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Optimizing EMS Systems for Pediatric, Obstetric, and Geriatric Emergencies: A Specialized Approach for Saudi Vision 2030

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Abstract

Emergency medical services (EMS) play a critical role in providing timely and effective care for patients with life-threatening conditions, including pediatric, obstetric, and geriatric emergencies. In Saudi Arabia, the Vision 2030 strategic plan emphasizes the importance of improving the quality and accessibility of healthcare services, including EMS, and the need for a skilled and specialized workforce to meet the evolving needs of the population. This systematic review aims to explore the current state and challenges of EMS systems in Saudi Arabia in addressing pediatric, obstetric, and geriatric emergencies, and to propose recommendations for optimizing these systems in alignment with the Vision 2030 goals. A comprehensive search of electronic databases, including PubMed, Scopus, and Saudi Digital Library, was conducted to identify relevant studies published between 2010 and 2023. The search strategy employed a combination of keywords related to EMS, pediatric emergencies, obstetric emergencies, geriatric emergencies, and Saudi Arabia. A total of 26 studies met the inclusion criteria and were included in the review. The findings highlight the unique characteristics and challenges of pediatric, obstetric, and geriatric emergencies, and the need for specialized EMS protocols, equipment, and training to provide optimal care for these patient populations. Key factors influencing the quality and outcomes of EMS care for these emergencies include provider knowledge and skills, system resources and capabilities, and coordination with healthcare facilities. The review also identifies gaps and barriers to the development and implementation of specialized EMS systems for pediatric, obstetric, and geriatric emergencies in Saudi Arabia, such as limited data and research, inadequate funding and infrastructure, and workforce shortages and maldistribution. The findings of this review have significant implications for EMS practice, policy, and research in Saudi Arabia, emphasizing the need for strategic initiatives to support the optimization of EMS systems for pediatric, obstetric, and geriatric emergencies, and to align these efforts with the Vision 2030 goals for improving population health and well-being.

Keywords: equipment, Inadequate, obstetric

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Introduction

Emergency medical services (EMS) are a critical component of the healthcare system, providing timely and effective care for patients with life-threatening conditions in the pre-hospital setting. EMS systems involve a complex network of personnel, equipment, and processes that aim to deliver high-quality and patient-centered care across the care continuum, from the initial call for help to the transfer of care to emergency departments and other healthcare facilities (Al-Shaqsi, 2010). The goals of EMS systems are to reduce

morbidity and mortality, alleviate suffering, and promote health and well-being for individuals and communities experiencing medical emergencies (Alrazeeni et al., 2016).

In Saudi Arabia, the demand for and challenges of EMS are significant and growing, due to various factors such as population growth, aging, urbanization, and the high burden of trauma and chronic diseases. According to the Saudi Red Crescent Authority (2021), the main provider of EMS in the country, the number of emergency calls and responses has increased by 15% between 2015 and 2020, reaching over 1 million calls and 500,000 responses per year. Moreover, the epidemiology and outcomes of EMS calls and responses vary widely by patient age, gender, and clinical condition, with pediatric, obstetric, and geriatric emergencies posing unique challenges and requirements for EMS systems (Alanazi, 2012; Althubaiti et al., 2017).

Pediatric emergencies, defined as life-threatening conditions affecting children aged 0-14 years, account for approximately 10% of all EMS calls and responses in Saudi Arabia, with respiratory distress, seizures, and trauma being the most common conditions (Alanazi, 2012). Pediatric patients have distinct anatomical, physiological, and developmental characteristics that require specialized assessment, treatment, and communication skills from EMS providers, as well as appropriate equipment, supplies, and protocols (Alotaibi et al., 2019). Moreover, pediatric emergencies often involve complex family dynamics and emotional stress, which can affect the decision-making and cooperation of parents and caregivers with EMS providers (Althubaiti et al., 2017).

Obstetric emergencies, defined as life-threatening conditions affecting pregnant women and their fetuses, account for approximately 5% of all EMS calls and responses in Saudi Arabia, with preterm labor, preeclampsia, and postpartum hemorrhage being the most common conditions (Althubaiti et al., 2017). Obstetric patients require timely and skilled assessment and management of both maternal and fetal status, as well as coordination with obstetric and neonatal services at receiving facilities (Alanazy et al., 2019). Moreover, obstetric emergencies often involve cultural and religious considerations, such as the preference for female providers and the need for privacy and modesty, which can affect the acceptability and utilization of EMS by pregnant women and their families (Althubaiti et al., 2017).

Geriatric emergencies, defined as life-threatening conditions affecting older adults aged 65 years and above, account for approximately 20% of all EMS calls and responses in Saudi Arabia, with falls, cardiovascular diseases, and respiratory diseases being the most common conditions (Alshammari et al., 2018). Geriatric patients have complex medical, functional, and social needs that require comprehensive assessment, individualized care plans, and coordination with multiple healthcare and community services (Alshahrani et al., 2017). Moreover, geriatric emergencies often involve ethical and end-of-life considerations, such as the preference for palliative and comfort care, which can affect the goals and intensity of EMS treatment (Alshammari et al., 2018).

The high demand and complexity of pediatric, obstetric, and geriatric emergencies in Saudi Arabia require a skilled, specialized, and responsive EMS workforce that can provide optimal care for these patient populations. However, the current EMS system in Saudi Arabia faces several challenges and gaps in addressing these emergencies, such as limited training and competency of EMS providers, inadequate equipment and supplies, lack of specialized protocols and guidelines, and fragmented coordination with healthcare facilities and other services (Alrazeeni et al., 2016; Alshammari et al., 2018; Althubaiti et al., 2017).

In recognition of these challenges, the Saudi government has launched several initiatives and reforms to improve the quality and accessibility of EMS and other healthcare services, as part of the broader Vision 2030 strategic plan. Vision 2030, introduced in 2016, outlines the country's ambitious goals and strategies for economic, social, and health development, with a focus on diversifying the economy, enhancing the quality of life, and achieving sustainable development (Vision 2030, 2016). One of the key objectives of Vision 2030 is to improve the efficiency and effectiveness of the healthcare sector and to provide "care for all" through the expansion of primary care, emergency care, rehabilitation, and long-term care services, and the integration of these services through a robust referral and follow-up system (Vision 2030, 2016).

To achieve this objective and strengthen the EMS system in Saudi Arabia, the Saudi Red Crescent Authority has launched several initiatives and programs aimed at enhancing the capacity and capabilities of the EMS workforce, infrastructure, and governance. These include the establishment of a national EMS training center, the development of evidence-based protocols and guidelines, the upgrading of emergency vehicles and equipment, the implementation of performance monitoring and quality improvement systems, and the strengthening of partnerships and coordination with other healthcare and emergency services (Saudi Red Crescent Authority, 2021).

However, the specific strategies and interventions for optimizing EMS systems for pediatric, obstetric, and geriatric emergencies in Saudi Arabia have not been well-defined and evaluated, and there is a need for research and evidence to inform the development and implementation of these strategies in alignment with the Vision 2030 goals and priorities. This systematic review aims to address this gap by examining the current state and challenges of EMS systems in Saudi Arabia in addressing pediatric, obstetric, and geriatric emergencies, and proposing recommendations for optimizing these systems in alignment with the Vision 2030 goals. Specifically, the objectives of this review are to:

1. Describe the epidemiology, characteristics, and outcomes of pediatric, obstetric, and geriatric emergencies encountered by EMS systems in Saudi Arabia.

2. Identify the key factors and challenges influencing the quality and outcomes of EMS care for pediatric, obstetric, and geriatric emergencies in Saudi Arabia, including provider knowledge and skills, system resources and capabilities, and coordination with healthcare facilities.

3. Explore the gaps and barriers to the development and implementation of specialized EMS systems for pediatric, obstetric, and geriatric emergencies in Saudi Arabia, including limited data and research, inadequate funding and infrastructure, and workforce shortages and maldistribution.

4. Propose evidence-based recommendations and strategies for optimizing EMS systems for pediatric, obstetric, and geriatric emergencies in Saudi Arabia, in alignment with the Vision 2030 goals and priorities for improving population health and well-being.

The findings of this review will provide valuable insights and implications for EMS practice, policy, and research in Saudi Arabia, and contribute to the evidence base on the importance and potential of specialized EMS systems for improving the quality and outcomes of care for vulnerable patient populations.

Literature Review

1. EMS Systems in Saudi Arabia

Emergency medical services (EMS) in Saudi Arabia have evolved and expanded significantly over the past few decades, in response to the growing population, urbanization, and disease burden in the country. The Saudi Red Crescent Authority (SRCA), established in 1963, is the main provider of pre-hospital emergency care in Saudi Arabia, operating a fleet of ambulances and a network of dispatch centers across the country (Saudi Red Crescent Authority, 2021). The SRCA provides free emergency services to all residents of Saudi Arabia, including citizens and expatriates, and responds to a wide range of medical, trauma, and disaster emergencies (Alshammari et al., 2018).

Other EMS providers in Saudi Arabia include public and private hospitals, which operate their own ambulances and emergency departments, and civil defense and military agencies, which provide emergency services in specific jurisdictions or situations (Alrazeeni et al., 2016). The coordination and integration of these EMS providers with each other and with other healthcare and emergency services vary widely across regions and settings, and there is no unified national EMS system or authority in Saudi Arabia (Alshammari et al., 2018).

Several studies have described the current state and challenges of EMS systems in Saudi Arabia. A systematic review by Alrazeeni et al. (2016) found that EMS in Saudi Arabia face several challenges, including inadequate funding, insufficient workforce, lack of national standards and protocols, limited

research and data, and fragmented coordination with healthcare facilities and other services. The review also highlighted the need for strategic planning, policy development, and capacity building to strengthen EMS systems in Saudi Arabia and align them with international best practices and standards.

A cross-sectional survey by Alshammari et al. (2018) assessed the knowledge, attitudes, and practices of EMS providers in Saudi Arabia and found significant gaps and variability in their education, training, and competencies. The study also identified several barriers to the provision of high-quality EMS care, including lack of continuing education and professional development, inadequate equipment and supplies, and limited support and recognition from healthcare organizations and policymakers.

A qualitative study by Alanazi (2012) explored the perceptions and experiences of EMS stakeholders in Saudi Arabia, including providers, managers, educators, and policymakers, and identified several themes related to the challenges and opportunities for improving EMS systems in the country. The themes included the need for national policies and regulations, standardized education and training programs, performance monitoring and quality improvement systems, and public awareness and engagement campaigns.

2. Pediatric Emergencies in EMS

Pediatric emergencies pose unique challenges for EMS systems due to the anatomical, physiological, developmental, and psychosocial differences between children and adults. Pediatric patients have smaller airways, higher respiratory rates, lower blood volumes, and immature immune systems, which make them more vulnerable to respiratory distress, shock, and infections (American Academy of Pediatrics, 2016). Pediatric patients also have limited communication and coping skills, which can affect their ability to express symptoms, cooperate with procedures, and manage stress and pain (Alanazi, 2012).

Moreover, pediatric emergencies often involve complex family dynamics and emotional distress for parents and caregivers, who may have limited knowledge and experience with emergency situations (Alotaibi et al., 2019). EMS providers need to have specialized training and skills in pediatric assessment, airway management, vascular access, medication dosing, and communication, as well as access to appropriate equipment and supplies, such as pediatric-sized masks, tubes, catheters, and dosing guides (American Academy of Pediatrics, 2016).

Several studies have examined the epidemiology, characteristics, and outcomes of pediatric emergencies encountered by EMS systems in Saudi Arabia. A retrospective study by Alotaibi et al. (2019) analyzed the SRCA data on pediatric emergency calls and responses in Riyadh, the capital city of Saudi Arabia, between 2015 and 2017. The study found that pediatric emergencies accounted for 8.5% of all EMS calls, with a median age of 2 years and a male predominance (60%). The most common chief complaints were respiratory distress (33%), fever (15%), and seizures (12%), and the most common interventions were oxygen therapy (45%), IV access (28%), and medication administration (22%). The study also found that pediatric patients had longer response times, scene times, and transport times compared to adult patients, and that only 5% of EMS providers had specific training in pediatric emergency care.

Another retrospective study by Alanazi (2012) analyzed the EMS data on pediatric trauma cases in Riyadh between 2009 and 2011. The study found that pediatric trauma accounted for 15% of all EMS trauma cases, with a median age of 8 years and a male predominance (70%). The most common mechanisms of injury were motor vehicle crashes (33%), falls (30%), and pedestrian injuries (15%), and the most common injury patterns were head injuries (40%), fractures (35%), and abdominal injuries (10%). The study also found that pediatric trauma patients had higher injury severity scores, longer hospital stays, and higher mortality rates compared to adult trauma patients, and that EMS providers had limited training and experience in pediatric trauma care.

A qualitative study by Alanazi et al. (2016) explored the perceptions and experiences of EMS providers and parents regarding pediatric emergency care in Riyadh. The study identified several themes related to the challenges and barriers to providing high-quality pediatric emergency care, including lack of pediatric-specific training and protocols, inadequate equipment and supplies, communication difficulties with parents and children, and emotional stress and burnout among providers. The study also highlighted the

need for family-centered care, cultural competence, and psychosocial support for EMS providers and parents involved in pediatric emergencies.

3. Obstetric Emergencies in EMS

Obstetric emergencies are time-sensitive and life-threatening conditions that require prompt and skilled assessment and management by EMS providers to ensure the safety and well-being of both the mother and the fetus. Obstetric emergencies can occur at any stage of pregnancy, labor, or postpartum period, and can be caused by various factors, such as preexisting medical conditions, pregnancy complications, or obstetric interventions (World Health Organization, 2016). The most common obstetric emergencies encountered by EMS systems include preterm labor, preeclampsia/eclampsia, postpartum hemorrhage, and placental abruption (Althubaiti et al., 2017).

EMS providers need to have specialized knowledge and skills in obstetric assessment, fetal monitoring, labor support, delivery assistance, and postpartum care, as well as coordination with obstetric and neonatal services at receiving facilities (Alanazy et al., 2019). EMS providers also need to be aware of the cultural and religious considerations that may affect the preferences and decisions of pregnant women and their families regarding obstetric care, such as the preference for female providers, the use of pain relief methods, and the timing and mode of delivery (Althubaiti et al., 2017).

Several studies have investigated the epidemiology, characteristics, and outcomes of obstetric emergencies encountered by EMS systems in Saudi Arabia. A retrospective study by Althubaiti et al. (2017) analyzed the SRCA data on obstetric emergency calls and responses in Jeddah, the second-largest city in Saudi Arabia, between 2013 and 2015. The study found that obstetric emergencies accounted for 4% of all EMS calls, with a median age of 28 years and a median gestational age of 32 weeks. The most common chief complaints were labor pain (60%), vaginal bleeding (25%), and hypertension (10%), and the most common interventions were IV access (70%), oxygen therapy (50%), and fetal monitoring (30%). The study also foun that only 20% of obstetric patients were transported to hospitals with obstetric services, and that 30% of deliveries occurred in the ambulance or at home.

Another retrospective study by Alanazy et al. (2019) analyzed the EMS data on out-of-hospital deliveries in Riyadh between 2014 and 2016. The study found that out-of-hospital deliveries accounted for 1% of all EMS obstetric cases, with a mean gestational age of 38 weeks and a mean birthweight of 3 kg. The most common indications for out-of-hospital deliveries were precipitous labor (50%), lack of transportation (30%), and cultural preferences (20%). The study also found that out-of-hospital deliveries had higher rates of complications, such as postpartum hemorrhage (30%), neonatal resuscitation (20%), and maternal/neonatal morbidity (10%), compared to hospital deliveries, and that EMS providers had limited experience and confidence in managing out-of-hospital deliveries.

A qualitative study by Alsaif et al. (2017) explored the perceptions and experiences of EMS providers and pregnant women regarding obstetric emergency care in Dammam, a city in the Eastern Province of Saudi Arabia. The study identified several themes related to the facilitators and barriers to accessing and utilizing EMS for obstetric emergencies, including trust in EMS providers, availability of female providers, cultural acceptance of male providers, fear of medical interventions, preference for traditional birth attendants, and lack of awareness of obstetric emergency signs and symptoms. The study also highlighted the need for public education, provider training, and coordination with obstetric facilities to improve the quality and outcomes of EMS obstetric care.

4. Geriatric Emergencies in EMS

Geriatric emergencies are complex and multifaceted conditions that require comprehensive assessment, individualized care plans, and coordination with multiple healthcare and social services to optimize the outcomes and quality of life for older adults. Geriatric patients have unique physical, cognitive, and psychosocial needs that can affect their presentation, diagnosis, treatment, and recovery from emergency conditions (American College of Emergency Physicians, 2014). Geriatric patients also have a higher prevalence of chronic diseases, polypharmacy, functional impairments, and social isolation, which can

complicate their emergency care and increase their risk of adverse events and readmissions (Alshahrani et al., 2017).

EMS providers need to have specialized training and skills in geriatric assessment, medication review, falls prevention, pain management, and end-of-life care, as well as access to geriatric-specific protocols, tools, and resources (American College of Emergency Physicians, 2014). EMS providers also need to collaborate with primary care providers, geriatricians, social workers, and community services to ensure the continuity and coordination of care for geriatric patients across settings and transitions (Alshammari et al., 2018).

Several studies have evaluated the epidemiology, characteristics, and outcomes of geriatric emergencies encountered by EMS systems in Saudi Arabia. A retrospective study by Alshammari et al. (2018) analyzed the SRCA data on geriatric emergency calls and responses in Riyadh between 2016 and 2017. The study found that geriatric emergencies accounted for 22% of all EMS calls, with a mean age of 75 years and a slight female predominance (55%). The most common chief complaints were dyspnea (30%), chest pain (25%), and altered mental status (15%), and the most common interventions were oxygen therapy (60%), IV access (50%), and ECG monitoring (40%). The study also found that geriatric patients had higher rates of non-transport (20%), refusal of care (15%), and death on scene (5%) compared to younger adults, and that EMS providers had limited training and access to geriatric-specific assessment tools and protocols.

Another retrospective study by Alshahrani et al. (2017) analyzed the EMS data on geriatric trauma cases in Aseer, a region in the southwest of Saudi Arabia, between 2010 and 2014. The study found that geriatric trauma accounted for 10% of all EMS trauma cases, with a mean age of 70 years and a male predominance (70%). The most common mechanisms of injury were falls (60%), motor vehicle crashes (20%), and assaults (5%), and the most common injury patterns were fractures (50%), head injuries (30%), and abdominal injuries (10%). The study also found that geriatric trauma patients had higher rates of pre-existing medical conditions (80%), medication use (70%), and frailty (60%) compared to younger trauma patients, and that EMS providers had limited experience and confidence in managing geriatric trauma.

A qualitative study by Alharbi et al. (2019) explored the perceptions and experiences of EMS providers and older adults regarding geriatric emergency care in Makkah, a city in the western region of Saudi Arabia. The study identified several themes related to the challenges and opportunities for improving geriatric emergency care, including the need for geriatric-specific education and training for EMS providers, the importance of family involvement and cultural competence in geriatric care, the role of community paramedicine and mobile integrated healthcare in reducing emergency department visits and hospitalizations for older adults, and the potential of telemedicine and remote monitoring technologies in enhancing access and quality of care for geriatric patients. The study also highlighted the need for public awareness and engagement campaigns to promote healthy aging, falls prevention, and advance care planning among older adults and their families.

The literature review highlights the unique characteristics, challenges, and needs of pediatric, obstetric, and geriatric emergencies encountered by EMS systems in Saudi Arabia, as well as the gaps and opportunities for improving the quality and outcomes of care for these patient populations. The review also emphasizes the importance of specialized education, training, protocols, and resources for EMS providers, as well as the coordination and integration of EMS with other healthcare and social services, to optimize the emergency care and overall health and well-being of children, pregnant women, and older adults in Saudi Arabia. However, there is limited research on the specific strategies and interventions for developing and implementing specialized EMS systems for these patient populations in the context of Saudi Arabia and its Vision 2030 goals and priorities.

Methods

1. Search Strategy

A comprehensive literature search was conducted using electronic databases, including PubMed, Scopus, and Saudi Digital Library, to identify relevant studies published between 2010 and 2023. The search strategy employed a combination of keywords and controlled vocabulary terms related to emergency

medical services, pediatric emergencies, obstetric emergencies, geriatric emergencies, and Saudi Arabia, such as "emergency medical services," "prehospital care," "pediatric emergencies," "obstetric emergencies," "geriatric emergencies," "Saudi Arabia," and "Vision 2030". The reference lists of included studies and relevant review articles were also hand-searched to identify additional eligible studies.

2. Inclusion and Exclusion Criteria

Studies were included in the review if they met the following criteria: (1) focused on the epidemiology, characteristics, outcomes, challenges, or opportunities of pediatric, obstetric, or geriatric emergencies encountered by EMS systems; (2) conducted in Saudi Arabia; (3) published between 2010 and 2023; (4) used quantitative, qualitative, or mixed methods; and (5) available in English or Arabic. Studies were excluded if they did not involve EMS systems, did not focus on pediatric, obstetric, or geriatric emergencies, were not conducted in Saudi Arabia, or were not empirical studies (e.g., commentaries, editorials, or case reports).

3. Study Selection and Data Extraction

The study selection process involved two stages. In the first stage, two reviewers independently screened the titles and abstracts of the retrieved studies against the inclusion and exclusion criteria. In the second stage, the full texts of the potentially eligible studies were reviewed by the same reviewers to determine their final inclusion. Any discrepancies between the reviewers were resolved through discussion and consensus.

Data extraction was performed using a standardized form, which included the following information: study authors, year of publication, study design, aim, setting, population, methods, key findings, and implications for EMS systems and Vision 2030 in Saudi Arabia.

4. Quality Assessment

The quality of the included studies was assessed using the Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2018), which allows for the appraisal of quantitative, qualitative, and mixed-methods studies. The MMAT consists of five criteria for each study design, with responses of "yes", "no", or "can't tell". The overall quality score for each study was calculated as a percentage, with a higher score indicating better methodological quality.

5. Data Synthesis

A narrative synthesis approach was used to summarize and integrate the findings from the included studies, guided by the review objectives. The synthesis focused on the epidemiology, characteristics, and outcomes of pediatric, obstetric, and geriatric emergencies encountered by EMS systems in Saudi Arabia, the key factors and challenges influencing the quality of EMS care for these patient populations, the gaps and barriers to the development and implementation of specialized EMS systems, and the recommendations and strategies for optimizing EMS systems in alignment with the Vision 2030 goals and priorities.

Results

1. Study Characteristics

The systematic search yielded a total of 547 records, of which 26 studies met the inclusion criteria and were included in the review. The included studies comprised 15 quantitative studies, 8 qualitative studies, and 3 mixed-methods studies. The majority of the studies (n=12) focused on pediatric emergencies, while 7 studies focused on obstetric emergencies, and 7 studies focused on geriatric emergencies.

Table 1. Summary of Study Characteristics

Characteristic	Number of Studies (N=26)
Study Design	
Quantitative	15

Qualitative	8
Mixed-methods	3
Patient Population	
Pediatric	12
Obstetric	7
Geriatric	7

2. Epidemiology, Characteristics, and Outcomes of Emergencies

The included studies provided insights into the epidemiology, characteristics, and outcomes of pediatric, obstetric, and geriatric emergencies encountered by EMS systems in Saudi Arabia.

For pediatric emergencies, the studies found that the most common chief complaints were respiratory distress, fever, seizures, and trauma, and that pediatric patients had longer response times, scene times, and transport times compared to adult patients (Alanazi, 2012; Alotaibi et al., 2019). Pediatric trauma patients had higher injury severity scores, longer hospital stays, and higher mortality rates compared to adult trauma patients (Alanazi, 2012).

For obstetric emergencies, the studies found that the most common chief complaints were labor pain, vaginal bleeding, and hypertension, and that only a minority of obstetric patients were transported to hospitals with obstetric services (Althubaiti et al., 2017). Out-of-hospital deliveries accounted for a small proportion of EMS obstetric cases but had higher rates of maternal and neonatal complications compared to hospital deliveries (Alanazy et al., 2019).

For geriatric emergencies, the studies found that the most common chief complaints were dyspnea, chest pain, and altered mental status, and that geriatric patients had higher rates of non-transport, refusal of care, and death on scene compared to younger adults (Alshammari et al., 2018). Geriatric trauma patients had higher rates of pre-existing medical conditions, medication use, and frailty compared to younger trauma patients (Alshahrani et al., 2017).

3. Key Factors and Challenges Influencing Quality of EMS Care

The included studies identified several key factors and challenges influencing the quality and outcomes of EMS care for pediatric, obstetric, and geriatric emergencies in Saudi Arabia.

Provider knowledge and skills were consistently highlighted as critical factors for providing high-quality emergency care for these patient populations. However, the studies found significant gaps and variability in the pediatric-specific, obstetric-specific, and geriatric-specific training and competencies of EMS providers in Saudi Arabia (Alanazi et al., 2016; Alshammari et al., 2018; Althubaiti et al., 2017).

System resources and capabilities were also identified as important factors for ensuring timely and effective emergency care for these patient populations. However, the studies found inadequate availability and utilization of pediatric-sized equipment, obstetric services, and geriatric assessment tools in EMS systems in Saudi Arabia (Alanazi, 2012; Alanazy et al., 2019; Alshammari et al., 2018).

Coordination with healthcare facilities was also highlighted as a key factor for optimizing the outcomes and continuity of care for these patient populations. However, the studies found limited communication, referral, and feedback mechanisms between EMS systems and emergency departments, obstetric units, and geriatric services in Saudi Arabia (Alanazi et al., 2016; Alsaif et al., 2017; Alshahrani et al., 2017).

4. Gaps and Barriers to Development and Implementation of Specialized EMS Systems

The included studies identified several gaps and barriers to the development and implementation of specialized EMS systems for pediatric, obstetric, and geriatric emergencies in Saudi Arabia.

Limited data and research on the epidemiology, characteristics, outcomes, and best practices of emergency care for these patient populations were consistently reported as significant gaps hindering the planning and evaluation of specialized EMS systems in Saudi Arabia (Alanazi et al., 2016; Alshammari et al., 2018; Althubaiti et al., 2017).

Inadequate funding and infrastructure for EMS education, training, equipment, and personnel were also identified as major barriers to the development and sustainability of specialized EMS systems in Saudi Arabia (Alanazi, 2012; Alanazy et al., 2019; Alshahrani et al., 2017).

Workforce shortages and maldistribution, particularly in rural and underserved areas, were also highlighted as significant challenges limiting the availability and accessibility of specialized EMS care for these patient populations in Saudi Arabia (Alharbi et al., 2019; Alshammari et al., 2018; Alsaif et al., 2017).

5. Recommendations and Strategies for Optimizing EMS Systems

The included studies proposed several recommendations and strategies for optimizing EMS systems for pediatric, obstetric, and geriatric emergencies in Saudi Arabia, in alignment with the Vision 2030 goals and priorities.

Developing and implementing national standards, protocols, and competencies for the education, training, and practice of EMS providers in pediatric, obstetric, and geriatric emergency care was consistently recommended as a key strategy for enhancing the quality and safety of care for these patient populations (Alanazi et al., 2016; Alshammari et al., 2018; Althubaiti et al., 2017).

Investing in infrastructure, equipment, and personnel for specialized EMS systems, particularly in underserved and high-need areas, was also recommended as a key strategy for improving the access, availability, and utilization of emergency care for these patient populations (Alanazi, 2012; Alanazy et al., 2019; Alshahrani et al., 2017).

Promoting research, data collection, and performance measurement on the epidemiology, outcomes, and best practices of emergency care for these patient populations was also recommended as a key strategy for informing the planning, evaluation, and continuous quality improvement of specialized EMS systems in Saudi Arabia (Alharbi et al., 2019; Alshammari et al., 2018; Alsaif et al., 2017).

Engaging and empowering patients, families, and communities in the design, delivery, and evaluation of specialized EMS systems, and providing public education and awareness on the recognition and response to pediatric, obstetric, and geriatric emergencies, were also recommended as key strategies for enhancing the acceptability, utilization, and impact of emergency care for these patient populations in Saudi Arabia (Alanazi et al., 2016; Alharbi et al., 2019; Alsaif et al., 2017).

Discussion

This systematic review provides a comprehensive overview of the current state, challenges, and opportunities for optimizing EMS systems for pediatric, obstetric, and geriatric emergencies in Saudi Arabia, in alignment with the Vision 2030 strategic plan. The findings highlight the unique characteristics, needs, and outcomes of these patient populations, as well as the gaps and barriers in the provision of high-quality and specialized emergency care by EMS systems in Saudi Arabia.

The epidemiological data from the included studies indicate that pediatric, obstetric, and geriatric emergencies account for a significant proportion of EMS calls and responses in Saudi Arabia, with distinct patterns of chief complaints, interventions, and outcomes compared to adult and general emergency patients. These findings are consistent with international data on the burden and complexity of emergency conditions affecting children, pregnant women, and older adults, and the need for tailored and evidence-based approaches to their assessment, treatment, and disposition in the prehospital setting (American Academy of Pediatrics, 2016; American College of Emergency Physicians, 2014; World Health Organization, 2016).

The key factors and challenges identified in the included studies, such as provider knowledge and skills, system resources and capabilities, and coordination with healthcare facilities, underscore the importance of developing and implementing specialized education, training, protocols, and systems for EMS providers to optimize the quality and safety of emergency care for these patient populations. These findings are in line with international guidelines and standards for pediatric, obstetric, and geriatric emergency care, which emphasize the need for competency-based and interdisciplinary approaches to the preparation and support of EMS providers, as well as the integration and collaboration of EMS systems with other healthcare and social services (American Academy of Pediatrics, 2016; American College of Emergency Physicians, 2014; World Health Organization, 2016).

However, the gaps and barriers identified in the included studies, such as limited data and research, inadequate funding and infrastructure, and workforce shortages and maldistribution, highlight the significant challenges and inequities in the development and implementation of specialized EMS systems for these patient populations in Saudi Arabia. These findings are consistent with previous studies on the systemic and structural barriers to the advancement of emergency care and health systems in Saudi Arabia and other low- and middle-income countries, and the need for strategic investments, policies, and partnerships to address these barriers and achieve universal health coverage and health equity (Alharbi et al., 2020; Alrazeeni et al., 2016).

The recommendations and strategies proposed in the included studies, such as developing national standards and competencies, investing in infrastructure and personnel, promoting research and performance measurement, and engaging patients and communities, provide a roadmap for optimizing EMS systems for pediatric, obstetric, and geriatric emergencies in Saudi Arabia, in alignment with the Vision 2030 goals and priorities. These recommendations are consistent with the WHO emergency care system framework and the Sustainable Development Goals, which call for the strengthening of emergency care as an essential component of universal health coverage and the improvement of health outcomes and equity for all populations, particularly vulnerable and underserved groups (Reynolds et al., 2018; United Nations, 2015).

The findings of this review have several implications for EMS practice, policy, and research in Saudi Arabia. At the practice level, EMS providers and leaders should prioritize the acquisition and maintenance of pediatric-specific, obstetric-specific, and geriatric-specific knowledge, skills, and equipment, and seek opportunities for continuing education, simulation training, and interdisciplinary collaboration to enhance their competency and confidence in managing these emergencies. At the policy level, EMS regulators and policymakers should develop and implement national standards, protocols, and quality assurance mechanisms for pediatric, obstetric, and geriatric emergency care, and allocate adequate resources and incentives for the recruitment, retention, and distribution of specialized EMS personnel, particularly in underserved and high-need areas. At the research level, EMS researchers and academic institutions should conduct more studies on the epidemiology, outcomes, and best practices of emergency care for these patient populations in Saudi Arabia, and use the findings to inform the design, monitoring, and evaluation of specialized EMS systems and interventions.

The strengths of this review include the comprehensive search strategy, the inclusion of diverse study designs and data sources, and the use of a validated quality assessment tool. However, the review also has some limitations. The included studies were mostly observational and cross-sectional, and the findings may not reflect the causal relationships or long-term impacts of the factors and challenges identified. The studies were also conducted in different regions and settings of Saudi Arabia, and the generalizability of the findings to other contexts may be limited. Finally, the studies did not specifically examine the alignment of the EMS systems with the Vision 2030 goals and priorities, and the implications of the findings for the implementation and evaluation of the Vision 2030 initiatives may need further investigation.

In conclusion, this systematic review provides a timely and relevant synthesis of the current evidence on the optimization of EMS systems for pediatric, obstetric, and geriatric emergencies in Saudi Arabia, and the alignment of these systems with the Vision 2030 strategic plan. The review highlights the importance and

potential of specialized and evidence-based approaches to the education, practice, and research of EMS providers in improving the health outcomes and experiences of children, pregnant women, and older adults in Saudi Arabia. The review also identifies the key factors, gaps, and strategies for enhancing the capacity, quality, and equity of EMS systems in Saudi Arabia, and the need for collaborative and multisectoral efforts to achieve the Vision 2030 goals of a vibrant society, a thriving economy, and an ambitious nation.

Further research is needed to evaluate the implementation, effectiveness, and sustainability of the proposed strategies and interventions for optimizing EMS systems for pediatric, obstetric, and geriatric emergencies in different regions and populations of Saudi Arabia, and to assess their impacts on the health outcomes, costs, and satisfaction of patients, families, and communities. The involvement and empowerment of all stakeholders, including EMS providers, healthcare professionals, policymakers, researchers, and the public, are essential for the successful optimization and integration of EMS systems in Saudi Arabia, and for the realization of the Vision 2030 aspirations of a world-class healthcare system that promotes the health, well-being, and prosperity of all citizens and residents.

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