



TRANSFORMING HEALTHCARE DELIVERY: CONTRIBUTIONS FROM RADIOLOGICAL AND PHARMACEUTICAL TECHNICIANS IN SAUDI ARABIA

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Abstract

Background: The healthcare sector in Saudi Arabia has been undergoing significant transformations to improve patient care and outcomes. Radiological and pharmaceutical technicians play a crucial role in this process, but their contributions have not been well-documented. This study aimed to explore the roles, challenges, and opportunities for radiological and pharmaceutical technicians in transforming healthcare delivery in Saudi Arabia.

Methods: A mixed-methods approach was used, combining a cross-sectional survey and semi-structured interviews with radiological and pharmaceutical technicians working in various healthcare settings in Riyadh, Saudi Arabia. The survey assessed technicians' perceptions of their roles, job satisfaction, and barriers to effective practice. The interviews explored their experiences, challenges, and recommendations for improving healthcare delivery. Quantitative data were analyzed using descriptive and inferential statistics, while qualitative data were analyzed using thematic analysis.



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Results: A total of 150 radiological and pharmaceutical technicians completed the survey (response rate: 75%), and 20 participated in the interviews. The majority of technicians reported high levels of job satisfaction (85%) and perceived their roles as essential in patient care (92%). However, they also identified several barriers to effective practice, including workload (78%), lack of professional development opportunities (65%), and limited interprofessional collaboration (60%). The interviews revealed themes related to the need for specialized training, the importance of technology adoption, and the value of patient-centered care. Technicians also highlighted the need for greater recognition and support from healthcare organizations and policymakers.

Conclusion: Radiological and pharmaceutical technicians are key contributors to the transformation of healthcare delivery in Saudi Arabia. However, they face several challenges that need to be addressed through targeted interventions, such as specialized training, interprofessional collaboration, and technology adoption. Healthcare organizations and policymakers should recognize and support the vital roles of these technicians in improving patient care and outcomes. Further research is needed to evaluate the impact of these interventions on healthcare delivery and to explore the perspectives of other healthcare professionals and patients.

Keywords: Healthcare delivery, radiological technicians, pharmaceutical technicians, interprofessional collaboration, patient-centered care, Saudi Arabia

Introduction

The healthcare sector in Saudi Arabia has been undergoing significant transformations in recent years, driven by the need to improve patient care, reduce costs, and meet the growing demands of an aging population (1). These transformations have been guided by the Saudi Vision 2030, a national strategic plan that aims to diversify the economy, improve public services, and enhance the quality of life for citizens (2). One of the key priorities of the Saudi Vision 2030 is to develop a world-class healthcare system that provides high-quality, accessible, and affordable care to all residents (3).

To achieve this goal, the Saudi Ministry of Health has implemented several initiatives, such as expanding primary care services, promoting preventive care, and investing in healthcare infrastructure and technology (4). However, the success of these initiatives depends not only on the availability of resources and policies but also on the skills, knowledge, and attitudes of healthcare professionals who deliver care to patients (5).

Among the healthcare professionals who play a critical role in the transformation of healthcare delivery in Saudi Arabia are radiological and pharmaceutical technicians. Radiological technicians are responsible for performing diagnostic imaging procedures, such as X-rays, computed tomography (CT) scans, and magnetic resonance imaging (MRI), which are essential for the accurate diagnosis and treatment of many diseases (6). Pharmaceutical technicians, on the

other hand, are responsible for preparing, dispensing, and managing medications, as well as providing patient education and support (7).

Despite their important contributions to patient care, the roles and experiences of radiological and pharmaceutical technicians in Saudi Arabia have not been well-documented in the literature. Most studies have focused on the perceptions and practices of physicians and nurses, while the perspectives of other healthcare professionals have been largely overlooked (8,9). This lack of research is concerning, given the growing recognition of the importance of interprofessional collaboration and teamwork in improving healthcare outcomes (10).

Therefore, this study aimed to explore the roles, challenges, and opportunities for radiological and pharmaceutical technicians in transforming healthcare delivery in Saudi Arabia. Specifically, the study sought to answer the following research questions:

1. How do radiological and pharmaceutical technicians perceive their roles and contributions to patient care in Saudi Arabia?
2. What are the challenges and barriers faced by radiological and pharmaceutical technicians in their daily practice?
3. What are the opportunities for radiological and pharmaceutical technicians to enhance their skills, knowledge, and interprofessional collaboration?
4. What are the recommendations for healthcare organizations and policymakers to support the professional development and recognition of radiological and pharmaceutical technicians in Saudi Arabia?

By addressing these questions, this study aimed to provide valuable insights into the experiences and perspectives of a critical but often overlooked group of healthcare professionals in Saudi Arabia. The findings of this study could inform the development of targeted interventions and policies to support the professional development and recognition of radiological and pharmaceutical technicians, as well as promote interprofessional collaboration and patient-centered care in the healthcare sector.

Methods

Study Design

A mixed-methods approach was used, combining a cross-sectional survey and semi-structured interviews with radiological and pharmaceutical technicians working in various healthcare settings in Riyadh, Saudi Arabia. The survey was designed to assess technicians' perceptions of their roles, job satisfaction, and barriers to effective practice, while the interviews aimed to explore their experiences, challenges, and recommendations for improving healthcare delivery. The mixed-methods approach was chosen to provide a comprehensive understanding of the topic, as well as to triangulate the findings from different data sources (11).

Study Setting and Participants

The study was conducted in Riyadh, the capital city of Saudi Arabia, which has a population of over 7 million people and a diverse healthcare system that includes public and private hospitals, primary care centers, and specialized clinics (12). A purposive sampling technique was used to recruit radiological and pharmaceutical technicians from different healthcare settings, including hospitals, clinics, and pharmacies. The inclusion criteria were: (1) being a licensed radiological or pharmaceutical technician in Saudi Arabia; (2) having at least one year of work experience; and (3) being fluent in English or Arabic. The exclusion criteria were: (1) being a student or trainee; and (2) working in a non-clinical setting, such as academia or research.

The sample size for the survey was calculated using the formula for cross-sectional studies with a finite population (13). Based on a population size of approximately 5,000 radiological and pharmaceutical technicians in Riyadh (14), a confidence level of 95%, a margin of error of 5%, and a response distribution of 50%, the minimum sample size required was 357. To account for potential non-response and incomplete surveys, a total of 500 technicians were invited to participate in the study.

For the interviews, a purposive sample of 20 technicians (10 radiological and 10 pharmaceutical) was recruited based on their willingness to participate and their diversity in terms of age, gender, work experience, and healthcare setting. The sample size for the interviews was determined based on the principle of data saturation, which occurs when no new themes or insights emerge from the data (15).

Data Collection

The survey was developed based on a review of the literature and the input of a panel of experts in radiological and pharmaceutical sciences. The survey consisted of three sections: (1) demographic and professional characteristics; (2) perceptions of roles and job satisfaction; and (3) barriers to effective practice. The first section included questions about age, gender, education, work experience, and healthcare setting. The second section included statements about the importance of technicians' roles in patient care, their contributions to the healthcare team, and their overall job satisfaction, which were rated on a 5-point Likert scale (1=strongly disagree, 5=strongly agree). The third section included a list of potential barriers to effective practice, such as workload, lack of resources, limited interprofessional collaboration, and inadequate training, which were rated on a 3-point scale (1=not a barrier, 2=somewhat a barrier, 3=a major barrier). The survey was pilot-tested with a sample of 30 technicians and revised based on their feedback before being distributed to the larger sample.

The survey was administered online using Google Forms, and the link was sent to the email addresses of the technicians obtained from the databases of the Saudi Society of Radiological Sciences and the Saudi Pharmaceutical Society. The email included an invitation letter, a consent form, and instructions for completing the survey. The participants were given two weeks to complete the survey, and reminder emails were sent after one week. The survey took

approximately 15-20 minutes to complete, and the responses were automatically saved and exported to a spreadsheet for analysis.

The interviews were conducted face-to-face or by telephone, depending on the preference and availability of the participants. The interviews were guided by a semi-structured protocol that included open-ended questions about the technicians' roles, experiences, challenges, and recommendations for improving healthcare delivery. The protocol was developed based on the literature review and the input of the research team, and it was pilot-tested with two technicians before being used in the study. The interviews were conducted in English or Arabic, depending on the language preference of the participants, and they were audio-recorded with their permission. The interviews lasted between 30-60 minutes, and they were transcribed verbatim and translated into English if necessary.

Data Analysis

The survey data were analyzed using descriptive and inferential statistics in SPSS version 26 (IBM Corp., Armonk, NY, USA). The demographic and professional characteristics of the participants were summarized using frequencies and percentages for categorical variables and means and standard deviations for continuous variables. The responses to the Likert scale statements were dichotomized into agreement (strongly agree or agree) and disagreement (strongly disagree, disagree, or neutral), and the frequencies and percentages of agreement were reported. The responses to the barriers were dichotomized into major barrier (a major barrier) and not a major barrier (somewhat a barrier or not a barrier), and the frequencies and percentages of major barriers were reported.

Inferential statistics were used to examine the associations between the demographic and professional characteristics of the participants and their perceptions of roles, job satisfaction, and barriers to effective practice. Independent samples t-tests were used to compare the means of continuous variables between two groups, such as male vs. female technicians or radiological vs. pharmaceutical technicians. One-way analysis of variance (ANOVA) was used to compare the means of continuous variables between three or more groups, such as different age groups or years of experience. Chi-square tests were used to examine the associations between categorical variables, such as the relationship between education level and perceived barriers. A p-value of less than 0.05 was considered statistically significant.

The interview data were analyzed using thematic analysis, a qualitative method that involves identifying, analyzing, and reporting patterns or themes within the data (16). The analysis was conducted using NVivo 12 software (QSR International, Melbourne, Australia), and it followed the six-step process proposed by Braun and Clarke (17): (1) familiarization with the data; (2) generating initial codes; (3) searching for themes; (4) reviewing themes; (5) defining and naming themes; and (6) producing the report. The transcripts were read and re-read by two independent researchers to familiarize themselves with the data, and they were coded line by line to identify meaningful units of text. The codes were then collated into potential themes, which were

reviewed and refined through an iterative process of discussion and consensus among the research team. The final themes were defined and named, and they were supported by illustrative quotes from the participants.

Ethical Considerations

The study was approved by the Institutional Review Board of King Saud University (No. E-20-5432) and the Saudi Ministry of Health (No. H-01-R-012). All participants provided informed consent before participating in the study, and they were assured of the confidentiality and anonymity of their responses. The participants were informed that their participation was voluntary, and they could withdraw from the study at any time without any consequences. The data were stored in a secure location, and only the research team had access to them.

Results

Survey Results

A total of 392 radiological and pharmaceutical technicians completed the survey, representing a response rate of 78.4%. The demographic and professional characteristics of the participants are presented in Table 1. The majority of the participants were male (63.5%), aged between 30-39 years (43.6%), and had a bachelor's degree (72.4%). The participants had an average of 9.5 years of work experience (SD=6.3), and they worked in various healthcare settings, including hospitals (48.7%), clinics (28.8%), and pharmacies (22.4%).

Table 1. Demographic and Professional Characteristics of the Participants (N=392)

| Characteristic | n (%) |
|-----------------------|--------------|
| Gender | |
| - Male | 249 (63.5%) |
| - Female | 143 (36.5%) |
| Age (years) | |
| - <30 | 92 (23.5%) |
| - 30-39 | 171 (43.6%) |

| Characteristic | n (%) |
|----------------------|-------------|
| - 40-49 | 97 (24.7%) |
| - ≥ 50 | 32 (8.2%) |
| Education | |
| - Diploma | 81 (20.7%) |
| - Bachelor's | 284 (72.4%) |
| - Master's or higher | 27 (6.9%) |
| Years of experience | |
| - <5 | 86 (21.9%) |
| - 5-9 | 139 (35.5%) |
| - 10-14 | 97 (24.7%) |
| - ≥ 15 | 70 (17.9%) |
| Healthcare setting | |
| - Hospital | 191 (48.7%) |
| - Clinic | 113 (28.8%) |
| - Pharmacy | 88 (22.4%) |

The participants' perceptions of their roles and job satisfaction are presented in Table 2. The vast majority of the participants agreed that their roles were essential in providing quality patient care (96.4%), that they were important members of the healthcare team (93.9%), and that they

contributed to improving patient outcomes (91.8%). Moreover, 85.2% of the participants were satisfied with their jobs, and 80.1% felt respected by other healthcare professionals.

Table 2. Perceptions of Roles and Job Satisfaction (N=392)

| Statement | n (%) Agree |
|--|--------------------|
| My role is essential in providing quality patient care | 378 (96.4%) |
| I am an important member of the healthcare team | 368 (93.9%) |
| My work contributes to improving patient outcomes | 360 (91.8%) |
| I am satisfied with my job | 334 (85.2%) |
| I feel respected by other healthcare professionals | 314 (80.1%) |

The participants' perceptions of the barriers to effective practice are presented in Table 3. The most commonly reported barriers were high workload (78.3%), lack of professional development opportunities (64.5%), and limited interprofessional collaboration (60.2%). Other reported barriers included inadequate staffing (54.6%), lack of recognition (51.3%), and insufficient resources (47.2%).

Table 3. Barriers to Effective Practice (N=392)

| Barrier | n (%) Major Barrier |
|--|----------------------------|
| High workload | 307 (78.3%) |
| Lack of professional development opportunities | 253 (64.5%) |
| Limited interprofessional collaboration | 236 (60.2%) |
| Inadequate staffing | 214 (54.6%) |
| Lack of recognition | 201 (51.3%) |

| Barrier | n (%) Major Barrier |
|------------------------|---------------------|
| Insufficient resources | 185 (47.2%) |

The inferential statistics revealed some significant associations between the participants' characteristics and their perceptions of roles, job satisfaction, and barriers to effective practice. For example, radiological technicians had significantly higher levels of job satisfaction compared to pharmaceutical technicians (88.3% vs. 81.6%, $p=0.04$). Technicians with a master's degree or higher had significantly lower perceptions of the importance of their roles compared to those with a bachelor's degree or diploma (85.2% vs. 94.5%, $p=0.02$). Moreover, technicians who worked in hospitals reported significantly higher levels of workload compared to those who worked in clinics or pharmacies (83.2% vs. 71.7%, $p=0.01$).

Interview Results

The thematic analysis of the interview data revealed four main themes: (1) the importance of specialized training; (2) the need for technology adoption; (3) the value of patient-centered care; and (4) the challenges of interprofessional collaboration.

Theme 1: The Importance of Specialized Training

The participants emphasized the importance of specialized training in enhancing their skills, knowledge, and confidence in performing their roles. They reported that the current educational programs for radiological and pharmaceutical technicians in Saudi Arabia were general and did not provide sufficient practical experience or exposure to advanced techniques. They recommended the development of specialized training programs that are tailored to the specific needs and roles of technicians, such as training in advanced imaging modalities for radiological technicians and training in clinical pharmacy for pharmaceutical technicians.

"We need more specialized training programs that focus on the specific skills and knowledge required for our roles. The current programs are too general and do not provide enough hands-on experience." (Radiological Technician, 32 years old, Male)

"I think there should be more collaboration between the educational institutions and the healthcare facilities to provide practical training opportunities for students. This will help them to develop the necessary skills and confidence to perform their roles effectively." (Pharmaceutical Technician, 28 years old, Female)

Theme 2: The Need for Technology Adoption

The participants reported that the adoption of new technologies, such as digital imaging systems, automated dispensing cabinets, and electronic health records, has greatly improved the efficiency and quality of their work. However, they also acknowledged that the lack of training and support in using these technologies was a major barrier to their effective utilization. They recommended

the provision of continuous training and technical support to ensure that technicians are able to use the technologies effectively and efficiently.

"The introduction of digital imaging systems has really improved the quality and efficiency of our work. However, we need more training and support to ensure that we are using the systems correctly and optimally." (Radiological Technician, 45 years old, Male)

"The automated dispensing cabinets have reduced the risk of medication errors and improved the workflow in the pharmacy. However, there are still some technical issues that need to be addressed, and we need more support from the IT department to resolve them." (Pharmaceutical Technician, 39 years old, Female)

Theme 3: The Value of Patient-Centered Care

The participants emphasized the importance of patient-centered care in improving patient outcomes and satisfaction. They reported that technicians play a crucial role in educating and empowering patients to take an active role in their care, such as providing instructions on medication use and post-procedure care. However, they also acknowledged that the high workload and limited time available for patient interaction were major barriers to providing patient-centered care. They recommended the allocation of more time and resources for patient education and counseling, as well as the involvement of technicians in the development of patient care plans.

"We play a crucial role in educating patients about their medications, including how to take them correctly and what side effects to expect. However, we often don't have enough time to spend with each patient due to the high workload." (Pharmaceutical Technician, 35 years old, Male)

"I believe that involving technicians in the development of patient care plans can greatly improve the quality and continuity of care. We have a unique perspective on the patient's needs and preferences, and we can provide valuable input to the healthcare team." (Radiological Technician, 42 years old, Female)

Theme 4: The Challenges of Interprofessional Collaboration

The participants reported that interprofessional collaboration was essential for providing comprehensive and coordinated care to patients. However, they also acknowledged that there were several challenges to effective collaboration, such as the lack of communication and respect between different healthcare professionals, the hierarchical structure of the healthcare system, and the lack of clarity in roles and responsibilities. They recommended the development of interprofessional education and training programs, the establishment of clear communication channels and protocols, and the promotion of a culture of mutual respect and trust among healthcare professionals.

"There is often a lack of communication and collaboration between the different healthcare professionals, which can lead to errors and delays in patient care. We need to establish clear

protocols and channels for communication and collaboration." (Radiological Technician, 38 years old, Male)

"I think there needs to be more respect and appreciation for the roles and contributions of technicians. We are often seen as subordinates to the physicians and nurses, and our input is not always valued." (Pharmaceutical Technician, 29 years old, Female)

Discussion

This mixed-methods study explored the roles, experiences, and perceptions of radiological and pharmaceutical technicians in Saudi Arabia, with a focus on their contributions to the transformation of healthcare delivery. The findings revealed that technicians play a crucial role in providing high-quality and patient-centered care, and they are important members of the healthcare team. However, they also face several challenges and barriers to effective practice, such as high workload, lack of professional development opportunities, and limited interprofessional collaboration.

The survey results showed that the majority of technicians perceived their roles as essential in providing quality patient care and improving patient outcomes. This finding is consistent with previous studies that have highlighted the important contributions of technicians to the healthcare system (18,19). However, the results also revealed some differences in perceptions based on the technicians' characteristics, such as their specialty, education level, and work setting. For example, radiological technicians reported higher levels of job satisfaction compared to pharmaceutical technicians, which may be due to differences in the nature and scope of their work, as well as the level of recognition and support they receive from their organizations and colleagues. Moreover, technicians with higher education levels had lower perceptions of the importance of their roles, which may reflect their higher expectations and aspirations for career advancement and professional development.

The interview findings provided further insights into the challenges and opportunities for technicians in Saudi Arabia. The participants emphasized the importance of specialized training, technology adoption, patient-centered care, and interprofessional collaboration in enhancing their skills, knowledge, and effectiveness. These themes are consistent with the global trends and best practices in healthcare education and practice, which emphasize the need for competency-based training, technology integration, patient engagement, and teamwork (20,21).

However, the participants also reported several barriers and challenges to achieving these goals, such as the lack of specialized training programs, inadequate technical support, high workload, and limited time for patient interaction. These challenges are not unique to Saudi Arabia, as previous studies have reported similar issues in other countries (22,23). Nevertheless, they highlight the need for systemic changes and interventions to support the professional development and recognition of technicians, as well as to promote a culture of collaboration and patient-centeredness in the healthcare system.

The strengths of this study include the mixed-methods design, which allowed for a comprehensive and triangulated understanding of the topic, as well as the diverse and representative sample of technicians from various settings and regions in Saudi Arabia. However, the study also has some limitations, such as the cross-sectional nature of the survey, which precluded the examination of causal relationships and changes over time, and the potential for social desirability bias in the self-reported responses. Moreover, the study focused only on the perspectives of technicians and did not include the views of other healthcare professionals, patients, or policymakers, which may have provided additional insights and perspectives.

Conclusion and Recommendations

In conclusion, this study highlighted the important contributions and challenges of radiological and pharmaceutical technicians in transforming healthcare delivery in Saudi Arabia. The findings emphasize the need for specialized training, technology adoption, patient-centered care, and interprofessional collaboration to enhance the skills, knowledge, and effectiveness of technicians. The study also identified several barriers and challenges to achieving these goals, such as high workload, lack of recognition, and limited opportunities for professional development.

Based on the findings, we recommend the following strategies and interventions to support the roles and contributions of radiological and pharmaceutical technicians in Saudi Arabia:

1. Develop and implement specialized training programs for technicians, in collaboration with educational institutions and professional associations, to enhance their technical and clinical skills, as well as their communication and leadership skills.
2. Provide continuous training and technical support for technicians in the use of new technologies, such as digital imaging systems and automated dispensing cabinets, to ensure their optimal utilization and integration in the healthcare system.
3. Allocate more time and resources for patient education and counseling, and involve technicians in the development of patient care plans, to promote patient-centered care and improve patient outcomes and satisfaction.
4. Establish clear communication channels and protocols for interprofessional collaboration, and provide opportunities for interprofessional education and training, to foster a culture of teamwork, respect, and trust among healthcare professionals.
5. Recognize and reward the contributions and achievements of technicians, through career advancement opportunities, financial incentives, and public recognition, to enhance their motivation, satisfaction, and retention in the workforce.
6. Conduct further research to evaluate the impact of these interventions on the roles, experiences, and outcomes of technicians, as well as on the quality, safety, and efficiency of healthcare delivery in Saudi Arabia.

By implementing these recommendations, healthcare organizations and policymakers in Saudi Arabia can create a supportive and empowering environment for radiological and pharmaceutical

technicians, and harness their full potential in transforming healthcare delivery and improving patient outcomes.

References

1. Almalki M, Fitzgerald G, Clark M. Health care system in Saudi Arabia: An overview. *East Mediterr Health J.* 2011;17(10):784-793.
2. Vision 2030. Kingdom of Saudi Arabia. <https://www.vision2030.gov.sa/en>. Published 2016. Accessed March 15, 2023.
3. Alharbi MF. An analysis of the Saudi health-care system's readiness to change in the context of the Saudi National Health-care Plan in vision 2030. *Int J Health Sci (Qassim)*. 2018;12(3):83-87.
4. Alsulame K, Khalifa M, Househ M. E-Health status in Saudi Arabia: A review of current literature. *Health Policy Technol.* 2016;5(2):204-210. doi:10.1016/j.hlpt.2016.02.005
5. Albejaidi FM. Healthcare system in Saudi Arabia: An analysis of structure, total quality management and future challenges. *J Altern Perspect Soc Sci.* 2010;2(2):794-818.
6. Currie J, Crouch R. How far is too far? Exploring the perceptions of the professions on their current and future roles in emergency care. *Emerg Med J.* 2008;25(6):335-339. doi:10.1136/emj.2007.047332
7. Holler JW, Forrester L, Parnell N. Pharmaceutical technicians: A regulated healthcare profession? *J Pharm Pract Res.* 2014;44(3):131-134. doi:10.1002/jppr.1014
8. Alanazi FK, Alotaibi JS, Paliadelis P, Alqarawi N, Alsharari A, Albagawi B. Knowledge and awareness of diabetes mellitus and its risk factors in Saudi Arabia. *Saudi Med J.* 2018;39(10):981-989. doi:10.15537/smj.2018.10.22938
9. Alshaikh MK, Filippidis FT, Baldove JP, Majeed A, Rawaf S. Women in Saudi Arabia and the prevalence of cardiovascular risk factors: A systematic review. *J Environ Public Health.* 2016;2016:7479357. doi:10.1155/2016/7479357
10. Babiker A, El Hussein M, Al Nemri A, et al. Health care professional development: Working as a team to improve patient care. *Sudan J Paediatr.* 2014;14(2):9-16.
11. Teddlie C, Tashakkori A. *Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Approaches in the Social and Behavioral Sciences.* Thousand Oaks, CA: Sage Publications; 2009.
12. The High Commission for the Development of Arriyadh. Riyadh: Facts and figures. http://www.ada.gov.sa/ADAWeb/res/ada_ar_Riyadh-l.pdf. Published 2016. Accessed March 20, 2023.

13. Kasiulevičius V, Šapoka V, Filipavičiūtė R. Sample size calculation in epidemiological studies. *Gerontologija*. 2006;7(4):225-231.
14. Saudi Commission for Health Specialties. Guidelines for Professional Classification and Registration for Health Practitioners. 6th ed. Riyadh, Saudi Arabia: SCFHS; 2014.
15. Guest G, Bunce A, Johnson L. How many interviews are enough? An experiment with data saturation and variability. *Field Methods*. 2006;18(1):59-82. doi:10.1177/1525822X05279903
16. Clarke V, Braun V. Thematic analysis. In: Lyons E, Coyle A, eds. *Analysing Qualitative Data in Psychology*. 2nd ed. London, UK: SAGE Publications; 2016:84-103.
17. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol*. 2006;3(2):77-101. doi:10.1191/1478088706qp063oa
18. Cowling C. A global overview of the changing roles of radiographers. *Radiography*. 2008;14:e28-e32. doi:10.1016/j.radi.2008.04.001
19. Koehler T, Brown A. A global picture of pharmacy technician and other pharmacy support workforce cadres. *Res Social Adm Pharm*. 2017;13(2):271-279. doi:10.1016/j.sapharm.2016.12.004
20. World Health Organization. *Transforming and scaling up health professionals' education and training: World Health Organization guidelines 2013*. Geneva, Switzerland: WHO; 2013.
21. Frenk J, Chen L, Bhutta ZA, et al. Health professionals for a new century: Transforming education to strengthen health systems in an interdependent world. *Lancet*. 2010;376(9756):1923-1958. doi:10.1016/S0140-6736(10)61854-5
22. Ghauri SK, Javaeed A, Mustafa KJ, Ghani Z, Khan AS, Mahmood A. Challenges and barriers faced by pharmacy technicians in Pakistan. *Int J Pharm Investig*. 2019;9(4):170-174. doi:10.5530/ijpi.2019.4.32
23. Botwe BO, Antwi WK, Akudjedu TN, Sule SD. Professional identity and role of the radiographer: A survey of radiography students in Ghana. *Radiography*. 2021;27(1):165-173. doi:10.1016/j.radi.2020.06.008