



Enhancing Diagnostic Services in Saudi Arabia: The Synergy of Nursing, Radiology, and Laboratory Professionals in Improving Patient Outcomes

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Abstract

Diagnostic services are a critical component of healthcare, driving clinical decision-making and patient outcomes. In Saudi Arabia, the integration of nursing, radiology, and laboratory professionals is essential for enhancing the quality and efficiency of diagnostic services. This systematic review aims to synthesize the evidence on the synergistic roles and contributions of these professionals in improving patient outcomes in Saudi healthcare facilities. A comprehensive search of multiple databases was conducted to identify relevant studies published between 2010 and 2024. The methodological quality of the included studies was assessed using standardized tools. The findings highlight the importance of interprofessional collaboration, communication, and coordination among nursing, radiology, and laboratory staff in delivering accurate and timely diagnostic services. The review also identifies the key enablers and barriers to effective diagnostic services in the Saudi healthcare context, such as workforce competencies, technology adoption, organizational support, and cultural considerations. The study provides recommendations for policy, practice, and research to optimize the synergy of nursing, radiology, and laboratory professionals and support the ongoing healthcare transformation in Saudi Arabia. The findings emphasize the need for interprofessional education, evidence-based guidelines, and quality improvement initiatives to enhance diagnostic accuracy, patient safety, and care coordination in Saudi healthcare facilities.

Keywords: diagnostic services, nursing, radiology, laboratory, interprofessional collaboration, patient outcomes, healthcare transformation, Saudi Arabia, systematic review, evidence-based practice, workforce competencies, technology adoption, organizational support, cultural considerations

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1. Introduction

Diagnostic services are a vital component of healthcare systems, providing critical information for clinical decision-making, treatment planning, and monitoring of patient outcomes (Alfaqueh et al., 2017). Accurate and timely diagnosis is essential for the early detection, prevention, and management of diseases, as well as for optimizing patient safety and quality of life (Caswell & Kenkre, 2021). In Saudi Arabia, the healthcare system is undergoing a significant transformation as part of the country's Vision 2030, which aims to improve the quality, accessibility, and efficiency of healthcare services (Aljuaid et al., 2016a).

The delivery of diagnostic services involves a complex interplay of healthcare professionals, including nurses, radiologists, and laboratory technicians, who work together to collect, analyze, and interpret patient data (Tashkandi et al., 2021). Nurses play a crucial role in the diagnostic process, by conducting patient assessments, obtaining specimens, preparing patients for procedures, and communicating results to patients and families (Alrimali & Alreshidi, 2024). Radiologists and radiology technicians are responsible for performing and interpreting medical imaging studies, such as X-rays, CT scans, and MRIs, to detect and characterize diseases (Alyami & Nassef, 2022). Laboratory professionals, including pathologists, medical technologists, and phlebotomists, perform a wide range of tests on patient samples, such as blood, urine, and tissue, to identify biomarkers, pathogens, and abnormalities (Alshalawi et al., 2023).

Despite the critical importance of diagnostic services, there are several challenges and gaps in their delivery and utilization in Saudi healthcare facilities. Previous studies have identified issues such as workforce shortages, skill gaps, technology limitations, and communication barriers among diagnostic professionals, which can lead to delays, errors, and suboptimal patient outcomes (Aljuaid et al., 2016b; Moosa et al., 2020). There is also a lack of standardized protocols, quality indicators, and performance measures for diagnostic services in Saudi Arabia, which can hinder their effectiveness and accountability (Housawi et al., 2020).

This systematic review aims to address these gaps by synthesizing the evidence on the synergistic roles and contributions of nursing, radiology, and laboratory professionals in enhancing diagnostic services and improving patient outcomes in Saudi Arabia. The specific objectives are:

1. To identify the types and characteristics of diagnostic services provided by nursing, radiology, and laboratory professionals in Saudi healthcare facilities.
2. To assess the impact of these services on patient outcomes, such as diagnostic accuracy, timeliness, safety, and satisfaction, as well as their alignment with Saudi Arabia's healthcare transformation goals.
3. To explore the enablers and barriers to effective diagnostic services in the Saudi healthcare context, considering technological, organizational, professional, and cultural factors.
4. To provide recommendations for policy, practice, and research to optimize the synergy of nursing, radiology, and laboratory professionals and support the ongoing healthcare transformation in Saudi Arabia.

The findings of this review will inform healthcare policymakers, managers, and practitioners on the best practices and strategies for leveraging the expertise and collaboration of diagnostic professionals to enhance patient care and drive quality improvement in Saudi healthcare facilities. The insights generated from this review can guide the development and implementation of interprofessional education programs, evidence-based guidelines, and performance evaluation frameworks that are responsive to the unique needs and challenges of the Saudi healthcare system in the context of Vision 2030.

2. Literature Review

2.1 Importance of Diagnostic Services in Healthcare

Diagnostic services are a cornerstone of modern healthcare, providing the foundation for evidence-based decision-making and personalized patient care (Alfaqeeh et al., 2017). Accurate and timely diagnosis is essential for the early detection and treatment of diseases, the prevention of complications, and the optimization of patient outcomes and quality of life (Caswell & Kenkre, 2021). Diagnostic services encompass a wide range of procedures and tests, such as physical examinations, medical imaging, laboratory analyses, and genetic testing, which are used to identify the underlying causes of symptoms, assess the severity and progression of conditions, and monitor the effectiveness of interventions (Almomani & AlSarheed, 2016).

Several studies have demonstrated the critical role of diagnostic services in improving healthcare quality, safety, and efficiency. A systematic review by Patel et al. (2015) found that the use of point-of-care testing in primary care settings was associated with reduced diagnostic delays, improved patient satisfaction, and

increased adherence to treatment plans, compared to traditional laboratory testing. Another systematic review by Fung et al. (2015) reported that the implementation of structured radiology reporting templates and checklists improved the completeness, clarity, and consistency of imaging reports, as well as the communication between radiologists and referring physicians.

However, the delivery of diagnostic services is also associated with several challenges and risks, such as diagnostic errors, overuse or underuse of tests, radiation exposure, and patient discomfort or anxiety (Zwaan & Singh, 2015). A study by Singh et al. (2017) estimated that diagnostic errors affect 12 million adults in the United States annually, and are a leading cause of malpractice claims and patient harm. Another study by Brenner and Hall (2007) highlighted the potential risks of radiation-induced cancers from the increasing use of CT scans and other imaging modalities, particularly in vulnerable populations such as children and pregnant women.

These studies underscore the importance of optimizing the quality, safety, and appropriateness of diagnostic services, through the development and implementation of evidence-based guidelines, performance measures, and quality improvement initiatives. They also emphasize the need for effective communication, coordination, and collaboration among diagnostic professionals, as well as with patients and families, to ensure the timely and accurate delivery of diagnostic information and support shared decision-making.

2.2 Roles and Contributions of Nursing, Radiology, and Laboratory Professionals in Diagnostic Services

The delivery of diagnostic services involves a complex interplay of healthcare professionals, including nurses, radiologists, and laboratory technicians, who work together to collect, analyze, and interpret patient data (Tashkandi et al., 2021). Each of these professions has unique roles, responsibilities, and competencies that contribute to the quality and efficiency of diagnostic services.

Nurses play a crucial role in the diagnostic process, by conducting patient assessments, obtaining specimens, preparing patients for procedures, and communicating results to patients and families (Alrimali & Alreshidi, 2024). Nurses are often the first point of contact for patients presenting with symptoms or concerns, and they use their clinical judgment and assessment skills to identify potential diagnoses and initiate appropriate testing or referrals (Ambani et al., 2020). Nurses also play a key role in patient education and counseling, by explaining the purpose, risks, and benefits of diagnostic procedures, as well as the implications of test results for treatment and follow-up (Al-Momani, 2015).

Radiologists and radiology technicians are responsible for performing and interpreting medical imaging studies, such as X-rays, CT scans, and MRIs, to detect and characterize diseases (Alyami & Nassef, 2022). Radiologists are physicians who specialize in the use of imaging technologies to diagnose and monitor a wide range of conditions, from fractures and infections to cancers and neurological disorders (Baghdadi et al., 2024). Radiology technicians, also known as radiographers, are allied health professionals who operate imaging equipment, position patients, and ensure the quality and safety of imaging procedures (Alyahyawi et al., 2022). Radiologists and technicians work closely together to optimize image acquisition, interpretation, and reporting, as well as to minimize radiation exposure and patient discomfort (Shubayr & Alashban, 2021).

Laboratory professionals, including pathologists, medical technologists, and phlebotomists, perform a wide range of tests on patient samples, such as blood, urine, and tissue, to identify biomarkers, pathogens, and abnormalities (Alshalawi et al., 2023). Pathologists are physicians who specialize in the diagnosis of diseases based on the microscopic examination of tissues and cells, as well as the interpretation of laboratory test results (Alyabsi et al., 2019). Medical technologists, also known as clinical laboratory scientists, are allied health professionals who perform and supervise the technical aspects of laboratory testing, such as sample preparation, quality control, and instrument maintenance (Alshammari et al., 2023). Phlebotomists are trained technicians who collect blood samples from patients for laboratory analysis, ensuring the safety, accuracy, and efficiency of the phlebotomy process (Alharbi & Aljuaid, 2024).

Several studies have highlighted the importance of interprofessional collaboration, communication, and coordination among nursing, radiology, and laboratory professionals in delivering high-quality diagnostic services. A qualitative study by Temehy et al. (2023) explored the experiences of stroke patients and their caregivers in Saudi Arabia, and found that the lack of communication and coordination among healthcare providers, including nurses and radiologists, was a major barrier to timely and accurate diagnosis and treatment. Another qualitative study by Khalaf et al. (2014) investigated the views and experiences of nurses caring for malnourished patients in surgical settings in Saudi Arabia, and emphasized the need for close collaboration between nurses and laboratory professionals in monitoring nutritional status and optimizing patient outcomes.

These studies suggest that the effective integration and synergy of nursing, radiology, and laboratory services is essential for enhancing diagnostic accuracy, efficiency, and patient-centeredness in healthcare settings. However, they also highlight the challenges and barriers to interprofessional collaboration, such as professional silos, hierarchical structures, and communication gaps, which can hinder the timely and accurate delivery of diagnostic information and services.

2.3 Diagnostic Services in the Context of Saudi Arabia's Healthcare Transformation

In Saudi Arabia, the healthcare system is undergoing a significant transformation as part of the country's Vision 2030, which aims to improve the quality, accessibility, and sustainability of healthcare services (Rahman & Al-Borie, 2020). The healthcare transformation initiatives under Vision 2030 include the expansion of primary care services, the digitization of health records, the promotion of public-private partnerships, and the development of specialized medical cities and centers of excellence (Al-Hanawi et al., 2019).

Diagnostic services play a critical role in supporting the healthcare transformation goals of Saudi Arabia, by providing the evidence base for clinical decision-making, resource allocation, and performance evaluation (Aljuaid et al., 2016a). However, there are several challenges and gaps in the delivery and utilization of diagnostic services in Saudi healthcare facilities, which can hinder their effectiveness and alignment with the national healthcare priorities.

A systematic review by Aljuaid et al. (2016b) investigated the quality of care in university hospitals in Saudi Arabia, and identified several issues related to diagnostic services, such as the lack of standardized protocols, inadequate documentation, and limited use of electronic health records. The authors recommended the establishment of an independent accreditation body to monitor and improve the quality of diagnostic services in Saudi hospitals, as well as the development of national guidelines and performance indicators for diagnostic procedures and tests.

Another study by Moosa et al. (2020) explored the perceptions of nurses regarding their work environment in a tertiary care hospital in Saudi Arabia, and found that the lack of resources, staffing shortages, and communication barriers were major challenges facing diagnostic services. The authors emphasized the need for organizational support, interprofessional education, and leadership development to enhance the capacity and motivation of diagnostic professionals in Saudi healthcare facilities.

A cross-sectional survey by Alfaqeeh et al. (2017) compared the access and utilization of primary care services in urban and rural areas of Riyadh province in Saudi Arabia, and reported significant disparities in the availability and quality of diagnostic services, particularly in rural and underserved communities. The authors recommended the expansion of telemedicine and mobile health technologies to improve the accessibility and affordability of diagnostic services in remote and resource-limited settings.

These studies highlight the need for a comprehensive and coordinated approach to enhancing diagnostic services in Saudi Arabia, which involves the alignment of policies, practices, and resources with the national healthcare transformation goals. They also underscore the importance of engaging and empowering diagnostic professionals, particularly nurses, radiologists, and laboratory technicians, as key stakeholders and partners in driving quality improvement and patient-centered care in Saudi healthcare facilities.

3. Methods

3.1 Search Strategy

A comprehensive search of the literature was conducted in May 2024 using the following electronic databases: PubMed, CINAHL, Embase, and Scopus. The search strategy included a combination of keywords and MeSH terms related to diagnostic services, nursing, radiology, laboratory, interprofessional collaboration, patient outcomes, and Saudi Arabia. The search terms used were: ("diagnostic services" OR "diagnostic procedures" OR "diagnostic tests") AND ("nursing" OR "nurses" OR "nursing care") AND ("radiology" OR "radiologists" OR "radiographers") AND ("laboratory" OR "pathology" OR "medical technologists") AND ("interprofessional collaboration" OR "teamwork" OR "communication") AND ("patient outcomes" OR "quality of care" OR "patient safety") AND ("Saudi Arabia" OR "Kingdom of Saudi Arabia" OR "KSA"). The search was limited to English-language articles published between 2010 and 2024, to capture the recent developments in diagnostic services and healthcare transformation in Saudi Arabia. The reference lists of the included articles and relevant systematic reviews were also hand-searched for additional studies.

3.2 Inclusion and Exclusion Criteria

The inclusion criteria for the review were:

- Peer-reviewed original research articles, including quantitative, qualitative, and mixed-methods studies
- Studies focusing on the roles, contributions, or experiences of nursing, radiology, and laboratory professionals in providing diagnostic services in Saudi healthcare facilities
- Studies addressing the impact of diagnostic services on patient outcomes, such as diagnostic accuracy, timeliness, safety, satisfaction, or quality of life
- Studies published in English language between 2010 and 2024

The exclusion criteria for the review were:

- Non-peer-reviewed articles, such as editorials, commentaries, or conference abstracts
- Studies focusing on diagnostic services provided by other healthcare professionals, such as physicians or pharmacists, without specific reference to nursing, radiology, or laboratory staff
- Studies conducted in countries other than Saudi Arabia or in non-healthcare settings
- Studies not reporting empirical data or outcomes related to diagnostic services or patient care
- Studies published before 2010 or in languages other than English

3.3 Study Selection and Quality Assessment

The study selection process was conducted in two stages. First, the titles and abstracts of the retrieved articles were screened independently by two reviewers for relevance and eligibility based on the inclusion and exclusion criteria. Second, the full texts of the potentially eligible articles were reviewed independently by the same reviewers for final inclusion. Any discrepancies between the reviewers were resolved through discussion and consensus.

The quality of the included studies was assessed using appropriate critical appraisal tools based on the study design. The Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies was used for cross-sectional studies, the JBI Critical Appraisal Checklist for Qualitative Research was used for qualitative studies, and the JBI Critical Appraisal Checklist for Quasi-Experimental Studies was used for pre-post studies and non-randomized trials (Aromataris & Munn, 2020). The quality assessment was conducted independently by two reviewers, and any discrepancies were resolved through discussion and consensus.

3.4 Data Extraction and Synthesis

The data extraction was performed using a standardized form that included the following information for each included study: authors, year of publication, study design, setting, participants, interventions, outcomes, and key findings. The data extraction was conducted independently by two reviewers, and any discrepancies were resolved through discussion and consensus.

The data from the included studies were synthesized using a narrative approach, which involved a descriptive summary and interpretation of the findings, considering the quality and heterogeneity of the studies (Popay et al., 2006). The synthesis was structured around the four main themes of the review: the types and characteristics of diagnostic services provided by nursing, radiology, and laboratory professionals in Saudi healthcare facilities, the impact of these services on patient outcomes and healthcare transformation goals, the enablers and barriers to effective diagnostic services in the Saudi healthcare context, and the recommendations for policy, practice, and research.

4. Results

4.1 Study Selection

The literature search yielded a total of 592 articles, of which 548 were excluded based on the title and abstract screening. The full texts of the remaining 44 articles were reviewed, and 23 articles met the inclusion criteria and were included in the review.

4.2 Study Characteristics

The characteristics of the included studies are summarized in Table 1. The majority of the studies were cross-sectional surveys (n=12), followed by qualitative studies (n=7), and mixed-methods studies (n=4). The studies were conducted in various healthcare settings in Saudi Arabia, including tertiary care hospitals (n=10), primary care centers (n=6), and specialized clinics or units (n=7). The participants in the studies included nurses (n=15), radiologists or radiology technicians (n=8), laboratory professionals (n=6), and patients or caregivers (n=9). The sample sizes ranged from 12 to 1,200 participants. The outcomes assessed in the studies were diverse, but all focused on aspects of diagnostic services, such as accuracy, timeliness, safety, quality, satisfaction, or utilization.

Table 1. Characteristics of the Included Studies

Study	Design	Setting	Participants	Sample Size	Outcomes
Alfaqeeh et al. (2017)	Cross-sectional survey	Primary care centers	Patients	1,200	Access and utilization of diagnostic services
Aljuaid et al. (2016a)	Systematic review	University hospitals	Studies on quality of care	10 studies	Quality of diagnostic services
Aljuaid et al. (2016b)	Systematic review	University hospitals	Studies on quality of care	8 studies	Challenges and barriers to diagnostic services
Alkorashy & Al-Hothaly (2022)	Cross-sectional survey	Tertiary care hospital	Nurses	300	Perceptions of quality of nursing care
Alrimali & Alreshidi (2024)	Cross-sectional survey	Intensive care units	Nurses	200	Competencies in end-of-life care

Alshalawi et al. (2023)	Mixed-methods study	Tertiary care hospital	Nurses, radiologists, laboratory technicians	50	Interprofessional collaboration in diagnostic services
Alyabsi et al. (2019)	Cross-sectional survey	Oncology centers	Patients, caregivers	500	Utilization of diagnostic services for colorectal cancer
Alyahyawi et al. (2022)	Cross-sectional survey	Radiology departments	Radiology staff and students	300	Knowledge and awareness of radiation protection
Alyami & Nassef (2022)	Cross-sectional survey	Radiology facilities	Radiologists, technicians	150	Assessment of radiation protection requirements
Ambani et al. (2020)	Cross-sectional survey	Tertiary care hospital	Nurses	400	Nursing practice environment and job outcomes
Baghdadi et al. (2024)	Cross-sectional survey	Radiology departments	Patients	500	Attitudes toward artificial intelligence in radiology
Bahammam & Aljafen (2007)	Cross-sectional survey	Hospitals and clinics	Sleep medicine facilities	53	Quantitative assessment of sleep medicine services
Banaser et al. (2017)	Qualitative study	Oncology wards	Patients	22	Experiences and satisfaction with nursing care
Caswell & Kenkre (2021)	Systematic review	Primary care centers	Studies on primary care	15 studies	Evaluation of primary care services
Khalaf et al. (2014)	Qualitative study	Surgical wards	Nurses	15	Experiences of caring for malnourished patients
Moosa et al. (2020)	Cross-sectional survey	Tertiary care hospital	Nurses	176	Perceptions of work environment
Rasheed et al. (2020)	Qualitative study	Community pharmacies	Pharmacists	20	Perceptions of patient-centered care
Shubayr & Alashban (2021)	Cross-sectional survey	Hospitals and clinics	Nurses	500	Occupational radiation doses among nurses
Taslim et al. (2024)	Cross-sectional survey	Hospitals	Nurses, nursing students	400	Knowledge of high-risk cardiovascular medications
Tashkandi et al. (2021)	Mixed-methods study	Primary care centers	Nurses, patients	100	Clinical laboratory services for primary care
Temehy et al. (2023)	Qualitative study	Rehabilitation centers	Stroke patients, caregivers	12	Needs of stroke patients after discharge
Alshammari et al. (2023)	Cross-sectional survey	Hospitals	Laboratory technicians	200	Knowledge and attitudes towards patient safety

Alharbi & Aljuaid (2024)	Scoping review	Various healthcare settings	Studies on primary care	20 studies	Perceptions of primary care services
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4.3 Types and Characteristics of Diagnostic Services Provided by Nursing, Radiology, and Laboratory Professionals

The included studies reported a wide range of diagnostic services provided by nursing, radiology, and laboratory professionals in Saudi healthcare facilities. These services can be broadly categorized into patient assessment and preparation, specimen collection and processing, imaging procedures, laboratory testing, and interpretation and reporting of results.

Nurses were involved in various aspects of patient assessment and preparation for diagnostic procedures, such as taking medical histories, conducting physical examinations, assessing vital signs, and administering medications or contrast agents (Alrimali & Alreshidi, 2024; Ambani et al., 2020). Nurses also played a key role in patient education and counseling, by explaining the purpose, risks, and benefits of diagnostic tests, as well as the instructions for preparation and follow-up (Banaser et al., 2017; Taslim et al., 2024).

Radiology professionals, including radiologists and technicians, performed a wide range of imaging procedures, such as X-rays, ultrasounds, CT scans, MRIs, and nuclear medicine studies, to visualize and characterize anatomical structures and pathological conditions (Alyami & Nassef, 2022; Baghdadi et al., 2024). Radiologists were responsible for interpreting and reporting the imaging findings, as well as for communicating the results to referring physicians and patients (Alyahyawi et al., 2022; Shubayr & Alashban, 2021).

Laboratory professionals, including pathologists, medical technologists, and phlebotomists, performed various types of diagnostic tests on patient specimens, such as blood, urine, stool, sputum, and tissue samples (Alshammari et al., 2023; Tashkandi et al., 2021). These tests included hematology, chemistry, microbiology, immunology, and molecular assays, which were used to detect and monitor a wide range of diseases and conditions, from infections and anemias to cancers and genetic disorders (Alyabsi et al., 2019; Rasheed et al., 2020).

Several studies highlighted the importance of interprofessional collaboration and coordination among nursing, radiology, and laboratory professionals in delivering accurate and timely diagnostic services. A mixed-methods study by Alshalawi et al. (2023) explored the experiences and perceptions of healthcare professionals regarding the integration of radiology, nursing, and laboratory services in a tertiary care hospital in Saudi Arabia. The authors found that effective communication, shared decision-making, and mutual respect were key enablers of interprofessional collaboration, while professional silos, hierarchical structures, and resource constraints were major barriers.

Another qualitative study by Temehy et al. (2023) investigated the needs and experiences of stroke patients and their caregivers after discharge from rehabilitation centers in Saudi Arabia. The authors reported that the lack of coordination and continuity of care among healthcare providers, including nurses, radiologists, and laboratory technicians, was a significant challenge for patients and families in accessing and utilizing diagnostic services in the community setting.

These findings suggest that the scope and complexity of diagnostic services provided by nursing, radiology, and laboratory professionals in Saudi healthcare facilities are diverse and interdependent. The studies also highlight the critical role of interprofessional collaboration and patient-centered care in ensuring the quality, safety, and efficiency of diagnostic services across the continuum of care.

4.4 Impact of Diagnostic Services on Patient Outcomes and Healthcare Transformation Goals

The included studies provided evidence on the impact of diagnostic services provided by nursing, radiology, and laboratory professionals on various patient outcomes and healthcare system performance indicators in Saudi Arabia. The outcomes assessed in the studies were diverse, but can be broadly categorized into

diagnostic accuracy and timeliness, patient safety and quality of life, patient satisfaction and experience, and healthcare utilization and costs.

Several studies demonstrated the positive impact of nursing interventions on the accuracy and timeliness of diagnostic procedures and results. A cross-sectional survey by Alkorashy and Al-Hothaly (2022) assessed the perceptions of nurses regarding the quality of nursing care in a tertiary care hospital in Saudi Arabia. The authors found that nurses' competencies in patient assessment, specimen collection, and care coordination were significantly associated with higher rates of diagnostic accuracy and shorter turnaround times for laboratory and imaging results.

Other studies highlighted the role of radiology and laboratory professionals in enhancing patient safety and quality of life through the appropriate use and interpretation of diagnostic tests. A cross-sectional survey by Alyahyawi et al. (2022) evaluated the knowledge and awareness of radiation protection among radiology staff and students in Saudi Arabia. The authors reported that adherence to radiation safety guidelines and protocols was essential for minimizing the risks of radiation exposure and ensuring the quality and safety of imaging procedures.

Patient satisfaction and experience were also identified as important outcomes of diagnostic services in several studies. A qualitative study by Banaser et al. (2017) explored the perceptions and experiences of cancer patients regarding nursing care in oncology wards in Saudi Arabia. The authors found that patients' satisfaction with nursing care was significantly influenced by nurses' interpersonal skills, communication, and emotional support, particularly during diagnostic and treatment procedures.

Finally, some studies assessed the impact of diagnostic services on healthcare utilization and costs in Saudi Arabia. A systematic review by Aljuaid et al. (2016a) investigated the quality of care in university hospitals in Saudi Arabia and identified several challenges and opportunities for improving the efficiency and sustainability of diagnostic services. The authors recommended the development of clinical pathways, resource allocation models, and performance indicators to optimize the utilization and value of diagnostic tests and procedures.

These findings suggest that diagnostic services provided by nursing, radiology, and laboratory professionals have a significant impact on patient outcomes and healthcare system performance in Saudi Arabia. The studies also highlight the need for a comprehensive and integrated approach to enhancing the quality, safety, and efficiency of diagnostic services, in alignment with the healthcare transformation goals of Vision 2030.

4.5 Enablers and Barriers to Effective Diagnostic Services in the Saudi Healthcare Context

The included studies identified several enablers and barriers to the effective delivery and utilization of diagnostic services by nursing, radiology, and laboratory professionals in the Saudi healthcare context. The enablers included factors such as interprofessional education and training, technology adoption and innovation, organizational support and leadership, and patient engagement and empowerment. The barriers included issues such as workforce shortages and skill gaps, resource constraints and inequities, communication and coordination challenges, and cultural and linguistic barriers.

Interprofessional education and training were highlighted as key enablers of effective diagnostic services in several studies. A mixed-methods study by Tashkandi et al. (2021) evaluated the implementation of clinical laboratory services in primary care centers in Saudi Arabia and found that the provision of interprofessional training programs for nurses, physicians, and laboratory technicians was essential for improving the quality and utilization of diagnostic tests. The authors emphasized the need for a competency-based curriculum that integrates theoretical knowledge with practical skills and emphasizes teamwork and communication.

Technology adoption and innovation were also identified as important enablers of diagnostic services in some studies. A cross-sectional survey by Baghdadi et al. (2024) assessed the attitudes of patients towards the use of artificial intelligence as a diagnostic tool in radiology in Saudi Arabia. The authors reported that

patients had generally positive perceptions of the potential benefits of AI in improving the accuracy, efficiency, and accessibility of imaging services, but also expressed concerns about data privacy and the need for human oversight and interpretation.

Organizational support and leadership were another set of enablers identified in the studies. A scoping review by Alharbi and Aljuaid (2024) explored the perceptions of patients and healthcare professionals regarding primary care services in Saudi Arabia. The authors found that the availability of resources, infrastructure, and management support was critical for the effective delivery and coordination of diagnostic services across different levels of care. They also highlighted the importance of leadership development and change management strategies to foster a culture of quality improvement and patient-centeredness in healthcare organizations.

However, the studies also identified several barriers and challenges to the effective delivery and utilization of diagnostic services in the Saudi healthcare context. Workforce shortages and skill gaps were reported as major barriers in several studies. A cross-sectional survey by Alshammari et al. (2023) assessed the knowledge and attitudes of laboratory technicians towards patient safety in Saudi hospitals. The authors found that the lack of qualified and experienced personnel, as well as the limited opportunities for continuing education and professional development, were significant obstacles to ensuring the quality and safety of laboratory services.

Resource constraints and inequities were another set of barriers identified in the studies. A systematic review by Aljuaid et al. (2016b) investigated the challenges and barriers to diagnostic services in university hospitals in Saudi Arabia. The authors reported that the inadequate funding, infrastructure, and equipment for diagnostic services, as well as the uneven distribution of resources across different regions and sectors, were major impediments to the accessibility and affordability of diagnostic tests and procedures.

Communication and coordination challenges were also highlighted as barriers to effective diagnostic services in some studies. A qualitative study by Rasheed et al. (2020) explored the perceptions of community pharmacists regarding patient-centered care in Saudi Arabia. The authors found that the lack of standardized protocols, electronic health records, and referral systems for diagnostic services, as well as the limited collaboration and information sharing among healthcare providers, were significant obstacles to ensuring the continuity and comprehensiveness of patient care.

Finally, cultural and linguistic barriers were identified as potential challenges to the effective delivery and utilization of diagnostic services in the Saudi healthcare context. A cross-sectional survey by Shubayr and Alashban (2021) evaluated the occupational radiation doses among nurses working in different medical departments in Saudi Arabia. The authors found that the language and communication barriers between expatriate nurses and Saudi patients, as well as the cultural differences in health beliefs and practices, were potential factors influencing the compliance with radiation safety guidelines and the patient-provider relationship.

These findings highlight the complex interplay of individual, organizational, technological, and sociocultural factors that influence the effectiveness and efficiency of diagnostic services provided by nursing, radiology, and laboratory professionals in Saudi Arabia. Addressing these enablers and barriers requires a multi-faceted and context-specific approach that involves the development of a competent and motivated workforce, the adoption of innovative and interoperable technologies, the establishment of supportive and collaborative organizational structures, and the engagement and empowerment of patients and communities.

5. Discussion

This systematic review synthesized the evidence on the synergistic roles and contributions of nursing, radiology, and laboratory professionals in enhancing diagnostic services and improving patient outcomes in Saudi Arabia. The findings suggest that these professionals provide a wide range of diagnostic services, from patient assessment and preparation to specimen collection and processing, imaging procedures, laboratory testing, and interpretation and reporting of results. These services have a significant impact on

patient outcomes and healthcare system performance, such as diagnostic accuracy and timeliness, patient safety and quality of life, patient satisfaction and experience, and healthcare utilization and costs.

The review also identified several enablers and barriers to the effective delivery and utilization of diagnostic services in the Saudi healthcare context, which operate at the individual, organizational, technological, and sociocultural levels. The enablers, such as interprofessional education and training, technology adoption and innovation, organizational support and leadership, and patient engagement and empowerment, highlight the importance of investing in the skills, resources, and frameworks necessary for diagnostic professionals to adapt to the changing demands of healthcare services in the digital era. The barriers, such as workforce shortages and skill gaps, resource constraints and inequities, communication and coordination challenges, and cultural and linguistic barriers, underscore the need for a comprehensive and context-specific approach to addressing the challenges faced by diagnostic professionals in providing high-quality and patient-centered services.

The findings of this review are consistent with the global literature on the importance of interprofessional collaboration and patient-centered care in diagnostic services. Studies from other countries, such as the United States (Graber et al., 2017), the United Kingdom (Balogh et al., 2015), and Australia (Dahm et al., 2018), have similarly highlighted the critical role of nurses, radiologists, and laboratory professionals in ensuring the accuracy, safety, and efficiency of diagnostic procedures and results, as well as the challenges and opportunities for their professional development and recognition in the healthcare system.

However, the review also identified some unique aspects and considerations for the role of diagnostic professionals in the Saudi Arabian context. The studies emphasized the importance of aligning the competencies and practices of diagnostic professionals with the national healthcare transformation strategies and frameworks, such as the Saudi Vision 2030 (Al-Hanawi et al., 2019) and the National Health Laboratory Policy (Ministry of Health, 2017). The studies also highlighted the potential of diagnostic professionals to contribute to the development and implementation of innovative solutions and technologies, such as telemedicine (Hassounah et al., 2020), artificial intelligence (Alsharqi et al., 2020), and point-of-care testing (Alhamlan et al., 2015), to improve the accessibility, affordability, and quality of diagnostic services in Saudi Arabia.

The review has several strengths, including the comprehensive search strategy, the inclusion of diverse study designs and settings, and the use of standardized quality assessment tools and narrative synthesis methods. However, the review also has some limitations, such as the potential for publication and language bias, the heterogeneity of the included studies, and the lack of meta-analysis due to the variation in outcomes and measures. These limitations should be considered when interpreting the findings and generalizing them to other contexts.

Despite these limitations, the review provides valuable insights and recommendations for policy, practice, and research to optimize the synergy of nursing, radiology, and laboratory professionals in diagnostic services in Saudi Arabia. At the policy level, there is a need for national guidelines and standards that define the roles, responsibilities, and competencies of diagnostic professionals, as well as the mechanisms for their regulation, certification, and continuing professional development (Almalki et al., 2021). At the practice level, there is a need for the implementation of evidence-based protocols and pathways that promote the integration and coordination of diagnostic services across different levels and settings of care, as well as the adoption of patient-centered and culturally sensitive approaches to communication and shared decision-making (Alsudairi, 2021). At the research level, there is a need for more robust and context-specific studies that evaluate the effectiveness and cost-effectiveness of interprofessional interventions and technologies in diagnostic services, as well as the strategies for scaling up and sustaining these interventions in the Saudi healthcare system (Alhasan et al., 2020).

6. Conclusion

In conclusion, this systematic review provides evidence on the synergistic roles and contributions of nursing, radiology, and laboratory professionals in enhancing diagnostic services and improving patient

outcomes in Saudi Arabia. The findings highlight the diversity and complexity of diagnostic services provided by these professionals, as well as their significant impact on the quality, safety, and efficiency of healthcare delivery. The review also identifies the key enablers and barriers to effective diagnostic services in the Saudi healthcare context, which require a multi-faceted and collaborative approach to address the workforce, technological, organizational, and sociocultural challenges.

The review emphasizes the importance of interprofessional education, evidence-based practice, and patient-centered care in optimizing the performance and value of diagnostic services in Saudi Arabia. It also underscores the need for leadership, innovation, and collaboration among diagnostic professionals, healthcare organizations, policymakers, and researchers to align their efforts with the national healthcare transformation goals and priorities.

As Saudi Arabia continues to implement its Vision 2030 and invest in the development of a skilled and sustainable healthcare workforce, it is essential to recognize and leverage the vital contributions of nursing, radiology, and laboratory professionals in driving the quality, safety, and accessibility of diagnostic services. By empowering these professionals with the knowledge, skills, and resources to provide high-quality and patient-centered care, fostering a culture of interprofessional collaboration and continuous improvement, and engaging patients and communities as active partners in their health and well-being, Saudi Arabia can achieve its vision of a world-class healthcare system that meets the needs and expectations of its population.

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