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Preparedness and barriers to pharmaceutical care among final-year pharmacy students and recent graduates: a cross-sectional study in Saudi Arabia

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Abstract

Background Pharmacy students' preparedness to provide pharmaceutical care (PC) is crucial for ensuring optimal patient outcomes. Understanding their self-assessed readiness across different competency areas and identifying barriers can help identify areas for improvement in pharmacy education.

Objective This study aimed to evaluate pharmacy students' perceptions of their preparedness to provide PC across technical, psychological, communication, administrative, and research domains, as well as the perceived barriers.

Method A cross-sectional study was conducted among 278 final year pharmacy students and recent graduates from various institutions in Saudi Arabia. A modified questionnaire, adapted and refined from a previous study, was tailored to the Saudi Arabian context to align with current educational and professional standards in pharmacy practice.

Results The majority of the participants were female, aged 24–26, and were predominantly enrolled in the PharmD program. The findings reveal that students generally felt well-prepared in technical, psychological, and communication domains of PC, with median confidence scores of 4 across most skills in these areas. However, they reported moderate confidence in administrative and research skills. Barriers, such as lack of private space for patient counseling and time constraints, were commonly perceived challenges to PC. Females perceived more barriers to providing PC compared to males ($p=0.002$). PharmD students reported higher perceived preparedness in technical ($p=0.008$), psychological ($p=0.013$), and research skills ($p=0.006$) compared to B.Pharm students. Additionally, recent graduates felt more prepared in administrative tasks compared to final years students ($p=0.045$).

Conclusion Pharmacy students apperceived themselves as moderately prepared for providing PC, with gaps in administrative and research domains. Additionally, overcoming commonly perceived barriers, such as lack of private counseling spaces and time constraints, may further support students in delivering effective PC. To address the

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moderate confidence in administrative and research skills, pharmacy curricula should integrate targeted, hands-on training through case-based learning, simulations, and research projects.

Keywords Pharmacy education, Pharmaceutical care, Saudi Arabia, Preparedness, Barriers

Introduction

The pharmacy profession has recently transitioned from a primary focus on medication dispensing to a more comprehensive role in direct patient care. Pharmacists are now encouraged to expand their responsibilities to include the provision of pharmaceutical care (PC). Hepler & Strand defined PC as "the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve a patient's quality of life" [1]. This approach emphasizes the pharmacist's active involvement in patient care, aiming to optimize medication use and enhance health outcomes, which requires a range of competencies including technical, psychological, communication, administrative, and research skills [2]. In Saudi Arabia, as in many parts of the Middle East and North Africs (MENA) region, initiatives to enhance pharmaceutical services have expanded over the past decade to address the growing demand for clinical pharmacists equipped to meet healthcare priorities and market needs [3]. Hospital-based PC services have achieved significant progress, recording thousands of clinical interventions to improve patient safety and supporting research and education initiatives [4, 5]. However, in community pharmacies, practice remains predominantly focused on dispensing, limiting opportunities for students to engage in patient-centered care [6].

Despite advancements in healthcare services, challenges remain in preparing students across diverse pharmacy settings. For the successful implementation of PC, it is crucial to prepare both current and future pharmacy practitioners. Literature emphasizes the significant role of pharmacy educators in shaping PC-ready practitioners [7–10]. Educators are encouraged to create learning strategies that encourage students to embrace PC, providing a thorough training in its principles and applications. They must also encourage students' clinical expertise, communication, problem-solving skills, and confidence to take on PC roles. A primary challenge for educators is to inspire students' interest in PC, as fostering positive attitudes can lead to greater adoption of PC in professional practice [11].

A systematic review of MENA pharmacy programs found that although students generally have positive attitudes and feel reasonably prepared, they encounter educational barriers such as outdated curricula, limited clinical training, and inadequate access to essential resources [12]. Similarly, a Saudi Arabia reported that despite students appreciation of PC obstacles such as restricted access to patient records and comprehensive drug information systems, hinder their readiness for professional practice [13]. A study from Qatar [14] further underscores these challenges, noting that students' enthusiasm for PC is tempered by insufficient drug information resources and time constraints. These findings collectively emphasize the need for educational reforms that enhance experiential learning and clinical exposure [15, 16].

In alignment with Vision 2030 which is a national strategy to diversify the economy and enhance key sectors, including healthcare and education,, the Education and Training Evaluation Commission in Saudi Arabia has underscored the need to integrate PC into pharmacy curricula to foster highly skilled graduates capable of meeting national healthcare priorities [17]. Notably, the PC concept has been integrated into the teaching process from the early years of pharmacy education, ensuring that students develop a strong foundation in patient-centered care. One of the key learning outcomes specifically highlighted is the ability to construct patient-centered, evidence-based PC plans using an interprofessional approach. However, there remains a scarcity of studies assessing PC education comprehensively. Previous studies have primarily focused on students in early stage of studies (level 7–10)10 [13] who lacked practical exposure to PC. In contrast, our study shifts the focus to final-year students, interns and recent pharmacy graduates, who completed their studies up to one year ago. This group is uniquely positioned to provide deeper insights into the effectiveness of the PC curriculum, as they have had greater opportunities to practice PC during advanced coursework, clinical rotations, or early professional experiences.

This study aims to assess the perceptions of final-year pharmacy students and recent graduates regarding their preparedness in technical, psychological, communication, administrative, and research competencies. By identifying critical gaps, we aim to offer evidence-based recommendations to enhance pharmacy education, align with Vision 2030's objectives, and meet international standards.

Methods

Study design and setting

This quantitative, non-experimental, cross-sectional study was conducted using an online survey, targeting final-year pharmacy students, interns and recent pharmacy graduates who completed their studies up to one year ago and final year pharmacy students from both

private and government universities and from different regions in Saudi Arabia. The study was conducted during the 2022/2023 academic year.

Inclusion criteria

The study included final-year pharmacy students, interns, and recent pharmacy graduates (within one year of graduation) from the four regions of Saudi Arabia. These groups were selected due to their direct exposure to pharmaceutical care (PC) through education, clinical training, and internships, allowing for more informed evaluations of their preparedness. Other students were excluded due to insufficient training and knowledge to accurately answer questions related to PC.

Study tool

In this study, a modified questionnaire (Supplementary file 1) was designed to thoroughly assess pharmacy students' perceptions of their preparedness across five key competency domains: technical, psychological, communication, administrative, and research. Adapted from a prior questionnaire [18], the instrument was refined to more accurately capture competencies and barriers relevant to PC within the Saudi Arabian context, ensuring alignment with current educational and professional standards in pharmacy practice. The questionnaire was administered in English language.

The questionnaire modifications involved minor language adjustments, and the introduction of a new section on barriers to effective PC. For instance, in the technical domain, terms were refined for clarity, such as changing "Recommend appropriate drug therapy" to "Suggest appropriate drug therapy," to reflect a more consultative approach suitable for student-level responses. The new barriers section identified context-specific challenges such as time constraints, limited access to up-to-date drug information resources, and insufficient training in PC noted as potential obstacles to practical application. By incorporating these elements, the questionnaire offers a more comprehensive understanding of students' perceived readiness and the practical limitations they may face in delivering PC.

Sampling procedure

The sample for this study was obtained through a convenience sampling approach, a type of nonprobability sampling. The study employed convenience sampling to allow quick access to participants who met the inclusion criteria. This approach is beneficial in studies with limited time or resources, enabling timely data collection. Although it may limit generalizability and introduce selection bias, efforts were made to include a diverse sample to enhance representativeness and ensure a broader range of perspectives. Participants included students who met specific inclusion criteria, were available, and expressed willingness to participate in the research.

Based on a 95% confidence level and an estimated margin of error of 5%, the sample size was calculated using the formula for population proportions:

$$n = z^2 \cdot p \cdot (1 - p)/E^2$$

Where:

Z = 1.96 (for a 95% confidence level).

P = expected proportion of participants meeting the study's criteria (assumed 50% for maximum variability).

E = margin of error (5%).

The calculated sample size was approximately 385 participants. However, due to time and resource constraints, a convenience sample of 278 participants was obtained, which remains sufficient for meaningful analysis, albeit with potential limitations on statistical precision. Additionally, a pilot study with 18 participants was conducted to pretest and refine the data collection tools and procedures.

Participants and data confidentiality

Participants were informed that the questionnaire aimed to assess their perceptions of readiness to effectively deliver PC. Confidentiality and anonymity were assured, with data access restricted to the principal investigator. Participation was voluntary, and respondents were reminded of their right to withdraw their responses at any time before the study's publication. The questionnaire's first page contained a consent form, providing students with the option to proceed or withdraw at any point. The study was approved by the Research Ethics Committee in the College of Pharmacy, Taibah University, KSA (COPTU-REC-65-20230412). The study was conducted following the Declaration of Helsinki's principles.

Questionnaire pilot testing, reliability, and internal consistency

To ensure the questionnaire's clarity, relevance, and suitability for assessing pharmacy students' and recent graduates' preparedness to provide PC, the tool underwent an initial validation process. Faculty members with experience in PC reviewed the questionnaire for clarity, relevance, and face validity, identifying any potentially ambiguous or sensitive items. Necessary changes were made based on the feedback to ensure that the questionnaire was clear and suitable for participants.

Following this review, a pilot study was conducted with 18 final-year pharmacy students and recent graduates to assess the questionnaire's reliability and internal consistency. Cronbach's alpha was calculated for each section, yielding an overall reliability score of 0.961 across 45 items, which indicates strong internal consistency.

Reliability scores for each domain were also high: 0.947 for technical aspects, 0.941 for psychological aspects, 0.838 for communication aspects, 0.926 for administrative aspects, and 0.854 for research aspects.

Data analysis

Descriptive statistics were used to summarize categorical variables, including frequencies and percentages. The distribution of students' perception data regarding their preparedness to provide PC was assessed using the Shapiro-Wilk normality test. Since the data was not normally distributed, nonparametric tests were employed for analysis. The Mann-Whitney U test was used to determine the significance of differences in preparedness scores among different groups involving two categories (e.g., gender and university type). For comparisons involving more than two groups (e.g., age groups, degree type, year of study, and location), the Kruskal-Wallis test was utilized. The effect size, measured by rank-biserial correlation, was calculated for significant results from the Mann-Whitney U tests to provide insight into the strength of the differences between groups. Statistical significance was established at a p-value < 0.05 for all analyses. The Statistical Package for Social Sciences (SPSS) version 26 was used to analyze the data.

Table 1 Demographic characteristics of students

Variables	*N* (%)
Gender	
Male	98(35.3)
Female	180(64.7)
Age **group (years)**	
21–23	75(27)
24–26	158(56.8)
≥ 27	45(16.2)
Degree	
B.Pharm	92(33.1)
PharmD	186(66.9)
Year of study	
Final year	28(10.1)
Internship	47(16.9)
Recent graduates (one year or less)	203(73)
University	
Government	248(89.2)
Private	30(10.8)
Location	
Western region	133(47.8)
Eastern region	44(15.8)
Northern region	30(10.8)
Southern region	71(25.5)

Results

Table 1 provides a demographic overview of 278 students. The cohort was predominantly female (64.7%, $n = 180$). Most students were aged 24–26 years (56.8%, $n = 158$), The majority were enrolled in the PharmD program (66.9%, $n = 186$). Regarding academic status, 73% ($n = 203$) were recent graduates (one year or less), while 16.9% ($n = 47$) were interns and 10.1% ($n = 28$) were in their final year. Most students attended government universities (89.2%, $n = 248$). Geographically, majority 47.8% ($n = 133$) were from the Western region, followed by the Southern region (25.5%, $n = 71$).

Table 2 summarizes pharmacy students' perceptions of their preparedness to provide PC, across various domains: technical, psychological, communication, administrative, and research aspects, as well as perceived barriers. The median scores for most technical skills (e.g., suggesting appropriate drug therapy, evaluating medications, providing patient counseling) were 4 (IQR: 3–5). Psychological preparedness also had a median of 4 for most items (e.g., applying ethical theories, understanding social impacts). However, decision-making involving problem synthesis scored slightly lower with a median of 3.5 (IQR: 3–5). Communication skills, such as conveying information to health professionals and patients, were rated highly, with median scores of 4 (IQR: 3–5). Administrative competencies received lower median scores, generally around 3 (IQR: 2–5).

The perception of preparedness in research-related activities, such as understanding the research process and critically reviewing publications, showed median scores of 3 (IQR: 3–5). Several barriers to providing PC were identified, with median scores of 3 or 4. Issues such as lack of private space for patient counseling and time constraints were rated as significant challenges (median 4, IQR: 3–5).

Table 3 shows differences in students' perceptions of their preparedness to provide PC across various demographic groups. The analysis used mean rank scores to compare perceptions in five domains: technical, psychological, communication, administrative, and research aspects, as well as barriers to providing care.

Female students scored higher than males across all aspects, but significant differences were only found for perceived barriers ($p = 0.002$). For barriers, females had a higher mean rank (149.80) compared to males (119.27) ($P = 0.002$). The effect size, measured by the rank-biserial correlation of -0.110, suggests a small to medium effect. PharmD students consistently had higher mean ranks across all domains compared to B.Pharm students. Statistically significant differences were found in technical aspects ($p = 0.008$), psychological aspects ($p = 0.013$), and research aspects ($p = 0.006$). Additionally, recent graduates (within one year or less) had higher mean ranks

Table 2 Pharmacy students' perception about their preparedness to provide PC

	Median (IQR)
Technical aspects	
1. Suggest appropriate drug therapy	4(3–5)
2. Evaluate medications and/or laboratory tests	4(3–5)
3. Integrate knowledge for pharmacotherapy	4(3–5)
4. Determine the appropriate drug delivery system	4(3–5)
5. Recommend medication doses and dosage schedules	4(3–5)
6. Identify/collect information to resolve a drug related therapy problem	4(3–5)
7. Evaluate laboratory test results for a specific patient	4(3–5)
8. Calculate and evaluate pharmacokinetic properties	3(3–5)
9. Evaluate information from patient's history and assessment	4(3–5)
10. Make reasonable conclusions when data is incomplete	3(3–5)
11. Provide counseling to patients	4(3–5)
12. Devise methods to seek optimal patient compliance (Assess patient adherence)	4(3–5)
13. Monitor therapeutic plan for a patient	4(3–5)
14. Document information on drug-related problems	4(3–5)
Psychological aspects	
15. Gather information to resolve a problem	4(3–5)
16. Synthesize information and decide a course of action for a problem	3.5(3–5)
17. Make decisions integrating social, cultural, and ethical issues	4(3–5)
18. Impact of values in professional interactions	4(3–5)
19. Apply ethical theories to professional decisions	4(3–5)
20. Understand social and cultural impact on health environment	4(3–5)
21. Understand practice related to changing societal expectations	4(3–5)
22. Appropriate interpersonal behaviors during patient interactions	4(3–5)
23. Contribute opinions/insights to healthcare team	4(3–5)
Communication aspects	
24. Communicate medical records information to health professionals	4(3–5)
25. Communicate medical records information to patient	4(3–5)
26. Collect information to respond to a patient DI request	4(3–5)
27. Respond to an information request from a patient	4(3–5)
Administrative aspects	
28. Evaluate, select, and purchase pharmaceuticals	3(2–5)
29. Develop and implement a pharmacy inventory control system	3(2–4)
30. Manage fiscal and human resources	3(2–4)
31. Develop and implement drug use evaluations and formulary	3(3–4)
Research aspects	
32. Describe the research process	3(3–5)
33. Provide a critical review of a publication	3(2–5)
34. Understand the importance and the impact of pharmaceutical care research	4(3–5)
Barriers	
35. No private space for counseling patients about their medications.	4(3–5)
36. Time constraints	4(3–5)
37. Lack of up-to-date drug information resources	3(2–4)
38. limited or insufficient training on pharmaceutical care	3(2–5)
39. Lack of confidence	3(2–4)
40. insufficient communication skills	3(2–5)
41. Limited integration of pharmaceutical care concept in pharmacy curriculum	3(2–4)
42. Regulatory restrictions	3(2–4)
43. Insufficient emphasis on the importance of pharmaceutical care during students' experiential training	3(2–4)
44. Emphasis on productivity over patient care	3(2–4)
45. Inadequate mentorship and guidance	3(2–5)

IQR = Interquartile Range

Table 3 Differences in scores of students' perception about their preparedness to provide PC among different groups

Variables	*N* (%)	Technical aspects		Psychological aspects		Communication aspects		Administrative aspects		Research aspects		Barriers	
		Mean rank	*P* value	Mean rank	*P* value	Mean rank	*P* value	Mean rank	*P* value	Mean rank	*P* value	Mean rank	*P* value
Gender			0.077		0.077		0.30		0.11		0.149		0.002
Male	98(35.3)	127.94		126.95		130.78		132.92		130.15		119.27	
Female	180(64.7)	145.79		144.79		143.16		143.08		144.95		149.80	
Age			0.150		0.639		0.720		0.224		0.350		0.913
21–23	75(27)	127.19		132.14		133.64		127.42		128.93		140.47	
24–26	158(56.8)	140.50		141.67		140.71		141.56		145.66		139.61	
≥ 27	45(16.2)	156.48		144.14		145.03		152.39		135.50		134.42	
Degree			0.008		0.013		0.057		0.196		0.006		0.365
B.Pharm	92(33.1)	121.25		122.59		126.58		130.68		120.96		142.07	
PharmD	186(66.9)	148.53		147.87		145.89		143.86		148.67		132.82	
Year of study			0.121		0.203		0.186		0.045		0.078		0.269
Final year	28(10.1)	120.41		122.27		125.55		112.34		112.59		128.84	
Internship	47(16.9)	125.04		127.48		124.80		125.63		129.48		124.83	
Recent graduates (one year or less)	203(73)	145.48		144.66		144.83		146.46		145.53		143.71	
University			0.467		0.887		0.607		0.163		0.905		0.183
Government	248(89.2)	138.28		139.26		138.65		137.18		139.3		136.77	
Private	30(10.8)	149.57		144.47		146.57		158.70		141.13		157.38	
Location			0.187		0.323		0.806		0.400		0.737		0.401
Western region	133(47.8)	138.83		144.30		142.67		133.88		144.17		143.33	
Eastern region	44(15.8)	141.47		134.86		142.16		143.34		139.39		140.68	
Northern region	30(10.8)	112.67		115.52		127.83		118.08		127.65		115.77	
Southern region	71(25.5)	150.87		143.51		136.85		147.32		135.84		139.67	

across all aspects compared to final-year students and interns. A significant difference was found in administrative aspects ($p = 0.045$).

Discussion

Final year pharmacy students, interns and recent pharmacy graduates reported generally high confidence in their preparedness for various aspects of PC, particularly in technical, psychological, and communication skills, with median scores of 4 for most items. Specifically, participants felt competent in tasks such as suggesting drug therapy, counseling patients, and applying ethical considerations. However, certain technical skills, like pharmacokinetic calculations, and psychological tasks requiring complex decision-making scored slightly lower, indicating areas of moderate confidence. Administrative and research-related competencies also reflected moderate confidence, suggesting these areas may benefit from enhanced support. Additionally, students identified significant barriers to effective PC, including lack of private space, time constraints, limited resources, and regulatory issues. These findings highlight students' overall preparedness while underscoring the need for targeted improvements in administrative, research, and environmental support.

This study's findings align with research from Saudi Arabia [13], Qatar [14], UAE [19], and the USA [18], highlighting common gaps in administrative and research competencies among pharmacy students and the need for targeted curriculum improvements. Our study's findings are similar to those of a previous Saudi study [13], where female students reported feeling more prepared than male students, and PharmD students reported feeling more prepared than B.Pharm students. This suggests that program-specific adjustments may help bridge competency gaps, particularly in technical and psychological skills. A study conducted in Qatar [14] complements these findings by emphasizing structural barriers like limited access to patient records and time constraints, which contribute to lower perceived readiness in administrative tasks. Similarly, a study from UAE [19] noted deficiencies in administrative and research competencies, with inadequate facilities and limited resources as additional challenges. These studies collectively stress the importance of enhancing practical training and infrastructure to improve preparedness. Moreover, our study supports the conclusions of a recent systematic review [12] emphasizing the need for curriculum enhancements that integrate practical training and address structural limitations. Such improvements would offer students a more consistent and comprehensive preparation to meet the demands of PC care in diverse healthcare settings. A study conducted in the USA also parallels these findings, particularly regarding administrative weaknesses and limited confidence in research skills, despite curricular adjustments [18]. Both the U.S. and our studies indicate that these competencies need reinforcement through early and consistent integration into the curriculum.

Our study findings have several implications for pharmacy education, emphasizing the need to strengthen certain competencies and address structural barriers to better prepare students for comprehensive PC. First, the moderate confidence in technical areas like pharmacokinetics and decision-making with incomplete data suggests a need for more focused training on analytical and problem-solving skills, possibly through problem-based learning and practical simulations [10, 20–23]. The lower scores in administrative and research skills highlight the importance of integrating management and research components more robustly into the curriculum, as these areas are critical for well-rounded pharmacy professionals. Additionally, the identified barriers, such as inadequate counseling space and limited resources, suggest that pharmacy programs should consider advocating for improved infrastructure in training environments, as well as aligning curriculum outcomes with real-world practice constraints [24]. Overall, these insights suggest that pharmacy education should incorporate a balanced focus on technical, psychological, communication, administrative, and research skills, while actively working to minimize barriers, to ensure graduates are fully equipped to meet the demands of modern PC.

This study addresses a critical gap in Saudi Arabian pharmacy education literature by examining pharmacy students' preparedness across key competencies and identifying areas for improvement in PC skills. The identification of barriers, such as resource limitations and time constraints, underscores practical challenges that impact students' training and readiness. resource limitations and time constraints were similarly reported by other studies around the world [14, 25–27]. These findings offer valuable insights for educators and policymakers to refine pharmacy education in Saudi Arabia, with an emphasis on strengthening competencies in PC to meet local and international standards. The study serves as a foundational reference for ongoing curriculum improvements and training resource allocation, setting a benchmark for future research in the region and fostering targeted advancements in pharmacy education.

Conclusion

While students generally reported high confidence in technical, psychological, and communication skills, moderate confidence in administrative and research competencies suggests specific gaps that may limit their effectiveness in practical settings. Additionally, structural and resource-related barriers, such as limited counseling space, time constraints, and regulatory issues, impact

students' ability to provide optimal care. Comparisons with studies from other MENA countries and the U.S. underscore the need for consistent curriculum enhancements across technical and soft skills, better alignment with real-world healthcare demands, and the integration of practical training to build competency in all aspects of PC.

Recommendations

To enhance pharmacy education in Saudi Arabia, several measures are recommended based on this study findings. First, incorporating targeted training on administrative and research skills into the curriculum can improve students' confidence in management and analytical tasks by providing structured learning experiences, including hands-on practice with simulated case scenarios and interactive problem-solving sessions. Curricula should also feature dedicated modules and experiential learning opportunities focused on administrative tasks (e.g., regulatory compliance, leadership) and research competencies (e.g., data analysis, evidence-based practice). Second, practical training should be improved by addressing obstacles such as limited counseling spaces and by fostering real-world experience through collaborations with healthcare facilities. Standardizing curriculum benchmarks across programs is essential to ensure consistent competency levels among graduates. Furthermore, additional research exploring factors such as personal attributes and extracurricular involvement can help refine educational strategies. Collaboration among educators, policymakers, and healthcare stakeholders is crucial, along with increased funding and shared resources, to overcome structural challenges. These efforts will better equip pharmacy graduates to meet the evolving demands of modern healthcare in Saudi Arabia.

Limitations

The sample was drawn from a convenient sample of institutions, which may not fully represent the broader student population across the country, limiting generalizability. Self-reported data introduces potential response biases, influenced by social desirability or limited self-awareness of competencies. Additionally, the study focused on specific domains of preparedness, omitting factors such as personal attributes, extracurricular activities, and unique curricular features, which could enhance understanding in future research. The cultural and educational context of Saudi Arabia presents unique elements that may not align with other regions, cautioning against direct cross-cultural comparisons. Moreover, variations in clinical training quality and faculty support, which likely influence perceived preparedness, were not explored and merit attention in future studies. Selection bias is another concern, as participants were recruited based on availability and willingness, potentially over-representing students who are highly motivated and equipped in PC. Broader geographic inclusion and random sampling in future research could improve representativeness.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12909-025-06947-9.

Supplementary Material 1

Author contributions

Mansour Adam Mahmoud contributed to the conceptualization, study design, and manuscript writing. Haifa A Fadil participated in data analysis, interpretation, and manuscript editing. Safaa Hassan Omer, Rahaf Faisal Alsharif and Mohammad Fahad Alsehli contributed to literature review and data collection. Saeed Obeid Alfadly and Samah Mohammed Hussein contributed to resource acquisition and data validation. Sultan S. Al Thagfan and Sultan O. Alolayan provided critical revisions and supervised the project. Yaser M. Alahmadi provided guidance on project administration and final manuscript approval. All authors read and approved the final manuscript.

Data availability

Data access is restricted to the principal investigator.

Declarations

Competing interests

The authors declare no competing interests.

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