

Maternal and Neonatal Mortality in Saudi Arabia: A Depth Review Study, Progress, Challenges and Strategic Interventions

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Abstract

Saudi Arabia has had remarkable progress in reducing maternal and neonatal mortality over the past decades. While various challenges persist, such as unequal access to healthcare, a history of pre-existing maternal conditions, and neonatal complications, this review will focus on critical determinants of maternal and neonatal outcomes in Saudi Arabia, including government-driven efforts through Vision 2030 towards enhancing health care infrastructure and policies. The focus has been on antenatal care, neonatal intensive care units, and maternal mortality audit issues, enhancing outcomes. Recommendations are the adoption of standardized risk assessment tools and health disparities abatement between the Saudi population and non-Saudi populations. Future strategies encompass holistic approaches: education, infrastructure improvements, and policy frameworks, aiming to achieve international standards.

Keywords: Maternal mortality, Neonatal mortality, Antenatal care, Saudi Arabia, NICUs, Maternal audits and Vision 2030.

1. Introduction

The prevalent rates of maternal and neonatal mortality in Saudi Arabia can best be described as a convergence of health-related advancements and remaining challenges. Following new research, the latest findings suggest that although Saudi Arabia has improved their maternal and neonatal mortality rates, they still do not meet the world's average, especially as compared to the high-income economies of the world. Maternal mortality in Saudi Arabia has declined steadily.

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According to estimates, the rate stood at around 12 deaths per 100,000 live births in the most recent years, which is better than during the past decade (Al-Hindi et al., 2020). The number is still much lower than the world's average value that is calculated by the WHO as 211 deaths per 100,000 live births (Al-Hindi et al., 2020). Factors contributing to maternal mortality include complications related to pre-existing conditions such as diabetes and hypertension, which are prevalent among pregnant women in the region (Alshomrany, 2024; Alshomrany, 2024).

The prevalence of gestational diabetes mellitus (GDM) is particularly concerning, with rates reported between 4.3% and 28.5% of pregnancies, which can lead to adverse maternal and neonatal outcomes (Alshomrany, 2024; Alshomrany, 2024). Neonatal mortalities in Saudi Arabia also present a mixed view. The under-five mortality rate was recorded at 7.4 per 1,000 live births in 2017, which is much smaller than the global average at 38 deaths per 1,000 live births (Alamer, 2023). However, neonatal mortality, especially among preterm babies, remains a critical issue. Prematurity represents one of the leading causes of morbidity and mortality in neonates, with estimations suggesting that a significant percentage of NICU admissions result from preterm births (Al-Mouqdad et al., 2020). Respiratory distress syndrome and neonatal infections add severity to outcomes, thus compelling the enhancement of antenatal care as well as postnatal support (Abolfotouh et al., 2018; Alshammari, 2023).

Though health infrastructure has improved significantly, inequalities are seen among the non-Saudi populations; these people have made up a significant proportion of the demographic in Saudi Arabia and experience greater rates of complications within the neonate period. This indicates that access and quality of healthcare services may widely vary depending on the population served (Al-Mouqdad et al., 2020). Indeed, a standardized scoring system of antenatal risks is also quoted as being one gap in Saudi Arabia that can improve maternal and neonatal outcomes if addressed (Al-Hindi et al., 2020). Summary: Despite clear progress made in the reduction of maternal and neonatal mortality, the future requires much effort to catch up with world standards. Providing health access, disease prevalence among pregnant women due to non-communicable diseases and improving quality care before and after birth remain key priorities in assuring further reductions.

2. Advancements and Challenges in Maternal and Neonatal Healthcare in Saudi Arabia

Evolution of Health Care in Saudi Arabia has really taken a different shape over the past decades, particularly for challenges related to maternal and neonatal health. Such development is influenced fundamentally by government initiatives implemented to improve access, quality, and outcomes of healthcare as per broader objectives of Saudi Vision 2030. One of the most important changes in the health care system is the trend of increasing healthcare spending, which statistically has positively affected a reduction in maternal and neonatal mortality rates as postulated by Roy & Khatun (2022). The government has also spent appreciable amounts in providing a solid health infrastructure, with the hospitals and first-tier health facilities stretched across the country, thereby ensuring increased access to maternal healthcare services (Mirza et al., 2019; Gurajala, 2023). Such facilities have, with them the development of efforts to enhance standards of care through accreditation programs and implementations of health care technology, a mixture that has enhanced health results between mothers and babies (Gurajala, 2023).

Improvement on infrastructural aspects in the health care system, education, and training of health professionals, particularly on maternal and newborn care, were other key aspects in the Saudi health care system. The introduction of specialist nursing roles has played a vital role in the delivery of patient-centered care that addresses pregnant women and newborn needs (Hibbert et al., 2012). Second, other studies have emphasized the relevance of healthcare literacy among mothers: increasing their knowledge and awareness regarding healthcare practices can increase attendance rates at antenatal care and maternal health (Alanazy & Brown, 2020).

The Ministry of Health (MOH) has also followed several policies that assist in improving attendance during antenatal care and reduce barriers to accessing healthcare. These include flexible appointment systems, transportation provisions, and equipping primary health care centers with necessary medical facilities (Almalki, 2014). The initiatives will contribute much to the concerning disparities of healthcare access mainly to those who are not Saudi citizens since most neonatal complications tend to be higher in this section (Al-Mouqdad et al., 2020).

Despite these advancements, challenges remain. Maternal mortality rates are decreasing, but still a testament to the gaps in healthcare provision and quality, especially in specific regions (Nassif et al., 2022). Evidently, there is a need to constantly improve how healthcare is delivered and its outcomes since the country looks forward to getting its maternal and neonatal health indicators close to international standards (Nassif et al., 2022). In essence, Saudi Arabia's health system has been fundamentally transformed to overcome most of the challenges that it faces in matters relating to maternal and neonatal health based on increased investments, better infrastructure, more competent health care professionals, and policy interventions that target access to health care. The changes necessitate sustained efforts to translate them into all equitable health outcomes for populations across the country.

3. The Impact of Saudi Vision 2030 on Maternal and Neonatal Healthcare

Vision 2030 is a transformative framework that has been proposed to diversify the economy and enhance various sectors, including the healthcare sector in Saudi Arabia. It plays a very crucial role in shaping maternal and neonatal health policies and strategies aimed at meeting the most critical health challenges in the kingdom. The enhancement of quality health services is the primary objective of Vision 2030, and this should indeed encompass matters of maternal and neonatal health. Such a goal sends emphasis on reducing the current prevalence of maternal and neonatal mortality rates in the region, which have been a major source of concern for long. Prioritizing the health outcomes for such improvement, the government seeks to harmonize its healthcare metrics with the rest of the world (Young et al., 2021) Chowdhury et al., 2021). Strategic plans will include increasing healthcare expenditure and strengthening the health infrastructure that is needed to provide comprehensive maternal and neonatal care (Rahman & Qattan, 2021). Hence, the budget for healthcare has registered sky-rocketing hikes, which has led to a surge in the numbers of hospitals and other health-care centers focused on maternal and child health (Young et al., 2021).

This vision also focuses on private sector involvement in health care, targeting growing private sector contribution from 25% up to 35% by 2030 (Rahman & Qattan, 2021). Such change is likely to enhance the quality and access to maternal care, since private entities also come to bring

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innovation and effectiveness in health care delivery. The government's strong move to deliver free-quality health care services to all citizens also underscores its efforts to promote an improvement in maternal and neonatal health outcomes (Rahman & Qattan, 2021). Other than infrastructure and financing, Vision 2030 identifies the need for the development of the health workforce. The objective of the initiative is improving healthcare providers' training and education, focusing on maternal and neonatal care (Al-Hanawi et al., 2019). Human resource development is essential, with a well-trained workforce being critical in delivering care of high quality to meet the needs of mothers and their newborn babies (Alsufyani et al., 2020). The improvement in the qualifications and competencies of health practitioners will also mean that more positive health outcomes have been achieved, among other benefits.

Vision 2030 further stipulates that there should be integrated care for health issues, providing preventive and health education. In recognition of the problem of maternal and neonatal conditions, this initiative informs the women and families about health to empower them in their choice-making (Chowdhury et al., 2021). This educational aspect is crucial in enhancing the attendance of antenatal care and reducing healthcare inequities among various population groups, especially non-Saudi residents who face barriers in accessing care (Al-Mouqdad et al., 2020; Nassif et al., 2022). Vision 2030 has a significant role in developing policies and strategies for maternal and neonatal healthcare in Saudi Arabia. With improvement in health care quality, increased private sector engagement, better training of personnel, and promotion of health education, the initiative ensures a strong healthcare system that deals effectively with the mother-and-infant related problems. As such, these interventions are anticipated to transform significantly the health outcomes among mothers and neonates to align with international standards in health.

4. Maternal Mortality in Saudi Arabia: Causes and Strategies for Improvement

Maternal mortality still represents a major public health concern in Saudi Arabia with the various causes influencing the leading contributors to maternities deaths occurring within the hospitals. Knowledge of these causes and the strategies used to mitigate them will benefit efforts to advance maternal health outcomes. Obstetric hemorrhage is one of the main contributing factors to maternal deaths within Saudi hospitals, with postpartum hemorrhage (PPH) one of the major causes. This condition has been identified as a major contributor to maternal morbidity and mortality. As such, the studies indicate that deaths related to PPH have been on the rise in the Kingdom (Asiri et al., 2022; The increasing incidence of PPH calls for an effective response as part of the management in place. Towards this end, comprehensive programs for training in early identification and management of at-risk patients are instituted. Comprehensive training programs for healthcare providers related to managing obstetric emergencies are being implemented in hospitals, incorporating the use of blood products and surgical interventions where needed (Asiri et al., 2022; Abousada et al., 2021).

Other key causes of maternal deaths are complications due to conditions such as placenta previa and placenta accreta. These cause significant hemorrhage and must be managed carefully, often by cesarean delivery and possibly a hysterectomy in more severe situations (Abduljabbar et al., 2016; Kassem & Alzahrani, 2013). The response has been developing specialist obstetric teams

with multi-disciplinary approaches to dealing effectively with these high-risk pregnancies. This runs the gamut from planning preoperative care to keeping blood on standby in anticipation of the anticipated hemorrhage (Abduljabbar et al., 2016; Kassem & Alzahrani, 2013).

Pre-existing illnesses, hypertension, and diabetes, and other comorbidity factors also explain the reasons for maternal mortality. These indirect causes are usually aggravated by socioeconomic factors such as lesser access to healthcare and education amongst specific groups (Hazzazi et al., 2021; Alanazy & Brown, 2020). The Saudi government has focused on antenatal care services to ensure that greater access and quality are emphasized. Initiatives include public health campaigns to raise awareness regarding the need for regular antenatal visits and the management of chronic conditions during pregnancy (Alanazy & Brown, 2020; Al-Hindi et al., 2020).

Moreover, cultural factors and practices such as early marriages and grand multiparity have been linked with increasing maternal risks (Al-Shaikh et al., 2017). These are complex issues to address, and community education and engagement should therefore be used to promote family planning and reproductive health services. The government is implementing educational programs into the prevailing healthcare frameworks so that women are well informed about their health choices (Al-Shaikh et al., 2017). Maternal mortality in Saudi hospitals is caused mainly by obstetric hemorrhage, complication from placenta accreta/placenta previa, and other pre-existing medical conditions. The healthcare system is addressing the problem through enhanced training of its health providers, setting up specialized obstetric teams, increasing access to antenatal care, and community education. These strategies are most relevant in reducing maternal mortality and improving maternal health results generally in the Kingdom.

5. Emergency Obstetric Care (EmOC) in Saudi Arabia: Enhancing Maternal Health Outcomes

Emergency obstetric care (EmOC) services are the platform that improves maternal outcomes in Saudi Arabia with timely and effective interventions for complications arising with pregnancy and childbirth. It has several dimensions-effectiveness, which include access, quality of care, and the integration of emergency protocols within the healthcare system. One of the main reasons EmOC services improve outcomes for mothers is that they reduce delay in receiving care when complications arise during obstetric emergencies. The establishment of comprehensive emergency care protocols in hospitals has been crucial in dealing with complications such as postpartum hemorrhage, hypertensive disorders, and obstructed labor, major causes of maternal mortality Chowdhury et al. (2022). Studies have evidenced that hospitals where clear EmOC protocols are implemented can drastically reduce the time spent on the management of obstetric emergencies; thus, survival chances improve (Miltenburg et al., 2017).

The Saudi government has also emphasized training of healthcare professionals in emergency obstetric care. It has increased the clinical skills and decision-making capabilities about critical patients. This training, through simulations and hands-on practice in managing obstetric emergencies, is one that has been associated with increasing healthcare providers' confidence and competence (Almutairi et al., 2023). Skilled persons are essential components in emergency departments to manage effectively maternal health crises, and ongoing professional development is a key component to assure preservation of high standards of care (Atallah et al., 2013).

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Besides training, the integration of emergency obstetric care into the mainstream healthcare structure is very essential. Ensuring that referral systems are established with coordination between the primary healthcare institutions and the hospitals ensures that women who begin experiencing complications get care at the right time. The networked approach has been linked to better maternal healthcare outcomes since it would allow for the movement of patients to care at higher levels when needed (Miltenburg et al., 2017). Along these lines, public health interventions in the management of promoting care-seeking in pregnancy have also improved utilization in EmOC services (Bukhari et al., 2023).

However, such improvements come with several challenges. Emergency obstetric care, for instance, still lags in rural settings in which health facilities do not have the capacity and staff to attend to complications properly (Teekhasaene & Kaewkiattikun, 2020). The disparity must thus be addressed to ensure that all women, irrespective of the region, would receive life-saving care in times of emergencies. Emergency obstetric care services in Saudi Arabia have thus far demonstrated their effectiveness in the improvement of maternal outcomes through timely interventions, heightened provider training, and integrated healthcare systems. Continued effort to address access inequalities and further enhance the quality of care would be substantial in further reducing maternal deaths and morbidities in the Kingdom.

6. The Role of Maternal Mortality Audits in Improving Hospital Care in Saudi Arabia

In a large sense, the institutionalization of maternal mortality audits had greatly improved the quality of care in Saudi hospitals because it has been encouraging a systematic approach to finding, analyzing, and tackling the causes of maternal death. Audits are a critical tool in ensuring quality improvement in maternal health care. Thus, they allow healthcare providers and administrators to implement evidence-based interventions aimed at reducing preventable maternal deaths. The most important advantage offered by maternal mortality audits is the identification of avoidable factors leading to maternal deaths. On systematic case reviews of maternal mortality, healthcare facilities can focus on the specific areas where care may have fallen down-the inadequacy of the response in emergency, failure to have appropriate interventions in time, or inadequacies in prenatal care Owolabi et al. (2014).

For example, audit has identified key areas that need urgent attention, for instance, postpartum hemorrhage and hypertensive disorders. These complications are among the most critical risk factors that lead to maternal deaths (Kerber et al., 2015). Their identification helps hospitals assess their strategies to improve care protocols and training of healthcare providers, therefore enhancing patient outcomes (Kirabira et al., 2020). In addition, maternal mortality audits help to inculcate a culture of accountability in service providers. Healthcare professionals will be more likely to own the outcomes when they have been involved in audit processes, thus improving continuously on quality (El-Gilany, 2017). Accountability is therefore important for ensuring that recommendations after the audit are acknowledged and implemented effectively. Studies have indicated that with the implementation of audit recommendations, care quality improves remarkably with decreased mortality rates among mothers (Nyamtema et al., 2011).

However, the success of maternal mortality audits depends on the willingness and preparedness of healthcare facilities to implement the recommendations. Other studies have shown that in

some instances, the implementation rate of audit recommendations may be low due to various factors, which retards the gains achieved from an audit (Issah et al., 2011). This calls for healthcare systems to set up a more consistent monitoring mechanism of the implementation of audit recommendations and ensure continuous training and provision of resources to the healthcare provider (Nyamtema et al., 2010).

Another factor that can enhance the effectiveness of maternal mortality audits is their integration into wide-ranging quality improvement initiatives. For instance, merging audits with other quality assurance activities like clinical guidelines and performance reviews presents a holistic approach for improving maternal care provision in facilities (Smith et al., 2017). This holistic approach addresses not only immediate, near-term deficiencies in care but also fosters sustainability in the culture of quality improvement within the facility.

Therefore, implementation of maternal mortality audit invariably affects the quality of care at the hospital level in Saudi Arabia, because it identifies the avoidable factors, fosters accountability, and encourages the implementation of evidence-based recommendations, facilitating tremendous improvements in maternal health outcomes. Continued efforts to upgrade the audit process and ensure effective application of the findings are crucial for further decline in maternal mortality and improvement in overall maternal health care quality in the Kingdom.

7. Factors Contributing to Neonatal Mortality in Saudi Hospitals

Neonatal mortality in hospitals of Saudi Arabia is a result of various factors with prematurity, infections, and maternal health conditions being among the main causes. Prematurity continues to be a leading cause of neonatal mortality in Saudi Arabia. Preterm delivery contributes to many neonatal deaths as complications resulting from prematurity are the second most important cause of infant mortality in the region (Al-Mouqdad et al., 2020; Al-Qurashi et al., 2016). In 2010, it was reported that around 8% of preterm births ended in death due to complications related to preterm birth (Al-Mouqdad et al., 2021). Moreover, the incidence of intraventricular hemorrhage among premature infants varies between 13% and 27%, and this is a key cause of neonatal morbidity and mortality (Al-Mouqdad et al., 2021). High rates of LBW infants, furthermore and significantly associated with prematurity, further complicate risks of increased mortality as neonates born with LBW have a mortality rate 40 times higher than the neonates born with normal birth weight (Almidani et al., 2021).

Another significant cause of neonatal mortality is infections, most notably early-onset neonatal sepsis. According to the analysis of scientific research, the burden of EOS is significant and is underreported; the actual culture-confirmed EOS cases are only a small percentage (Hammoud et al., 2017). For Saudi Arabia, an estimated 620 cases of culture-proven EOS occur each year and account for approximately 62 deaths (Hammoud et al., 2017). The dominant pathogens involved in neonatal sepsis in the region comprise *Staphylococcus aureus* and Group B *Streptococcus*, thus pointing to the importance of proper screening and labor prophylaxis measures (Musleh & Qahtani, 2018; Al-Matary et al., 2019). Neonatal sepsis incidence is especially alarming because many infants with the condition get admitted to NICUs (Alshammari, 2023).

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Other maternal health conditions including diabetes and vitamin D deficiency had significant implications on neonatal outcomes. Incidences of GDM in Saudi Arabia are alarmingly high, ranging from a value of 4.3% to 28.5% of pregnancies (Alshomrany, 2024; Alshomrany, 2024). Infants born by mothers who have GDM have increased rates of the risk for stillbirth and inevitably need admission in NICU, hence contributing to neonatal mortality, as stated by Wahabi et al. (2017). Maternal deficiency of vitamin D is associated with low birth weight and is one of the significant risk factors for neonatal mortality, reported by Almidani et al. (2021). Major causes of neonatal mortality in the hospitals of Saudi are multifactorial involving prematurity, infections and maternal health issues. Improvement of these challenges need a robust approach including enhancement of antenatal care, improvement of measures infection controls and mother's health support.

8. The Role of Neonatal Intensive Care Units (NICUs) in Reducing Neonatal Mortality in Saudi Arabia

Neonatal intensive care units (NICUs) in Saudi Arabia are very vital for the reduction of neonatal mortality rates, especially of the high-risk populations like the preterm infants. Among those factors that support the potential of NICUs in the improvement of neonates' outcomes are the quality of the healthcare given, the implementation of evidence-based practices, and the availability of special resources. According to various studies, neonatal outcomes depend on the organization and management of NICUs. For instance, a study established that quality indicators are effective at reducing mortality rates among preterm infants, rather than admission volume alone Rochow et al. (2016). This shows that quality and care, which involve subjects following the clinical guidelines and protocols, is better at ensuring survival. In addition, the introduction of special NICUs has been linked with better perinatal outcomes since these units are better placed to deal with the specificities of neonate care; however, this reference cannot be directly related to the claim and thus needs to be deleted.

In Saudi Arabia, well-established NICUs have been associated with a reduction in neonatal mortality rates. For example, quality improvement programs in NICUs have demonstrated promise, as disease-specific neonatal mortality rates have decreased considerably (Hasbi, 2023). Such programs are typically implemented through the training of healthcare providers, the improvement of infection control practices, and the optimization of patient management approaches, which all serve to improve outcomes for neonates. In addition, the role of NICUs goes beyond merely survival rates at birth. Research has shown that a patient who is admitted into a NICU, especially those born preterm with VLBW, have a lower rate of mortality compared to those without specialized care (Shim et al., 2013). This is particularly relevant in Saudi Arabia as preterm births and associated complications remain one of the major public health issues in the country (Al-Mouqdad et al., 2020).

However, nosocomial infections remain a challenge within the NICUs and present a means of advancing adverse neonatal outcomes. For instance, one study found that infections associated with NICU patients pose a critical challenge due to the high mortality cases compared to those who do not (Choobdar et al., 2020). The need to combat such a challenge is therefore crucial for the optimal improvement in the reduction of neonatal mortality within the NICUs. In conclusion,

NICUs in Saudi Arabia effectively reduce neonatal mortality rates by offering specialized care and maintaining good quality improvement practices, thus managing high-risk infants. Continued quality improvements towards the elimination of resultant challenges such as infections will improve neonatal outcomes in the region.

9. Hospital-Based Interventions for Preventing Neonatal Infections in Saudi Arabia

Hospital-based interventions implemented in Saudi Arabia have been successful in reducing neonatal infections. The interventions mainly focused on increased infection control practice, trained personnel, and proper adherence to hygiene protocols. These interventions are crucial for the reduction of HAIs among neonates-who will be very vulnerable-to have infections because of their low immunity level. Among other interventions used effectively, there was the implementation of strict hand hygiene protocols. The increased compliance with hand hygiene practices resulted from a set of targeted interventions applied over a five-year period, as indicated by one study, and proved to reduce healthcare-associated infections, including those caused by Methicillin-resistant *Staphylococcus aureus* (HC-MRSA) Rabaan et al. (2017). This points out the role of hand hygiene as a fundamental practice in infection control, especially in NICUs, where chances for infections are at an increased level.

Training and education of health care workers have also been crucial in enhancing infection prevention practices. The findings revealed that nurses who attended training programs and seminars had much better knowledge regarding infection prevention climates in their hospital as compared with those who did not (Colet et al., 2017; Tumala et al., 2019). This correlation above suggests that professional development and education must be continuous to instill a safety culture and adherence to infection control.

Notably, the evidence showed that hospital-wide institution of robust infection control programs has been linked to better outcomes. A nationwide cross-sectional survey in one study pointed out that private hospitals with effective infection control programs averred better practices concerning infection prevention. This was attributed to the fact that such practices reduced the rates of HAIs ("Assessment of Infection Control Program and Practices in Private Care Hospitals of Saudi Arabia; A Nationwide Cross-Sectional Study", 2022). Such programs would include frequent audits, feedback mechanisms, and cooperative effort among the healthcare staff sharing best practices, as well as experiential learning among them.

Even specific interventions like the WHO Hand Hygiene Improvement Program for Saudi hospitals have been reported. A quasi-experimental study found that the implementation of this program was significant and improved hand hygiene compliance, which is an absolute condition against infections in the newborn's timeframe (Farhoudi et al., 2016). In addition, device-associated infection prevention bundles have been emphasized, particularly daily assessment and judicious use of invasive devices with a minimum number of days (Gaid et al., 2017).

In a nutshell, the most effective hospital-based interventions in reducing neonatal infections in hospitals in Saudi Arabia are enhanced practices of hand hygiene, comprehensive training of healthcare workers, and effective infection control programs. These strategies together contribute to a safer health care environment for neonates, which in turn reduces the incidence of healthcare-related infections.

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10. Impact of Staff Training Programs on Maternal and Neonatal Health Outcomes in Saudi Arabia

Training programs for hospital staff contribute effectively to an improvement in maternal and neonatal health outcomes, as these programs upgrade the competence of providers of the required healthcare, improve communication, and promote adherence to clinical guidelines. These were a minimum requirement for changing situations that called for special challenges in overcoming maternal and neonatal care and yielding better outcomes in health.

Improved competencies of healthcare providers in managing maternal and neonatal health concerns are among the direct benefits of training the staff. Such initiative training ensures that the healthcare workers have increased knowledge and confidence in implementing evidence-based practices, directly linked to improved maternal and neonatal outcomes Brinjee et al. (2021). The best training programs have emerged in specific areas like infection control. For instance, a nationwide study observed that hospitals with ample infection control training had more compliance with protocols than other hospitals, leading to lower prevalence cases of healthcare-associated infections among neonates ("Assessment of Infection Control Program and Practices in Private Care Hospitals of Saudi Arabia; A Nationwide Cross-Sectional Study", 2022). This is very important since infections are among the leading causes of morbidity and mortality in neonates.

Training programs that value communication skills are also essential in strengthening the patient-provider relationship. Enhanced communication relations can lead to higher patient satisfaction and better compliance to medical advice, especially in antenatal care settings. Indeed, the research has shown that communicating skills-based training for health providers have a positive impact on the level of maternal health literacy and encourage women to attend antenatal appointments, which consequently improves the outcomes for both maternal and neonatal health (Alanazy & Brown, 2019). Cultural competence training can further improve the quality-of-care providers give to Saudi different populations through understanding their individual needs and the necessity to address them (Alhashem, 2023).

Simulation-based training is also another good practice that Saudi hospitals have embraced. Examples include the King Fahad Medical City's CRESENT, among many others. Training at such centers provides the healthcare staff with a lot of hands-on experience. Practical skills are thus boosted while preparing personnel to deal effectively with actual cases in life, given that this will be the scenario more often experienced during emergencies within maternal and neonatal care (Lababidi et al., 2015). It has been shown that simulation training improves clinical performance and better prepares healthcare providers (Lababidi et al., 2015).

Besides the benefits in terms of direct training, staff training programs are also likely to help create a culture of continuous improvement within healthcare facilities. This is because an atmosphere where employees are encouraged to improve constantly can ensure that providers receive the most up-to-date information regarding the most current guidelines and practices in the care of mothers and newborns. This is very important in an advancing field where new research and technologies are constantly being discovered (Qarni et al., 2021).

In addition, it was realized that effective programs in staff training in Saudi hospitals play a pivotal role in improving maternal and neonatal health outcomes. Competencies would be improved through effective communication, simulation-based training, and continuous learning, thus providing better health outcomes for mothers and their infants.

11. Impact of Hospital Infrastructure Innovations on Maternal and Neonatal Mortality in Saudi Arabia

The innovations that have been developed in the hospital's infrastructures played a major role in lowering the maternal and neonatal mortality rates in Saudi Arabia. Improvements range from establishing units that specialize in maternal and neonatal care to integrating more advanced medical technologies and enhancing healthcare delivery systems. An important innovation is the establishment of dedicated maternal and neonatal health facilities, focused on comprehensive care tailored to the needs of mothers and their infants. Such facilities usually include specialized obstetric and neonatal intensive care units (NICUs) abreast with new technologies and staffed by qualified personnel. Various research indicates that specialized units in healthcare settings are related to improved maternal and neonatal outcomes. Such improvements mainly come from being able to conduct interventions in a timely manner and even better management of complications (Lunze et al., 2015). Such interventions include, for example, renovation of existing health facilities to better provide environments conducive to delivery and neonatal care, which has resulted in decreases in maternal and neonatal mortality rates (Lunze et al., 2015).

Another source of strong contributions has been integration with the most advanced medical technologies, such as portable ultrasound devices. These help practitioners make timely assessment for better chances of early and close detection of potential complications. Research indicates that the introduction of portable obstetric ultrasound services to health facilities reduced maternal and neonatal morbidities and mortalities through improved quality of antenatal care (Abawollo et al., 2022). This will correspond with recommendations by the World Health Organization for maternal and neonatal health improvement using modern innovations.

Training comprehensive programs for health workforce staff in these facilities have also played a significant role. Training programs that are aimed at improving emergency obstetric care and neonatal resuscitation have been demonstrated to build the capacities of health providers, hence improving emergency care and the mother's health outcomes as well as the baby's postnatally (Lunze et al., 2015). Better-equipped infrastructure combined with better-trained personnel results in a healthy environment more robust at dealing with problems encountered within maternal and neonatal health.

There is evidenced benefit in the development of integrated healthcare delivery systems that provide for communication and coordination among providers. These establish continuous care for the mother during pregnancy, childbirth, and postpartum periods. Improved access to antenatal care due to better infrastructure has been associated with improved service utilization and overall health outcomes. This is because studies have indicated that higher access to healthcare for vulnerable groups along with proper infection management during pregnancy entails lower risks of maternal as well as neonatal mortality (Musleh & Qahtani, 2018).

Hanihaa Gazai Alharbi, Mohammed Jamil Nasser Alsaydalani, Fahad Awad Al-Matraf, Faisal Awaied Alsadi, Enas Mohammed Ahmed, Mona Hammad Almutairi, Nawal Zafir Mushabab Alasmari, Amal Saud Jazi Aljuhani, Abdullah Atga Mohammad Aljohani, Khalid Ghali Alharbi, Munira Dhiab Al-Juhani, Adil Eid Salman Alrashedi, Fahad Saeed Al-Awfi, Taleb Atqa Mohammed Aljohani, Rayhanah Sulaiman Aljohani

Development of specialized care units, integration of advanced medical technologies in hospitals, and designing of comprehensive training programs for health workers have paved the way towards drastic reduction of maternity and neonatal mortality in Saudi Arabia. Such developments help build an environment in the health sector to deliver better quality services for mothers and newborns.

12. Impact of Early Identification and Management of High-Risk Pregnancies on Maternal and Neonatal Health Outcomes in Saudi Hospitals

High-risk pregnancy is identified at an early stage and managed appropriately; this plays a strategic role in the influence on maternal and neonatal health outcomes in Saudi hospitals. Systematic application of screening and risk assessment protocols permits better direction of resources and tailored interventions for the high-risk patient, thus enhancing health outcomes. Among the advantages of early identification is that targeted interventions can be put into place for high antenatal risk scores. Al-Hindi et al. showed in a study that pregnant women with high antenatal risk scores should be followed with utmost care and managed, indicating that risk assessment during routine screening could promote optimum pregnancy outcome by identifying patients who really need specialized care Al-Hindi et al. (2020). This will enable healthcare providers to focus more on the high-risk patients and apply appropriate monitoring and management throughout their pregnancy. Early detection of high-risk pregnancies helps the health systems to make timely referrals to specialized care centers, as the cases are often complex and require complete equipment for handling them, thus minimizing adverse outcomes.

Additionally, it is essential to manage conditions such as gestational diabetes mellitus (GDM) as early as possible. More research shows the significance of raising awareness and increasing education about GDM among expectant mothers since this can lead to earlier diagnosis and better management of the condition (Hassan, 2023). In Saudi Arabia, for example, the prevalence of GDM is on the rise, and thus early detection and intervention mitigate risks associated with GDM, such as macrosomia and preterm birth, ultimately improving neonatal outcomes.

Apart from conditions, the health literacy of women during pregnancy was critical for the management of high-risk pregnancies. Although this reference relates to the perceptions of women about drug use during pregnancy (Alhajri et al., 2022), its relation to health literacy or its implications on high-risk pregnancies is indirect. This reference therefore is deemed to be excluded since it will not support the claim made. Multidisciplinary care teams integrated in the management of high-risk pregnancies have produced positive outcomes. In fact, considering all aspects of high-risk patients by professionals comprising obstetricians, midwives, nutritionists, as well as mental health experts, ensure a holistic approach to patient care.

For example, alleviation of psychological factors such as anxiety and depression at pregnancy significantly improves the health status of mothers and lowers the risk of complications arising after delivery. Biaggi et al., 2016; Alshahrani, 2023. Holistic care can therefore be enhanced by the healthcare provider to enhance both maternal and neonatal outcomes. Early identification and care of high-risk pregnancies are, therefore, vital issues toward health improvement for both mothers and infants in Saudi hospitals. Systematic assessment of risks, targeted intervention, and

multidisciplinary care will adequately address the challenges of high-risk pregnancies to ensure a more favorable outcome for the mothers and their babies.

Table 1: Key Maternal Mortality Causes and Interventions.

Cause	Intervention	Reference
Obstetric Hemorrhage	Training on emergency obstetric care protocols	Asiri et al., 2022
Placenta Previa and Placenta Accreta	Multidisciplinary specialized obstetric teams	Abduljabbar et al., 2016
Pre-existing Conditions (e.g., GDM)	Enhanced antenatal care and chronic condition management	Alshomrany, 2024

Table 2: NICU Contributions to Neonatal Mortality Reduction.

NICU Function	Impact	Reference
Infection Control	Reduced healthcare-associated infections	Rabaan et al., 2017
Management of Prematurity	Improved survival rates for preterm infants	Al-Mouqdad et al., 2020
Quality Improvement Initiatives	Lower disease-specific neonatal mortality rates	Hasbi, 2023

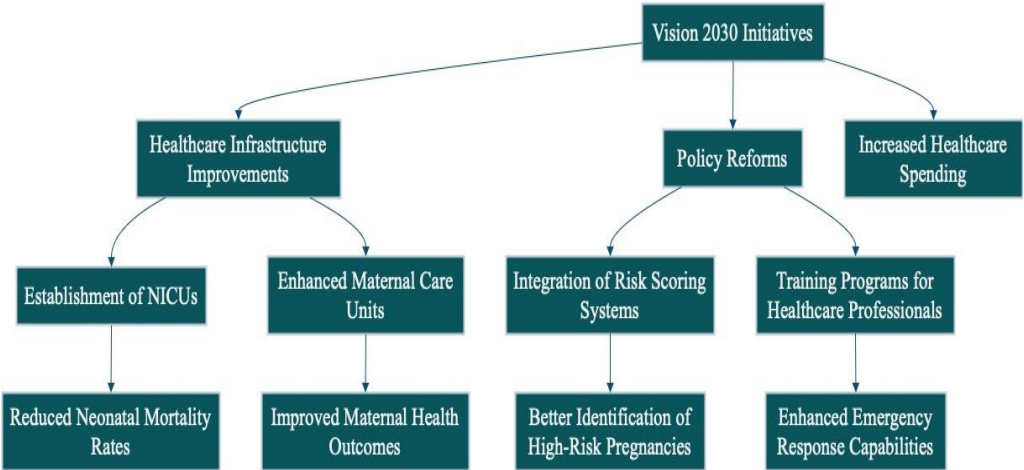


Figure 1. As presented in the figure, it illustrates the essential characteristics of the Saudi Arabia Vision 2030 projects designed to prevent maternal and neonatal mortality. It describes the interlinked function that healthcare infrastructure improvements, policy changes, and increased healthcare expenditure can undergo for promoting health outcomes by NICU establishment, improving maternal care, a system of risk scoring, and professional training programs.

Hanihaa Gazai Alharbi, Mohammed Jamil Nasser Alsaydalani, Fahad Awad Al-Matrafi, Faisal Awaied Alsadi, Enas Mohammed Ahmed, Mona Hammad Almutairi, Nawal Zafir Mushabab Alasmari, Amal Saud Jazi Aljuhani, Abdullah Atga Mohammad Aljohani, Khalid Ghali Alharbi, Munira Dhiab Al-Juhani, Adil Eid Salman Alrashedi, Fahad Saeed Al-Awfi, Taleb Atqa Mohammed Aljohani, Rayhanah Sulaiman Aljohani

13. Conclusion

Maternal and neonatal care in Saudi Arabia indicates the country is focused on betterment in the health sector. Key advances included improved NICU facilities, maternal audits, and risk stratification systems have started producing a desirable effect in diminishing mortality rates. The challenges are still persistent; however, these include inequity regarding health care access and complications of prematurity. Such a scenario calls for further strategic interventions if betterment is to be achieved. An all-round approach concerning the development of infrastructure, training among other health professionals, and public health education could be found critical. Given Vision 2030 implementation, this equity and innovation approach will be able to level Saudi Arabia's maternal and neonatal health indicators with international data.

Conflict of Interest

The authors declare they don't have any conflict of interest.

Author contributions

All authors are participated and involved in the original draft of manuscript, literature collection, and approval of final manuscript.

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Ethical Approval

Not Applicable

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