

Discussion

This protocol aims to describe the development, validation, and utilization of a tool to assess the knowledge, attitudes, and practices towards ChatGPT (KAP-C) in pharmacy practice and education in three low- and middle-income countries (LMICs) (Nigeria, Pakistan, and Yemen). In addition, the study highlights the application of the KAP-C tool among pharmacists and pharmacy students through a survey to guide the understanding and the potential of ChatGPT in the pharmacy profession alongside associated opportunities and challenges. ChatGPT, an exceptional generative AI model developed by OpenAI in 2022, is a monumental technological leap forward.⁵³ Powered by state-of-the-art natural language processing (NLP), it has revolutionized various NLP applications, including chatbots, virtual assistants, language translation, and text generation, setting new standards of excellence and innovation. With its remarkable capabilities, ChatGPT has pushed the boundaries of what is possible in understanding and generating human-like text, making it a groundbreaking tool for countless industries, including pharmacy. ChatGPT has the potential to revolutionize how pharmacists and other healthcare professionals interact with patients, access drug information, and enhance the learning experience for pharmacy students.

The KAP-C tool should demonstrate satisfactory psychometric properties, including content validity (for items relevance), face validity (for items clarity), reliability (for items internal consistency) and construct validity (for items),⁵⁴ indicating that it is suitable for measuring KAP towards ChatGPT in pharmacy settings. In the case of the KAP-C tool, content validity assesses the relevance of each item in capturing individuals' KAP towards ChatGPT. It is crucial to ensure that the items included in the tool cover all relevant aspects of KAP and are specific to the context of ChatGPT in pharmacy practice and education. The content validity index (CVI) assesses the proportion of experts who agree on the relevance and adequacy of each item. Items with a CVI

value of 0.78 or higher are considered to have satisfactory content validity.¹⁹ Face validity refers to the clarity of each item in capturing individuals' KAP towards ChatGPT in pharmacy settings. This process helps to identify any items that may be ambiguous to respondents. The face validity index (FVI) assesses the proportion of participants who agree on the clarity of each item. Items with an FVI value of 0.80 or higher are considered to have satisfactory face validity.²² Reliability assesses the internal consistency and stability of the KAP-C tool over time and across different contexts using measures such as Cronbach's alpha coefficient.⁵⁴ A high Cronbach's alpha value (usually above 0.70) indicates good internal consistency reliability, suggesting that the items in the tool are measuring KAP consistently. Construct validity involves examining the relationships between the scores obtained from the KAP-C tool and other constructs using exploratory factor analysis (EFA) to evaluate construct validity. The EFA helps identify the KAP-C tool's underlying factor structure, while CFA confirms the hypothesized factor structure.⁵⁴

The use of ChatGPT in healthcare and education has been a topic of discussion in recent times.^{55,56} The KAP-C survey will provide insight into the prevalence of ChatGPT usage and associated KAP indices among pharmacists and pharmacy students. Identifying predictors and barriers that can affect its application in this field is important. One possible predictor could be the level of digital proficiency among practitioners, while a potential barrier could be concern regarding privacy or security when using AI-powered chatbots.⁵³ Furthermore, it is essential to acknowledge that healthcare professionals, including pharmacists, ensure patient safety and privacy. Therefore, any technology used in this context must adhere to strict ethical guidelines. By analyzing factors like KAP indices, predictors, barriers, and ethical considerations related to its implementation in practice settings, we can better understand how to leverage these technologies effectively while preserving our commitment towards providing safe patient care standards.

The internet infrastructure, digital literacy, cultural norms, and regulatory policies of Nigeria, Pakistan and Yemen may affect how people use ChatGPT. Internet infrastructure determines the availability and quality of online access in different regions.⁵⁷ Digital literacy affects how well people understand and use new technologies,⁵⁸ cultural norms influence the adoption rate of innovative chatbots,⁵⁹ and regulatory policies shape how companies like ChatGPT develop and market the products in each country, depending on the data privacy laws and other regulations.

The study may be limited by the study design, which involves an online survey that may introduce selection bias, as it may not capture the perspectives of individuals without internet access or those who choose not to participate. The generalizability of the findings may be limited to the selected countries (Nigeria, Pakistan, and Yemen). It may not reflect the experiences and perceptions of pharmacists and pharmacy students in other regions, especially the high-income countries. Additionally, the study relies on self-reported data, which may be subject to recall or social desirability bias. The cross-sectional design limits the ability to establish causality or assess changes over time. The study may also encounter challenges in achieving a representative sample size and ensuring the KAP-C tool's construct validity, which requires a larger sample. Despite these potential limitations, the study provides a valuable foundation for understanding the current landscape of ChatGPT application in pharmacy practice and education. It offers insights for future research and interventions in harnessing AI advancements in pharmacy. Finally, it is essential to consider the limitations and ethical implications of using AI-based tools, like ChatGPT, in pharmacy settings, including data privacy, potential biases, and the need for human supervision and critical evaluation.

Conclusions

The use of generative AI-based technology like ChatGPT has the potential to revolutionize pharmacy practice and education. The study will describe the psychometric properties of the tool to assess the knowledge, attitudes, and practices towards ChatGPT in pharmacy practice and education in low- and middle-income countries (Nigeria, Pakistan, and Yemen). The integration of ChatGPT in areas such as drug information retrieval and interactive learning holds great potential for significantly enhancing the roles of pharmacists, educators, and students. The findings could serve as a template for the ethical integration of ChatGPT into various pharmaceutical settings. The results will also inform relevant stakeholders of the need to provide a conducive environment towards integrating ChatGPT and similar AI technologies in pharmacy practice and education. The study will also provide valuable information to chatbot developers to further customize their products to the needs and preferences of pharma professionals.

Data availability statements

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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Author contribution

Conceptualization: [MM, NK, MZ, FYA]; Methodology: [MM, NK, MZ, FYA, AAB]; Formal analysis and investigation: [MM, NK, FYA, AAB, SM]; Writing - original draft preparation: [MM, NK, MZ, FYA, AAB, BKL, ASW, AH, SM, RA, AH, AS]; Writing - review and editing: [MM, NK, MZ, FYA, AAB, BKL, ASW, AH, SM, RA, AH, AS]; Resources: [MM, MZ, NK, ASW,

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