

Exploring the Impact of Education on Medication Safety Practices Among Pharmacy Technicians and Health Assistants in Saudi Arabia's Vision 2030 Framework: A Review

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Abstract

Medication safety is a critical component of healthcare quality and patient safety. In Saudi Arabia, the Vision 2030 framework emphasizes the importance of developing a skilled healthcare workforce to improve the quality and efficiency of healthcare services. Pharmacy technicians and health assistants play a vital role in medication management and patient care, but their knowledge and practices related to medication safety may vary. This review aims to explore the impact of education on medication safety practices among pharmacy technicians and health assistants in Saudi Arabia within the context of the Vision 2030 framework. A comprehensive search of PubMed, Scopus, and Web of Science databases was conducted for studies published between 2010 and 2024, using keywords such as "medication safety," "pharmacy technicians," "health assistants," "education," "training," and "Saudi Arabia." A total of 22 studies met the inclusion criteria and were included in the review. The findings suggest that education and training programs can improve pharmacy technicians' and health assistants' knowledge, attitudes, and practices related to medication safety, such as medication preparation, dispensing, monitoring, and patient education. However, the studies also identified various barriers to implementing medication safety practices, such as workload, time constraints, inadequate resources, and lack of interprofessional collaboration. The review highlights the need for standardized education and training programs, competency assessment, and continuing professional development for pharmacy technicians and health assistants in Saudi Arabia, aligned with the Vision 2030 goals. Further research is needed to evaluate the long-term impact of education on medication safety outcomes and to identify best practices for integrating medication safety into the roles and responsibilities of pharmacy technicians and health assistants in Saudi Arabia.

Keywords: medication safety, pharmacy technicians, health assistants, education, training, Saudi Arabia, Vision 2030

1. Introduction

Medication safety is a global public health priority, as medication errors and adverse drug events can cause significant harm to patients, increase healthcare costs, and reduce the quality of care (World Health Organization, 2017). In Saudi Arabia, medication errors are a common problem, with an estimated prevalence of 18-56% in hospital settings (Aljadhey et al., 2013). The Saudi Ministry of Health has identified medication safety as a key priority in its strategic plans, including the National Transformation Program 2020 and the Vision 2030 framework (Alomi et al., 2018a).

The Vision 2030 framework, launched in 2016, is a comprehensive roadmap for economic and social reforms in Saudi Arabia, aiming to diversify the economy, improve public services, and enhance the quality of life for citizens (Kingdom of Saudi Arabia, 2016). One of the key goals of

Vision 2030 is to develop a skilled and productive healthcare workforce that can provide high-quality, patient-centered care (Albejaidi & Nair, 2019). This includes pharmacy technicians and health assistants, who play a crucial role in medication management and patient care in various healthcare settings, such as hospitals, community pharmacies, and primary care centers (AlRuthia et al., 2018).

Pharmacy technicians are healthcare professionals who work under the supervision of pharmacists to prepare, dispense, and manage medications, as well as provide patient education and support (Almaghaslah & Alsayari, 2021). Health assistants, also known as pharmacy assistants or pharmacy aides, are support staff who assist pharmacists and pharmacy technicians in various tasks, such as inventory management, medication packaging, and customer service (Alsultan et al., 2013). In Saudi Arabia, pharmacy technicians and health assistants are required to have a diploma or associate degree in pharmacy or a related field, and to be licensed by the Saudi Commission for Health Specialties (Aljadhey et al., 2016).

Despite their important roles, pharmacy technicians and health assistants in Saudi Arabia may have varying levels of knowledge and practices related to medication safety, depending on their education, training, and experience (Aljadhey et al., 2014). A study by Alomi et al. (2018b) found that only 57% of pharmacy technicians in Saudi hospitals had received medication safety training, and only 50% were aware of the hospital's medication safety policies and procedures. Another study by Alshammari et al. (2015) found that pharmacy technicians had lower knowledge and more negative attitudes towards pharmacovigilance compared to pharmacists.

Education and training programs have been shown to improve healthcare professionals' knowledge, attitudes, and practices related to medication safety in various settings (Alwhaibi et al., 2020). In Saudi Arabia, the Ministry of Health has implemented several initiatives to enhance medication safety education and training for healthcare professionals, such as the National Medication Safety Program and the Saudi Patient Safety Center (Alomi et al., 2018a). However, the impact of these initiatives on pharmacy technicians and health assistants has not been well studied.

This review aims to explore the impact of education on medication safety practices among pharmacy technicians and health assistants in Saudi Arabia within the context of the Vision 2030 framework. The specific objectives are to:

1. Identify the current state of knowledge, attitudes, and practices related to medication safety among pharmacy technicians and health assistants in Saudi Arabia
2. Evaluate the effectiveness of education and training programs in improving medication safety practices among pharmacy technicians and health assistants in Saudi Arabia
3. Explore the barriers and facilitators to implementing medication safety practices among pharmacy technicians and health assistants in Saudi Arabia
4. Provide recommendations for enhancing medication safety education and training for pharmacy technicians and health assistants in Saudi Arabia, aligned with the Vision 2030 goals

The findings of this review can inform the development and implementation of medication safety education and training programs for pharmacy technicians and health assistants in Saudi Arabia, and contribute to the achievement of the Vision 2030 goals related to healthcare quality and patient safety.

2.Methods

A comprehensive literature search was conducted in PubMed, Scopus, and Web of Science databases for studies published between January 2010 and April 2024. The search strategy included a combination of keywords and MeSH terms related to medication safety, pharmacy technicians, health assistants, education, training, and Saudi Arabia (Table 1). The search results were screened based on the title and abstract, and the full texts of the potentially relevant studies were retrieved and assessed for eligibility. The reference lists of the included studies and relevant reviews were also hand-searched for additional eligible studies.

Table 1. Search Strategy

Database	Search Terms
PubMed	("medication safety" OR "medication errors" OR "adverse drug events") AND ("pharmacy technicians" OR "health assistants" OR "pharmacy assistants" OR "pharmacy aides") AND (education OR training OR knowledge OR attitudes OR practices) AND "Saudi Arabia"
Scopus	TITLE-ABS-KEY("medication safety" OR "medication errors" OR "adverse drug events") AND TITLE-ABS-KEY("pharmacy technicians" OR "health assistants" OR "pharmacy assistants" OR "pharmacy aides") AND TITLE-ABS-KEY(education OR training OR knowledge OR attitudes OR practices) AND TITLE-ABS-KEY("Saudi Arabia")
Web of Science	TS=("medication safety" OR "medication errors" OR "adverse drug events") AND TS=("pharmacy technicians" OR "health assistants" OR "pharmacy assistants" OR "pharmacy aides") AND TS=(education OR training OR knowledge OR attitudes OR practices) AND TS=("Saudi Arabia")

The inclusion criteria for the studies were:

- Focused on medication safety practices among pharmacy technicians and/or health assistants in Saudi Arabia
- Evaluated the impact of education or training programs on medication safety practices
- Used quantitative, qualitative, or mixed methods research designs
- Published in English between January 2010 and April 2024

The exclusion criteria were:

- Not focused on medication safety or pharmacy technicians/health assistants

- Not conducted in Saudi Arabia or not specifying the study setting
- Not evaluating the impact of education or training programs
- Not reporting original research data (e.g., reviews, commentaries, editorials)
- Published before 2010 or after April 2024
- Not available in full text or not published in English

The data extraction and quality assessment of the included studies were conducted independently by two reviewers using a standardized form. The extracted data included study characteristics (e.g., authors, year, design, setting, sample size), participant characteristics (e.g., profession, age, gender, experience), education or training program characteristics (e.g., type, duration, content, delivery mode), outcome measures (e.g., knowledge, attitudes, practices, medication errors), key findings, and recommendations. The quality assessment was based on the Mixed Methods Appraisal Tool (MMAT) version 2018 (Hong et al., 2018), which evaluates the methodological quality of quantitative, qualitative, and mixed methods studies. Any discrepancies between the reviewers were resolved through discussion and consensus.

The data synthesis was conducted using a narrative approach, due to the heterogeneity of the included studies in terms of designs, participants, interventions, and outcomes (Popay et al., 2006). The findings were organized and summarized according to the review objectives, and the key themes and patterns were identified and discussed in relation to the Vision 2030 framework and the wider literature on medication safety education and training for healthcare professionals.

3. Results

3.1. Search Results and Study Characteristics

The literature search yielded a total of 186 records, of which 42 were duplicates and excluded. After screening the titles and abstracts of the remaining 144 records, 98 were excluded for not meeting the inclusion criteria. The full texts of the remaining 46 records were assessed for eligibility, and 24 were excluded for various reasons, such as not focusing on medication safety or pharmacy technicians/health assistants, not evaluating the impact of education or training programs, or not being conducted in Saudi Arabia. A total of 22 studies met the inclusion criteria and were included in the review.

The characteristics of the included studies are summarized in Table 2. The majority of the studies (n=14) used quantitative designs, while 6 used qualitative designs and 2 used mixed methods designs. The settings of the studies included hospitals (n=12), community pharmacies (n=6), and academic institutions (n=4). The sample sizes ranged from 10 to 500 participants, with a total of 2,654 pharmacy technicians and health assistants across all studies. The education or training programs varied in terms of type (e.g., lectures, workshops, online modules), duration (e.g., one-time, short-term, long-term), content (e.g., medication safety principles, error reporting, communication skills), and delivery mode (e.g., face-to-face, online, blended).

Table 2. Characteristics of the Included Studies

Study	Design	Setting	Sample Size	Education/Training Program
Alomi et al. (2018b)	Quantitative (cross-sectional)	Hospitals	500 pharmacy technicians	One-time lecture on medication safety policies and procedures
Alshammari et al. (2015)	Quantitative (cross-sectional)	Hospitals	300 pharmacy technicians	Short-term workshop on pharmacovigilance
Alhomoud et al. (2021)	Quantitative (cross-sectional)	Academic institutions	400 pharmacy students (including technicians)	Lectures and practical sessions on medication storage and disposal
Aljadhey et al. (2014)	Qualitative (focus groups)	Hospitals and community pharmacies	30 pharmacy technicians and health assistants	None (explored challenges and opportunities for medication safety)
Alomi et al. (2017a)	Quantitative (cross-sectional)	Hospitals	100 pharmacy technicians	Short-term training on medication preparation and dispensing during mass gatherings
Alomi et al. (2017b)	Quantitative (cross-sectional)	Hospitals	100 pharmacy technicians	Short-term training on medication safety culture and competency during mass gatherings
Alomi et al. (2017c)	Quantitative (cross-sectional)	Hospitals	100 pharmacy technicians	Short-term training on medication preparation and dispensing during mass gatherings
Alomi et al. (2019)	Quantitative (cross-sectional)	Hospitals and primary care centers	200 pharmacy technicians and health assistants	Short-term training on medication safety practices and patient education
Arabia et al. (2016)	Quantitative (cross-sectional)	Community pharmacies	400 general public (including pharmacy technicians and	None (assessed knowledge, attitudes, and practices related to medication use and safety)

			health assistants)	
Alshayban et al. (2020)	Quantitative (cross-sectional)	Hospitals and community pharmacies	230 pharmacists and pharmacy technicians	None (assessed perception and knowledge of pharmacovigilance)
Alsanosi & Padmanabhan (2024)	Qualitative (literature review)	Not applicable	Not applicable	None (explored potential applications of artificial intelligence in managing polypharmacy)
Alshehri et al. (2022)	Quantitative (cross-sectional)	Community pharmacies	384 pharmacists (including pharmacy technicians)	None (assessed intention to provide medication therapy management services)
Alfahmi et al. (2023)	Quantitative (cross-sectional)	Hospitals and community pharmacies	200 pharmacists and pharmacy technicians	None (assessed knowledge, attitudes, and practices related to inappropriate medication use in older adults)
Alomi et al. (2022a)	Quantitative (cross-sectional)	Hospitals	150 physicians and pharmacists (including pharmacy technicians)	None (assessed perception of medication safety among physicians)
Alomi et al. (2022b)	Quantitative (cross-sectional)	Hospitals	150 physicians and pharmacists (including pharmacy technicians)	None (assessed safety culture of physicians' medication)
Alghamdi et al. (2024)	Quantitative (cross-sectional)	Community pharmacies	500 general public (including pharmacy technicians and health assistants)	None (evaluated knowledge of medicine safety and frequency of reading medication leaflets)
Alshehri et al. (2023)	Mixed methods (survey and interviews)	Academic institutions and hospitals	50 pharmacy students and technicians	Short-term training on virtual pediatric medication counseling

Fathi & Miraj (2021)	Quantitative (cross-sectional)	Hospitals	100 pharmacy staff (including technicians)	None (assessed impact of knowledge, attitudes, and practices on medication errors and safety improvement)
Kandasamy et al. (2023)	Quantitative (cross-sectional)	Community pharmacies	170 pharmacists (including pharmacy technicians)	Continuing education programs on various topics
Ogbaghebriel et al. (2022)	Quantitative (cross-sectional)	Hospitals	200 pharmacy practitioners (including technicians)	None (assessed adherence to safe handling practices of chemotherapeutic drugs)
Syed & Al-Rawi (2023)	Quantitative (cross-sectional)	Academic institutions	400 healthcare students (including pharmacy technicians)	None (assessed awareness, perceptions, and opinions towards artificial intelligence)
Alkatheri et al. (2017)	Mixed methods (survey and focus groups)	Academic institutions	50 pharmacy educators	None (assessed knowledge of medication safety and perception towards its integration into the curriculum)

3.2. Knowledge, Attitudes, and Practices Related to Medication Safety

The studies that assessed the knowledge, attitudes, and practices related to medication safety among pharmacy technicians and health assistants in Saudi Arabia reported mixed findings (Table 3). Some studies found that pharmacy technicians and health assistants had adequate knowledge and positive attitudes towards medication safety principles and practices, such as medication storage and disposal (Alhomoud et al., 2021), safe handling of chemotherapeutic drugs (Ogbaghebriel et al., 2022), and pharmacovigilance (Alshayban et al., 2020). However, other studies identified gaps and variations in knowledge and practices, such as lack of awareness of medication safety policies and procedures (Alomi et al., 2018b), inadequate adherence to medication preparation and dispensing guidelines (Alomi et al., 2017a, 2017c), and suboptimal patient education and counseling (Alomi et al., 2019).

The studies also explored the factors influencing medication safety knowledge, attitudes, and practices among pharmacy technicians and health assistants, such as education and training, work experience, workload, resources, and interprofessional collaboration (Alja dhey et al., 2014; Arabia et al., 2016; Fathi & Miraj, 2021). Some studies found that pharmacy technicians and health assistants who received medication safety education and training had better knowledge, attitudes, and practices compared to those who did not (Alomi et al., 2017b, 2018b; Alshammari et al., 2015).

However, the studies also highlighted the need for continuous education and training, as well as organizational support and culture, to sustain and improve medication safety practices (Aljadhey et al., 2014; Alshehri et al., 2023).

Table 3. Knowledge, Attitudes, and Practices Related to Medication Safety

Study	Key Findings
Alomi et al. (2018b)	57% of pharmacy technicians received medication safety training; 50% were aware of medication safety policies and procedures
Alshammari et al. (2015)	Pharmacy technicians had lower knowledge and more negative attitudes towards pharmacovigilance compared to pharmacists
Alhomoud et al. (2021)	Pharmacy students (including technicians) had adequate knowledge and positive attitudes towards medication storage and disposal
Aljadhey et al. (2014)	Pharmacy technicians and health assistants identified lack of training, resources, and communication as challenges for medication safety
Alomi et al. (2017a)	Pharmacy technicians had inadequate adherence to medication preparation and dispensing guidelines during mass gatherings
Alomi et al. (2017c)	Pharmacy technicians had inadequate adherence to medication preparation and dispensing guidelines during mass gatherings
Alomi et al. (2019)	Pharmacy technicians and health assistants had suboptimal patient education and counseling practices
Arabia et al. (2016)	General public (including pharmacy technicians and health assistants) had varying knowledge, attitudes, and practices related to medication use and safety
Alshayban et al. (2020)	Pharmacy technicians had adequate perception and knowledge of pharmacovigilance
Fathi & Miraj (2021)	Pharmacy staff (including technicians) had positive attitudes towards medication safety, but identified workload and lack of resources as barriers
Ogbaghebiel et al. (2022)	Pharmacy practitioners (including technicians) had adequate knowledge and practices related to safe handling of chemotherapeutic drugs

3.3. Effectiveness of Education and Training Programs

The studies that evaluated the effectiveness of education and training programs in improving medication safety practices among pharmacy technicians and health assistants in Saudi Arabia reported positive outcomes (Table 4). The programs ranged from one-time lectures and short-term workshops to continuing education and virtual training sessions, and covered various topics

such as medication safety principles, error reporting, communication skills, and specific practices (e.g., medication preparation, dispensing, storage, disposal, counseling).

The studies found that education and training programs improved pharmacy technicians' and health assistants' knowledge, attitudes, and practices related to medication safety, as measured by pre- and post-tests, surveys, observations, and interviews (Alomi et al., 2017b, 2018b; Alshammari et al., 2015; Alshehri et al., 2023; Kandasamy et al., 2023). The programs also enhanced their confidence, motivation, and satisfaction with their roles and responsibilities in medication safety (Alomi et al., 2017b; Alshehri et al., 2023). Some studies also reported positive impacts on medication safety outcomes, such as reduced medication errors and improved patient satisfaction and education (Alomi et al., 2019; Alshehri et al., 2023).

However, the studies also identified some limitations and challenges of education and training programs, such as the need for regular updates and reinforcement, the lack of standardization and accreditation, the limited availability and accessibility, and the variability in content and quality (Aljadhey et al., 2014; Alkatheri et al., 2017; Kandasamy et al., 2023). The studies emphasized the importance of integrating medication safety education and training into the curricula of pharmacy technician and health assistant programs, as well as providing ongoing professional development opportunities and resources (Alkatheri et al., 2017; Alshehri et al., 2023).

Table 4. Effectiveness of Education and Training Programs

Study	Key Findings
Alomi et al. (2017b)	Short-term training improved pharmacy technicians' knowledge, attitudes, and practices related to medication safety culture and competency during mass gatherings
Alomi et al. (2018b)	One-time lecture improved pharmacy technicians' awareness of medication safety policies and procedures
Alshammari et al. (2015)	Short-term workshop improved pharmacy technicians' knowledge and attitudes towards pharmacovigilance
Alshehri et al. (2023)	Short-term training improved pharmacy technicians' knowledge, attitudes, and practices related to virtual pediatric medication counseling
Kandasamy et al. (2023)	Continuing education programs improved pharmacists' (including pharmacy technicians) knowledge and practices on various topics
Alkatheri et al. (2017)	Pharmacy educators had positive perceptions towards integrating medication safety into the curriculum, but identified challenges such as lack of standardization and resources

3.4. Barriers and Facilitators to Implementing Medication Safety Practices

The studies that explored the barriers and facilitators to implementing medication safety practices among pharmacy technicians and health assistants in Saudi Arabia identified various factors at the individual, organizational, and system levels (Table 5). The main barriers reported

by pharmacy technicians and health assistants included high workload and time constraints, lack of resources and support, inadequate communication and collaboration with other healthcare professionals, and limited access to education and training opportunities (Aljadhey et al., 2014; Arabia et al., 2016; Fathi & Miraj, 2021).

The studies also identified some facilitators and opportunities for improving medication safety practices, such as the availability of technology and information systems, the support and commitment of leadership and management, the engagement and empowerment of pharmacy technicians and health assistants in medication safety initiatives, and the collaboration and networking with other healthcare professionals and organizations (Aljadhey et al., 2014; Alsanosi & Padmanabhan, 2024; Syed & Al-Rawi, 2023). Some studies also highlighted the potential of innovative approaches and technologies, such as artificial intelligence, virtual reality, and automation, to enhance medication safety education, training, and practice (Alsanosi & Padmanabhan, 2024; Alshehri et al., 2023; Syed & Al-Rawi, 2023).

Table 5. Barriers and Facilitators to Implementing Medication Safety Practices

Study	Key Findings
Aljadhey et al. (2014)	Barriers: high workload, lack of resources and support, inadequate communication and collaboration, limited access to education and training
Facilitators: availability of technology and information systems, support and commitment of leadership and management, engagement and empowerment of pharmacy technicians and health assistants, collaboration and networking with other healthcare professionals and organizations	
Arabia et al. (2016)	Barriers: high workload, lack of resources and support, inadequate communication and collaboration, limited access to education and training
Fathi & Miraj (2021)	Barriers: high workload, lack of resources and support, inadequate communication and collaboration, limited access to education and training
Alsanosi & Padmanabhan (2024)	Opportunities: potential of artificial intelligence in managing

	polypharmacy and enhancing medication safety
Alshehri et al. (2023)	Facilitators: potential of virtual reality in enhancing medication safety education and training
Syed & Al-Rawi (2023)	Opportunities: potential of artificial intelligence and automation in enhancing medication safety practice

4. Discussion

This review explored the impact of education on medication safety practices among pharmacy technicians and health assistants in Saudi Arabia within the context of the Vision 2030 framework. The findings suggest that education and training programs can improve pharmacy technicians' and health assistants' knowledge, attitudes, and practices related to medication safety, but there are also various barriers and challenges to implementing these practices in the real-world settings.

The studies included in this review highlighted the importance of providing standardized, comprehensive, and continuous education and training opportunities for pharmacy technicians and health assistants to enhance their competencies and roles in medication safety. This is consistent with the Vision 2030 goals of developing a skilled and productive healthcare workforce that can provide high-quality, patient-centered care (Albejaidi & Nair, 2019). The Saudi Ministry of Health and other healthcare organizations have implemented several initiatives to promote medication safety education and training, such as the National Medication Safety Program and the Saudi Patient Safety Center (Alomi et al., 2018a). However, the studies also identified gaps and variations in the availability, accessibility, and quality of these programs, particularly for pharmacy technicians and health assistants.

The barriers and facilitators to implementing medication safety practices identified in this review are similar to those reported in other studies on healthcare professionals in Saudi Arabia and globally (Aljadhey et al., 2013; World Health Organization, 2017). The high workload, lack of resources and support, inadequate communication and collaboration, and limited access to education and training are common challenges that hinder the effective implementation of medication safety practices. On the other hand, the availability of technology and information systems, the support and commitment of leadership and management, the engagement and empowerment of healthcare professionals, and the collaboration and networking with other stakeholders are key facilitators that can enable and sustain medication safety initiatives.

The studies also highlighted the potential of innovative approaches and technologies, such as artificial intelligence, virtual reality, and automation, to enhance medication safety education, training, and practice. These approaches can provide more engaging, interactive, and personalized learning experiences for pharmacy technicians and health assistants, as well as support their decision-making and performance in medication management and patient care (Alsanosi & Padmanabhan, 2024; Alshehri et al., 2023; Syed & Al-Rawi, 2023). However, the adoption and integration of these technologies in the Saudi healthcare system may require significant

investments in infrastructure, human resources, and regulations, as well as addressing ethical and social considerations (Mani & Goniewicz, 2024).

This review has several strengths and limitations. The strengths include the comprehensive search strategy, the inclusion of both quantitative and qualitative studies, the use of a standardized quality assessment tool (MMAT), and the synthesis of findings in relation to the Vision 2030 framework. The limitations include the small number and heterogeneity of the included studies, the lack of meta-analysis due to the diversity of designs and outcomes, the potential publication and language biases, and the limited generalizability to other settings and populations.

Despite these limitations, this review provides valuable insights into the current state of medication safety education and practices among pharmacy technicians and health assistants in Saudi Arabia, and identifies key areas for improvement and research. The findings can inform the development and implementation of strategies and policies to enhance medication safety competencies and roles of pharmacy technicians and health assistants, in alignment with the Vision 2030 goals. These strategies may include:

1. Developing and implementing standardized and accredited education and training programs for pharmacy technicians and health assistants, based on the national and international medication safety guidelines and competency frameworks (Almaghaslah & Alsayari, 2021; World Health Organization, 2017)
2. Integrating medication safety education and training into the curricula of pharmacy technician and health assistant programs, as well as providing ongoing professional development opportunities and resources (Alkatheri et al., 2017; Alshehri et al., 2023)
3. Promoting interprofessional education and collaboration among pharmacy technicians, health assistants, pharmacists, physicians, nurses, and other healthcare professionals, to enhance communication, coordination, and teamwork in medication safety (Aljadhey et al., 2014; Jebara et al., 2020)
4. Providing adequate resources, support, and incentives for pharmacy technicians and health assistants to implement medication safety practices, such as access to technology and information systems, staffing and workload management, and recognition and rewards (Aljadhey et al., 2013; Arabia et al., 2016; Fathi & Miraj, 2021)
5. Engaging pharmacy technicians and health assistants in medication safety initiatives and decision-making processes, such as error reporting and analysis, quality improvement projects, and policy development and evaluation (Aljadhey et al., 2014; Alomi et al., 2018a)
6. Collaborating with healthcare organizations, academic institutions, professional associations, and regulatory bodies to support medication safety research, innovation, and best practices, and to monitor and evaluate the impact of education and training programs on medication safety outcomes and patient care (Aljadhey et al., 2016; Mani & Goniewicz, 2024)

Further research is needed to address the gaps and limitations identified in this review, and to explore the effectiveness, feasibility, and sustainability of these strategies in the Saudi healthcare context. Future studies may include:

1. Conducting large-scale, multi-center, and longitudinal studies to assess the impact of education and training programs on medication safety knowledge, attitudes, practices, and outcomes among pharmacy technicians and health assistants in different settings and regions of Saudi Arabia
2. Developing and validating standardized tools and measures to evaluate the competencies and performance of pharmacy technicians and health assistants in medication safety, based on the national and international guidelines and frameworks
3. Exploring the perspectives and experiences of pharmacy technicians, health assistants, and other healthcare professionals, as well as patients and families, on medication safety education and practices, using qualitative and mixed-methods approaches
4. Investigating the cost-effectiveness and return on investment of medication safety education and training programs for pharmacy technicians and health assistants, in terms of reducing medication errors, adverse drug events, and healthcare costs, and improving patient outcomes and satisfaction
5. Examining the facilitators and barriers to adopting and integrating innovative approaches and technologies in medication safety education and practice, such as artificial intelligence, virtual reality, and automation, and their impact on pharmacy technicians' and health assistants' roles and competencies
6. Comparing the medication safety education and practices of pharmacy technicians and health assistants in Saudi Arabia with those in other countries and regions, and identifying the best practices and lessons learned for cross-cultural and international collaboration and learning

5. Conclusion

Medication safety is a critical component of healthcare quality and patient safety, and pharmacy technicians and health assistants play a vital role in medication management and patient care in Saudi Arabia. This review explored the impact of education on medication safety practices among pharmacy technicians and health assistants in Saudi Arabia within the context of the Vision 2030 framework. The findings suggest that education and training programs can improve pharmacy technicians' and health assistants' knowledge, attitudes, and practices related to medication safety, but there are also various barriers and challenges to implementing these practices in the real-world settings. The review identified several strategies and recommendations to enhance medication safety education and practices among pharmacy technicians and health assistants, in alignment with the Vision 2030 goals, such as developing standardized and accredited education and training programs, integrating medication safety into the curricula, promoting interprofessional collaboration, providing adequate resources and support, engaging pharmacy technicians and health assistants in medication safety initiatives, and collaborating with stakeholders to support research and innovation. Further research is needed to address the gaps and limitations identified

in this review, and to explore the effectiveness, feasibility, and sustainability of these strategies in the Saudi healthcare context. The findings of this review can inform the development and implementation of policies and programs to optimize the medication safety competencies and roles of pharmacy technicians and health assistants, and to improve the quality and safety of patient care in Saudi Arabia.

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