

DETERMINANTS OF NEONATAL MORTALITY AND EVALUATION OF
NEONATAL RESUSCITATION SERVICES AT SECONDARY CARE HOSPITAL OF
DISTRICT PAKPATTAN

Amaan^{*1}, Abid Rasheed², Ali Siftain³, Sultan Ayaz⁴

^{*1,2,3,4}Department of Public Health, Government college university Faisalabad

¹amaanishaq.000@gmail.com, ²faisalabad.drabidrashid@gcuf.edu.pk, ³alisiftain@gcuf.edu.pk,

⁴sultan.ayaz@gcuf.edu.pk

DOI: <https://doi.org/10.5281/zenodo.22724255>

Keywords

Neonatal mortality; APGAR score; Antenatal care; Neonatal resuscitation; Newborn survival; Maternal and neonatal health

Article History

Received: 05 June 2026

Accepted: 27 August 2026

Published: 12 September 2026

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Corresponding Author: *

Amaan

Abstract

Neonatal mortality remains a critical public health challenge, particularly in low- and middle-income countries, where preventable causes continue to contribute significantly to under-five child deaths. Despite being a national health priority, neonatal deaths remain high due to inadequate antenatal care, birth complications, infections, and limited access to quality neonatal care services. Identifying the determinants of neonatal mortality and assessing the availability and readiness of neonatal resuscitation services are essential steps toward improving newborn survival and achieving Sustainable Development Goals (SDGs). This study aimed to determine the prevalence of neonatal mortality, identify associated factors contributing to neonatal deaths, and assess the availability and quality of neonatal resuscitation services at District Headquarters (DHQ) Hospital, Pakpattan. A quantitative cross-sectional study was conducted at DHQ Hospital Pakpattan from May to July 2025. A total of 160 mothers and their newborns were selected through a simple random sampling technique. Data were collected using a structured questionnaire, hospital records, and a neonatal resuscitation facility assessment checklist adapted from the World Health Organization Service Availability and Readiness Assessment (WHO-SARA) guidelines. Data were analyzed using SPSS version 26. Descriptive statistics, including mean, standard deviation, frequencies, and percentages, were calculated. Associations between neonatal mortality and independent variables were assessed using chi-square tests and independent sample t-tests. Multiple binary logistic regression analysis was performed to identify independent predictors of neonatal mortality. A p-value <0.05 was considered statistically significant. Among the 160 newborns included in the study, 25 deaths were recorded, indicating a neonatal mortality prevalence of 15.6%. Bivariate analysis showed significant associations between neonatal mortality and maternal education, need for neonatal resuscitation, birth asphyxia, neonatal sepsis, antenatal care visits, birth weight, and one-minute APGAR score (p<0.05). No significant association was observed with postnatal visits, mode of delivery, availability of equipment, place of residence, maternal age,

and parity. Multivariable logistic regression analysis revealed that the number of antenatal care visits (AOR=0.682, $p=0.036$) and one-minute APGAR score (AOR=0.652, $p=0.027$) were significant independent predictors of neonatal mortality. However, after adjusting for birth weight, birth hypoxia, and neonatal infection, these associations lost statistical significance. The study concluded that neonatal mortality remains high at DHQ Hospital Pakpattan. Lower APGAR scores and inadequate antenatal care were identified as important factors associated with neonatal deaths. Strengthening antenatal care services, improving early newborn assessment, ensuring timely neonatal resuscitation, and enhancing the quality of maternal and neonatal healthcare services may significantly reduce preventable neonatal deaths.

1. Introduction

Neonatal mortality continues to be one of the biggest public health problems across the globe and an important indicator of the quality of the performance of the maternal and neonatal healthcare system. The neonatal period is described as the first 28 days of life, during which time the newborn adapts physiologically to independent life after being in the intrauterine environment. In the neonatal period, the risk of developing any problem which could become a cause of death if not managed immediately increases sharply (Abdullah et al., 2016). For this reason, decreasing the neonatal mortality rate is an important priority in global public health because it contributes greatly to the mortality rate among under-five-year-old children.

Even though the mortality rate among under-five-year-old children has considerably decreased over the past decades, neonatal mortality rates have continued to decrease much more slowly. As deaths due to childhood infections including pneumonia, diarrhea, and malaria have dropped due to improved immunization programs and disease control measures, neonatal deaths continue to contribute to the total mortality rate among children (Perlman et al., 2020). The majority of neonatal deaths take place in the first week of birth, specifically during the first 24 hours of birth because of complications arising from pregnancy, labor, delivery, and adaptation of neonates. The causes of death include premature births, birth asphyxia, neonatal infections, congenital defects, and respiratory disorders. The above conditions are still problematic in

developing and low-income countries due to inadequate health care provision.

On a global scale, there is still disparity between neonatal mortality rates in high-income and low-resourced nations. Neonatal deaths have been greatly reduced in high-income countries because of healthcare for all, trained birth attendants, neonatal intensive care units, efficient referral systems, and antenatal care programs. On the other hand, low- and middle-income countries still continue to face higher levels of neonatal mortality because of insufficient number of health workers, delayed referrals, lack of neonatal units, inadequate medical equipment, and unequal access to health services. The above disparities illustrate that neonatal survival is highly affected by the availability and preparedness of healthcare systems (Alizadeh et al., 2025).

South Asia continues to be one of the regions with a relatively higher burden of neonatal mortality. Although there have been improvements in the health indicators of mothers and their children, problems such as poverty, maternal malnutrition, underutilization of antenatal care services, scarce healthcare resources, and inequitable distribution of skilled health practitioners still threaten the survival of newborns. According to studies in the region, neonatal conditions play a significant role in mortality and morbidity in the population of South Asia (PDHS, 2022). While there have been gradual reductions in neonatal mortality levels, there is still need for much more effort to attain international goals through improvements in maternal and newborn health services.

The Sustainable Development Goals (SDGs) aim at reducing avoidable neonatal mortality through quality and access to maternal and neonatal healthcare services. To attain these goals, efforts should involve adequate antenatal care, skilled delivery care, emergency obstetric care, neonatal resuscitation, prevention of infections, early breastfeeding, and proper postnatal care (American Academy of Pediatrics & American College of Obstetricians and Gynecologists, 2015). Previous studies have shown that a considerable portion of neonatal mortality can be prevented through interventions made before, during, and after childbirth.

Neonatal deaths are the result of several determinants that include factors related to the mother, obstetrics, the neonate, and healthcare services. The health status of women pre-pregnancy and during pregnancy has a direct effect on fetal growth, gestation results, and neonatal survival (Muzzamil et al., 2022). Antenatal care can assist in identifying problems with the pregnancy, nutrition counseling, fetal screening, immunizations, readiness for birth, and referral of high-risk pregnancies. Antenatal care enables women to have safe pregnancies and deliveries, minimizing neonatal risks.

Socio-demographic features of mothers are vital for neonatal survival as well. Education status of the woman correlates with better knowledge of care during pregnancy, signs of newborn danger, healthcare service usage, and behavior of seeking medical help (Baqui et al., 2016). Well-educated mothers tend to go to antenatal facilities, give birth in the presence of skilled professionals, identify newborn health problems, and follow recommendations about infant care.

Moreover, the age of the mother and her parity have been considered other crucial factors influencing the outcome of neonates. An adolescent mother is prone to higher risks owing to immaturity, malnutrition, inadequate knowledge on reproductive health, and lack of access to healthcare (Mayer et al., 2022). Likewise, older maternal age is a contributing factor increasing pregnancy-related risks. Parity is known to impact the newborn child due to long duration

of labor among primiparous women and nutritional depletion in multipara.

In respect of modifiable maternal factors, antenatal care attendance is one of the most critical indicators of neonatal survival. Regular check-ups during pregnancy are vital in helping the healthcare providers to detect diseases of the pregnant woman, monitor the baby's development in utero, identify high risk pregnancies, conduct counselling, and educate the family for the delivery. Lack of antenatal care leads to greater risks of prematurity, low birth weight, birth complications, and neonatal mortality.

There are a number of neonatal clinical problems that play a significant role in the increase of neonatal mortality rates. Premature birth is among the most common ones since premature babies are at high risk of developing respiratory problems, infection, problems with feeding, and thermoregulation because their respiratory, immune, cardiovascular and neurologic system are not fully developed (Liu et al., 2016). Low birth weight is another factor that increases neonatal mortality rates because these babies have a smaller amount of physiological reserves and are more prone to infections and respiratory diseases. Low birth weight can be caused by maternal malnutrition, complications of pregnancy and intrauterine growth retardation.

Birth asphyxia is also among the major factors of neonatal mortality in areas where there is no proper obstetric management and resuscitation services. Inadequate oxygen supply prior to birth, during labor or immediately after birth may cause hypoxia, brain injuries and even death of infants (Lee et al., 2013). It is very important to monitor the process of labor, have skilled attendance at birth, recognize the signs of fetal distress and perform newborn resuscitation.

The neonatal infections have been identified to pose a serious threat to the lives of many infants since they have not yet developed fully-fledged immunity. The vulnerability of the infants to infection has been heightened by the acquisition of infections through the process of pregnancy, delivery, or post-delivery. Failure to diagnose infection early enough, lack of infection

prevention techniques, insufficient laboratory services, and lack of adequate treatment facilities have been identified as key contributors of mortality in neonates.

APGAR scoring is a common method of evaluating the condition of neonates shortly after birth. The assessment tool comprises five indicators including heart rate, respiration, muscle tone, reflex response, and color of skin in order to evaluate the infant's adaptability following delivery (Lawn et al., 2014). Neonates whose condition is poor, in terms of adaptation are likely to register low APGAR scores which increases their mortality.

Neonatal resuscitation is one of the most efficient measures aimed at reducing the number of immediate newborn deaths. There is a share of babies who need help in establishing breathing immediately after birth; otherwise, there may be some problems, namely birth asphyxia, neurologic injuries and even death of babies. The WHO stresses that all deliveries should have professional healthcare personnel with all needed resuscitation equipment (Bhutta et al., 2011). Immediate resuscitation during the first minute after birth, also called the "Golden Minute", which involves airway management, thermal protection, stimulation and positive-pressure ventilation if needed, may increase survival rates in newborns. But there are two more factors that influence the effectiveness of neonatal resuscitation: healthcare workers' skills and competencies. All necessary equipment should be available in delivery areas. Self-inflating bags, masks, oxygen, airway and emergency drugs are the things that should be provided. Unfortunately, in many healthcare organizations from developing countries there are not enough medical devices, there are no proper supplies and training programs (Jehan et al., 2009).

Training programs, such as Helping Babies Breathe (HBB), have been found to yield positive results regarding improvement of neonatal resuscitation skills among healthcare professionals, especially in resource-limited environments (Budhathoki et al., 2019). The training programs emphasize the use of simple

evidence-based practices that can be implemented right after childbirth and have been linked to higher confidence among providers, improved implementation of resuscitation guidelines, and fewer preventable infant deaths. Continuous training, supervision, and preparedness of facilities are important elements of good neonatal emergency care.

Neonatal mortality is a serious problem in Pakistan despite an overall improvement in maternal and child health services in the country. National research shows that a significant percentage of infant deaths occurs in the neonatal stage and is caused by preventable reasons, including low birth weight, premature births, birth asphyxia, neonatal infections, late access to healthcare, and lack of appropriate neonatal care services (Hug et al., 2021). There are regional differences in healthcare infrastructure, mother's educational level, referral process, and access to skilled healthcare providers.

While previous research has explored the determinants of neonatal mortality in Pakistan, there is very little evidence available on the district level neonatal mortality patterns and neonatal resuscitation readiness in secondary health facilities. Since district hospitals cater to a larger population and usually deal with higher risks during labor and newborn emergencies, but facility specific information on mortality patterns and service readiness is scarce (Carlo et al., 2019). Thus, locally produced evidence is needed to ascertain major determinants of mortality and neonatal care service gaps in order to develop strategies for improved newborn survival.

Thus, this study was conducted to ascertain the prevalence and determinants of neonatal mortality and to assess neonatal resuscitation services at District Headquarters Hospital, Pakpattan (Goldenberg et al., 2018). In the study, neonatal mortality prevalence rate was determined, association of neonatal mortality with socio-demographic characteristics of mothers was assessed, the association of obstetric and neonatal factors such as antenatal visits, birth weight, APGAR score, birth asphyxia, neonatal sepsis, mode of delivery, and need for neonatal

resuscitation with mortality outcomes was explored, and presence of neonatal resuscitation equipment was assessed.

2. Literature Review

Neonatal mortality continues to be one of the main metrics for evaluating the efficacy of the maternal and neonatal healthcare system in any country in the world. Literature review shows that a number of interacting determinants of neonatal mortality have been found, including maternal, neonatal, socio-economic, and healthcare determinants (de Souza et al., 2019). Neonatal period, which refers to the first 28 days after delivery, is considered the most vulnerable stage of the human lifespan since newborns rapidly adapt their physiological processes and are particularly prone to develop complications related to their prenatal, labor, and immediate postpartum period. Literature highlights the need to take a multi-faceted approach to reduce neonatal mortality rates, such as improvement of antenatal care, assistance of a skilled birth attendant, identification of newborn complications, resuscitation, infection prevention, and development of healthcare facilities.

Literature review performed previously showed that neonatal mortality is not related to one reason, but rather is caused by the interaction of all above-mentioned factors. Factors such as maternal nutrition, antenatal health care service usage, maternal education level, pregnancy complications, weight at birth, gestational age, birth asphyxia, infections of the neonate, and presence of health care services have been identified as significant determinants of infant survival. In addition, the recent literature suggests that improvement in neonatal outcomes involves enhancing healthcare system capacity through skilled health care workers, presence of neonatal equipment, effective referrals, and proper practices of newborn health care (Darmstadt et al., 2005).

The information collected from global, regional, and national literature reviews provides significant data regarding the magnitude of neonatal mortality problem and its determinants. This

understanding is crucial for developing interventions, especially in poor countries where avoidable neonatal mortality constitutes a serious problem (Darmstadt et al., 2005). The subsequent literature review highlights the issue of global and regional burden of neonatal mortality, neonatal mortality determinants, neonatal resuscitation service provision, readiness of healthcare facilities, and gaps in current research.

2.1 Global and Regional Burden of Neonatal Mortality

Neonatal deaths remain a public health issue of concern, especially in low- and middle-income countries where availability of quality maternal and newborn health care services still poses a challenge. Despite much improvement made in reducing mortality among children below five years old, neonatal deaths have reduced slowly and have become one of the largest contributors to child mortality (Carlo et al., 2019). Neonatal period is the most important period in ensuring the survival of children as many children die during this period due to pregnancy, labour, delivery and adaptation-related problems.

World Health Organization defines neonatal deaths as death of a live-born baby within the first 28 days after birth. This can be subdivided into early neonatal deaths which occur within the first seven days after delivery and late neonatal deaths which occur from the eight to the twenty-eighth day. Past studies indicate that the majority of neonatal deaths occur in the early neonatal period, especially within the first 24 hours after delivery (Budhathoki et al., 2019).

A number of global trends have shown wide disparities in the survival rate of newborns between high-income nations and low-resource nations. There is a marked decrease in neonatal mortality in high-income nations due to provision of maternal health care for all, highly advanced neonatal intensive care units, skilled professionals, newborn screening and other evidence-based practices (Bhutta et al., 2011). Contrary to this, some low- and middle-income nations are still facing the problem of high rates of neonatal mortality due to lack of proper healthcare

infrastructure, skilled workforce, emergency care services and economic disparities.

One of the regions where neonatal deaths are high is South Asia. Earlier researches have linked this burden to the problems like poverty, underutilization of antenatal care services, insufficient presence of skilled birth attendants, inadequacy of neonatal intensive care facilities and occurrence of many maternal complications (Bhutta et al., 2014). Neonatal mortality rate has decreased in some South Asian countries; however, variations exist in these countries due to variations in their health care systems, maternal education level and economic status.

The first week is seen to be the most crucial time for the survival of neonates as a great number of deaths occur immediately after birth. This shows that the interventions done at the time of delivery can have the greatest impact on reducing neonatal deaths (Baqui et al., 2016). There is evidence to suggest that proper assistance at the time of delivery, early identification of problems among newborns, resuscitation, prevention of infections, and proper care for the newborn can reduce neonatal deaths significantly.

Some of the leading causes of neonatal deaths which were identified from past studies include prematurity, birth asphyxia, sepsis in the neonate, congenital problems, and respiratory issues. Even though the contribution of the different causes of neonatal deaths differs across various regions, there is evidence to show that many neonatal deaths can be prevented through early identification, proper clinical intervention, and adequate maternal and newborn health services (American Academy of Pediatrics & American College of Obstetricians and Gynecologists, 2015).

Sustainable Development Goals have focused on minimizing avoidable neonatal mortality through better maternal and newborn healthcare services. Recommendations from global level call for efforts to strengthen health systems, promote neonatal resuscitation training, skilled birth attendance, emergency obstetric care, infection prevention, and postnatal care. But many nations still face difficulties in meeting these objectives due to lack

of resources and healthcare inequality (de Souza et al., 2019).

Pakistan is among countries that experience a high burden of neonatal mortality rate in the South Asian region. Previous literature review revealed birth asphyxia, low birth weight, pre-mature babies, neonatal infections, poor antenatal care, and scarcity of neonatal healthcare services as significant factors responsible for mortality rate in neonates (Alizadeh et al., 2025). Studies from local healthcare facilities at district level revealed problems of shortage of trained personnel, neonatal equipment, and readiness for emergencies in newborns.

2.2 Determinants of Neonatal Mortality

The neonatal mortality rate is determined by a number of factors related to mothers, obstetrics, neonates, socio-economic circumstances, and healthcare services. The previous research proved that in order to save the lives of neonates, it is not enough to consider only the state of infants, but it is also necessary to pay attention to maternal health, pregnancy care quality, delivery practices, and healthcare services provided (Abdullah et al., 2016). In all cases, the following variables were found to be significant predictors of neonatal deaths: antenatal care utilization, maternal education level, birth weight, gestational age, birth asphyxia, neonatal infections, APGAR score, and healthcare facility readiness. All these variables usually overlap; hence, to improve the neonatal mortality rates, it is necessary to deal with several risk factors.

Among various factors which affect neonatal outcomes, antenatal care has been recognized as one of the most significant ones. It offers possibilities for early detection and management of potential complications, nutrition counseling, immunization, diagnosis of pregnancy-related disorders, and preparation of delivery. Previous research has demonstrated that pregnant women who receive proper antenatal care are at reduced risk of pregnancy and delivery complications, thus resulting in increased rates of infant survival. On the other hand, lack of antenatal care results in increased chances of pregnancy complications,

preterm delivery, underweight babies, and infant mortality. Still, factors such as economic constraints, transport problems, lack of knowledge, and access to healthcare centers remain barriers to antenatal care utilization, especially for the poor (Baqui et al., 2016).

Maternal education has emerged as another crucial social factor affecting infant survival rate. Educated women are characterized by better healthcare behavior, better knowledge of pregnancy and infant danger signs, proper utilization of services related to maternal health, and better newborn care practices. Previous studies have revealed that mothers with more education are likely to visit antenatal clinics, deliver in health centers, utilize health services, and use proper newborn care practices (Goldenberg et al., 2018). On the other hand, low maternal education has been linked to delayed healthcare seeking, failure to recognize the complications, and high risks of neonatal deaths. Research carried out in Pakistan has also shown the link between low maternal education and neonatal deaths.

Birth weight is among the best predictors of neonatal survival. Babies who weigh less at birth are vulnerable to conditions such as respiratory distress, hypothermia, infections, problems while feeding, and other health issues that could increase their risks of dying. Previous studies have suggested that low birth weight could be linked to premature births, intrauterine growth restriction, malnourished mothers, infections in mothers, pregnancy problems, and inadequate antenatal care. Improving the nutritional status of mothers, enhancing antenatal care, preventing premature delivery, and providing appropriate neonatal care have been stressed by various studies (Hug et al., 2021).

Prematurity and complications associated with prematurity continue to be the primary causes of neonatal deaths worldwide. Neonates born prematurely have underdeveloped physiological systems, and hence they are highly susceptible to problems like respiratory distress, infections, feeding difficulties, and instability in body temperature. It has been documented in previous

research that premature babies and low-birth-weight infants need careful monitoring and neonatal care, which might not always be accessible in some healthcare facilities due to resource constraints (Jehan et al., 2009). Lack of adequate neonatal intensive care units and other supporting facilities raises the risk of neonatal deaths among the vulnerable infants.

Birth asphyxia continues to be one of the major preventable factors for neonatal deaths, especially in developing nations where there is limited access to quality skilled maternal healthcare and neonatal emergency care services. Birth asphyxia is caused by lack of adequate oxygenation before, during, or immediately after birth. Birth asphyxia may result in brain damage, organ dysfunction, and even death if not promptly managed (Lawn et al., 2014). Previous research has highlighted the role of skilled delivery, proper intrapartum surveillance, early detection of distress, and prompt neonatal resuscitation in preventing birth asphyxia deaths.

Studies from Pakistan have also found that asphyxia at birth is another important cause of neonatal deaths. It has been observed that the lack of identification of distress in the fetus, long labor, poor monitoring during childbirth, and low competency level of the healthcare providers in resuscitating neonates contribute to poor neonatal outcomes (Lee et al., 2013).

Neonatal sepsis is yet another cause of morbidity and mortality in the newborns, especially in resource-poor regions. Because of the immature immune system of the babies, they are highly susceptible to any kind of infection that can be contracted during the course of pregnancy, childbirth, or the postnatal period. It has been shown by previous studies that the late detection of infection, failure to implement preventive measures against infections, lack of facilities for proper diagnosis, and inadequate treatment options for newborns are some of the important factors contributing to neonatal deaths due to infections.

In Pakistan, neonatal sepsis has been identified as one of the leading causes of deaths among infants. A study found prematurity, prolonged rupture of

membranes and low birth weight as some of the critical risk factors associated with neonatal infections and mortality. This highlights the need for enhanced infection control, better neonatal care facilities and early diagnosis and management of the infected infants (Liu et al., 2016).

The APGAR score is a popular clinical measure to assess the status of newborn babies soon after birth. The five parameters measured through APGAR score include heart rate, respiratory effort, muscle tone, reflex response and skin color (Bhutta et al., 2011). There have been previous studies which have found that low APGAR scores have been associated with increased morbidities, greater resuscitation efforts and higher mortality rates.

APGAR score has been found to be a predictor of neonatal mortality in multiple researches. A low APGAR score may denote intra partum complication, physiological malfunctioning, respiratory failure, or hypoxic injury. Several researches carried out in Pakistan also indicated that infants who have low APGAR scores were associated with higher mortality risk than those with normal APGAR scores (de Souza et al., 2019). This highlights the need for immediate newborn assessment and effective neonatal management.

The association between delivery type and neonatal mortality has been analyzed in several populations, but results have been inconsistent. The effect of delivery method on neonatal mortality seems to be influenced by maternal and fetal complications rather than delivery method itself. Neonatal survival rate may decrease when caesarean delivery is performed based on proper obstetrical indication like fetal distress or obstructed labor. But after controlling for other covariates, some researches suggested that birth weight, gestational age, birth asphyxia, and neonatal care quality have more impact on neonatal mortality than delivery method (Mayer et al., 2022).

In conclusion, from the literature review above, one can establish that the causes of neonatal mortality are as a result of the joint effect of maternal health problems, baby attributes, and

healthcare variables (Ezeh et al., 2014). The solution to this problem will have to be an integrated approach that will involve improved antenatal care, mother education, neonatal complication prevention and treatment, among others.

2.3 Neonatal Resuscitation Services and Health Facility Readiness

Resuscitation at birth is recognized as one of the interventions with the greatest impact on reducing the risk of death from immediate causes, especially asphyxia and respiratory failure at birth. In previous studies, it was noted that some newborn babies needed help to start breathing after birth and that intervention in this critical period could have a significant effect on survival rates (World Health Organization [WHO], 2022). Lack of resuscitation leads to lack of oxygenation, hypoxia, brain damage, and newborn baby's death. Thus, having a trained healthcare provider present during birth with proper equipment available is an essential part of the quality newborn care.

The World Health Organization pays attention to the need for immediate newborn care and resuscitation in the first minutes after birth. The time right after childbirth, which is also called "Golden Minute," is a unique moment when healthcare professionals should be able to detect breathing problems of the baby and take proper actions (Muzzamil et al., 2022). Such actions as maintaining body heat, placing the airway, drying and stimulating the baby, and using positive-pressure ventilation as needed will ensure the prevention of any complications from birth asphyxia and ensure the survival of the newborns. But the effectiveness of such measures is contingent upon early identification of problems of newborns, competence of the provider, and the presence of proper equipment.

It is vital to highlight that the availability of neonatal resuscitation equipment in healthcare facilities significantly influences the quality of emergency care for newborns. In order to be able to deal with emergencies in delivery rooms, certain pieces of equipment such as self-inflating bags and masks, oxygen sources, airways management

equipment, thermal care equipment, and other necessary supplies should be available. There is evidence from previous studies proving that shortage of equipment, improper maintenance of the equipment, lack of supplies, and unpreparedness of the facilities may impede the timely delivery of intervention by healthcare providers (UNICEF, 2023).

Alongside availability of equipment, the competencies of the healthcare providers themselves are critical for successful neonatal resuscitation. While adequate resources may be in place, inadequate training and lack of practical experience on the part of healthcare providers may lower the quality of newborn emergency care (WHO, 2020). Previous literature highlights the importance of regular training and assessment of skills alongside supportive supervision as strategies to enhance competencies of healthcare providers in neonatal resuscitation. Thus, capacity-building of healthcare providers is an important approach in lowering rates of avoidable deaths of neonates in PDHS (2022).

One of the initiatives designed to increase neonatal resuscitation competencies is the Helping Babies Breathe (HBB) program, which focuses on improving the practices of neonatal resuscitation in healthcare settings with limited resources. Research has shown that HBB training can help healthcare providers acquire new knowledge, increase their confidence and perform the required procedures for newborn care right after the baby is born. This training focuses on simple evidence-based actions taken within the first minute of life to assist healthcare providers in dealing with neonatal breathing problems and birth asphyxia deaths (Soni et al., 2025).

Facility readiness is yet another critical issue that can impact neonatal outcomes. A well-equipped facility is one that is made up of adequately trained health care providers and functioning equipment. It must have adequate referral systems, newborn care policies, infection control measures, and continuous quality improvement processes (Wang et al., 2025). Previous research has shown that lack of facility readiness can result in delays in newborn care and even avoidable deaths (Perlman et al.,

2020). Thus, assessment of facility readiness helps in recognizing the existing problems and improving newborn care services.

Although there have been many efforts to improve maternal and newborn health care services, most health care facilities in developing nations are still struggling with neonatal emergencies. Some of these issues include unavailability of trained health care providers, lack of access to neonatal support, unavailability of appropriate equipment, and non-uniform use of newborn care guidelines. This means that it is crucial to assess neonatal resuscitation services within such health care facilities to find out if there are enough resources available.

In Pakistan, enhancement of neonatal resuscitation services and health facility preparedness will continue to be important in lowering neonatal mortality rates that are often caused by preventable deaths. Research conducted in the past has found the existence of deficiencies in neonatal care services such as lack of trained staff members, emergency newborn care supplies, and problems in the referral and surveillance system (Soni et al., 2025). District-based hospitals are responsible for offering maternal and neonatal healthcare services; nevertheless, there is scarce evidence on whether they are ready to respond to neonatal emergencies. Examination of neonatal resuscitation services offered in such facilities can generate evidence for improving newborn care practices.

Generally, the literature highlights the need for not only identification of clinical risk factors but also for the improvement of newborn survival rates through healthcare facility preparedness, provision of necessary equipment, health workers' competences, and neonatal resuscitation services as well as continuous improvement of newborn care services (Shane et al., 2017).

2.4 Conceptual Framework and Research Gap

Understanding neonatal mortality from a conceptual perspective would entail analyzing the interplay between maternal characteristics, obstetric, neonatal, and healthcare service-related factors. In the past, scholars have shown that there

are multiple factors that influence neonatal mortality. These range from maternal and socioeconomic characteristics to pregnancy conditions, neonatal health, and availability of healthcare services. Maternal education, antenatal care access, maternal health, birth weight, APGAR scores, birth asphyxia, neonatal infections, and neonatal resuscitation facilities are just but some of the determinants that might be involved in neonatal mortality (Ratekin et al., 2025). It follows that one needs to understand neonatal mortality in terms of its multiple causes.

From past literature, the issue of neonatal mortality has been found to be multi-dimensional as there are different causes interlinked with each other in terms of the neonatal death phenomenon. It has been found that maternal risk factors play an important role in the development of pregnancy and delivery outcome. In turn, the condition of newborns depends on the delivery outcomes. In the same manner, the availability of the healthcare personnel, functional equipment, and good neonatal care practices is important for identification and management of newborns' problems in time (Perlman et al., 2020).

Though the number of studies devoted to the issue of neonatal mortality and factors associated with this problem is numerous, there are some gaps in the literature that should be filled out. The current literature is characterized by the identification of individual risk factors such as preterm birth, low birth weight, asphyxia during birth, neonatal infections, maternal health-care use and others (de Souza et al., 2019). Nevertheless, little attention is paid to the determination of neonatal mortality factors and healthcare facilities' readiness for neonatal resuscitation.

Despite the availability of research in Pakistan on the factors contributing to neonatal mortality, very little literature exists concerning the level of healthcare facilities within districts and their preparedness to manage neonatal emergencies. Most of the available studies have been carried out on the national level or on tertiary health care facilities, whereas the secondary level hospitals providing services to a large number of mothers and neonates have not been studied in detail (Lee

et al., 2013). The challenges faced by these hospitals in terms of trained personnel, neonatal equipment, referrals, and neonatal care facilities need to be assessed.

The District Headquarters Hospitals play a significant role in the provision of maternal and newborn health services, especially for the populations that do not have access to tertiary healthcare facilities (Liu et al., 2016). Nevertheless, there is not much information available on the patterns of neonatal mortality and neonatal resuscitation service readiness within such hospitals. Conducting an assessment of such facilities will be very useful for identifying the gaps and areas that need improvement.

For that reason, the current research fills this void through the analysis of neonatal mortality prevalence, risk factors among mothers and newborns, and the provision and quality of neonatal resuscitation service at District Headquarters Hospital, Pakpattan (Perlman et al., 2020). Combining clinical factors with health care facility evaluation, the current study will provide a thorough knowledge about factors resulting in neonatal deaths.

3. Materials and Methods

3.1 Study Design and Setting

Quantitative cross-sectional study was performed for determining the neonatal mortality status, determining factors linked with neonatal mortality and assessing the presence of neonatal resuscitation facilities at District Headquarters (DHQ) Hospital, Pakpattan. This study was performed during three-month period from May to July 2025. It was thought that cross-sectional study design was appropriate for this study as it enables us to analyze neonatal mortality and factors associated with it at a single point in time. This study was conducted at the Neonatal Unit and Department of Obstetrics and Gynecology at District Headquarters Hospital, Pakpattan, Punjab, Pakistan. DHQ Hospital is a tertiary level public health care facility that offers antenatal care services, emergency obstetric care, caesarean sections, neonatal resuscitation and specialized neonatal care services. This hospital provides

health care services to urban and rural population of Pakpattan district as well as referral cases from surrounding areas.

3.2 Study Population and Sample Size

The study population comprised of the mothers and their infants delivered at DHQ Hospital, Pakpattan. Information regarding the infants and mothers was collected by means of hospital data and an interview conducted with the mothers to collect relevant information regarding the maternal characteristics, obstetric history, and infant clinical condition.

The total number of subjects recruited for the study was 160. The sample size was determined using the single population proportion formula:

$$n = Z^2 \times p(1 - p) / e^2$$

Where:

- n = Required sample size
- Z = Standard normal variate at 95% confidence level (1.96)
- p = Expected prevalence of neonatal mortality
- e = Margin of error

The sample size to be taken was determined according to the estimated prevalence of neonatal mortality and precision level to be attained. Altogether, 160 subjects were enrolled for the study.

3.3 Sampling Technique and Data Collection

Simple random sampling technique was adopted for the selection of participants. A sampling frame was generated through the data found in the records of delivery and neonatal admission at DHQ Hospital during the study period. All eligible mother-neonate pairs were assigned an identification number, and the required sample size was selected through a computer-generated random number table.

Data collection was done through a number of sources including structured questionnaire, hospital records and neonatal resuscitation facility assessment checklist. Structured Questionnaire was used to collect data on maternal socio-demographic characteristics, obstetric history,

pregnancy characteristics and maternal healthcare utilization.

Hospital records, which included labor room record, delivery record, neonatal admission record and neonatal outcome record were accessed to collect clinical data regarding newborns' characteristics and outcomes. Data collected included maternal age, parity, educational status, place of residence, antenatal care visits, postnatal care visits, mode of delivery, birth weight, APGAR score at one minute, birth asphyxia, congenital malformations, neonatal sepsis, need for neonatal resuscitation, presence of neonatal resuscitation equipment and neonatal mortality.

Availability and readiness for neonatal resuscitation were measured using an adapted neonatal resuscitation service availability and readiness assessment (SARA) checklist according to the WHO guidelines. This was done using a checklist that measured the availability of neonatal resuscitation equipment and other necessary resources in the neonatal unit.

Daily review of completed questionnaires and collected data was performed prior to data entry.

3.4 Data Analysis

The collected data were analyzed using Microsoft Excel software and Statistical Package for the Social Sciences (SPSS) version 26.0.

Descriptive statistics were used to present characteristics of study variables. The mean and standard deviation (SD) were used for continuous variables while the frequencies and percentages were used for categorical variables.

Bivariate analyses were performed to identify factors that had association with neonatal mortality. For associations of categorical variables with neonatal mortality, Chi-square test was used. For continuous variables, independent sample t-test was done.

In bivariate analysis, significant variables and clinically important variables were selected for multiple binary logistic regression analysis to identify independent factors of neonatal mortality. The results of the logistic regression analyses were described using regression coefficients (B), standard error (SE), Wald statistic, odds ratio

(AOR) and corresponding p-value. The model fitness was determined using Omnibus Test of Model Coefficients, Cox and Snell R^2 and Nagelkerke R^2 . P value <0.05 was statistically significant.

3.5 Eligibility Criteria and Ethical Considerations

Infants born in the DHQ Hospital, Pakpattan during the study period, their mothers and individuals with all relevant hospital information were considered for the study. In addition, mothers willing to give additional information through interview sessions were included in the study.

Infants born outside DHQ Hospital, infants transferred to the hospital after birth from other health care centers, individuals with incomplete information and those mothers refusing to participate in interviews were excluded from the study.

Approval for the study was taken from the Institutional Review Board (IRB) prior to the data collection process. Permission to perform the study was taken from the Medical Superintendent and Head of concerned department in the DHQ Hospital, Pakpattan. Informed written consent was taken from mothers during every interview session (Shane et al., 2017). Anonymity and

confidentiality were maintained by providing unique identification numbers to the participants rather than using personal identifiers. All the collected information was kept confidential and used only for research purposes. Participants were told about their right to withdraw from the study at any point without affecting their healthcare services.

4. Results

The total number of mother-baby dyads included in this study was 160. Demographic, obstetric, and neonatal features of the subjects have been considered as well as the factors associated with neonatal mortality and predictors of neonatal deaths. The outcomes of this study are shown in descriptive analysis, bivariate analysis, and multivariable logistic regression analysis.

4.1 Baseline Characteristics of Study Participants

Continuous variables' descriptive features are shown in Table 1. Mean maternal age was 30.21 ± 7.47 years with the age range being 18 to 42 years. Birth weight of newborns had a mean of 2845.89 ± 845.94 grams, with 1235 grams and 4175 grams being the minimum and maximum birth weight, respectively. Mean maternal parity was 4.05 ± 2.57 while mean antenatal visits were 6.04 ± 3.86 .

Table 1. Baseline Characteristics of Study Participants

Variable	N	Minimum	Maximum	Mean $\pm$ SD
Maternal age (years)	160	18	42	30.21 ± 7.47
Birth weight (grams)	160	1235	4175	2845.89 ± 845.94
Parity	160	0	8	4.05 ± 2.57
Antenatal visits	160	0	12	6.04 ± 3.86

4.2 Neonatal Mortality Prevalence and Clinical Characteristics

Out of the 160 neonates enrolled in the research, 25 neonates (15.6%) died during the neonatal

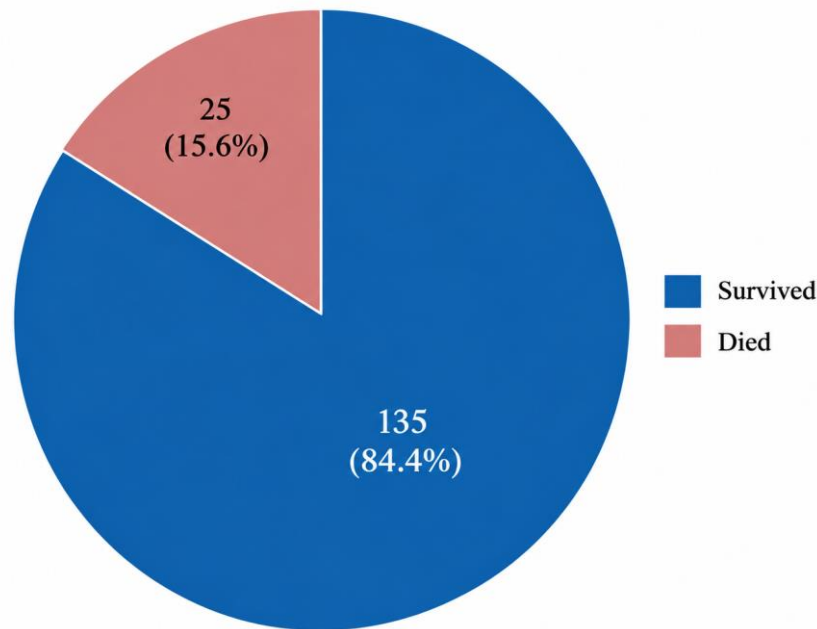
period whereas 135 neonates (84.4%) lived. The total prevalence rate of neonatal mortality was 15.6%.

Table 2. Neonatal Mortality Status

Neonatal Outcome	Frequency	Percentage
Survived	135	84.4%

Neonatal Outcome	Frequency	Percentage
Died	25	15.6%
Total	160	100%

Figure 1. Neonatal mortality distribution among study participants



Major neonatal clinical disorders are distributed in Table 3. Birth asphyxia occurred in 48 neonates (30.0%), while 112 neonates (70.0%) had no birth asphyxia. In relation to neonatal infections, 34 neonates (21.3%) were found to have neonatal

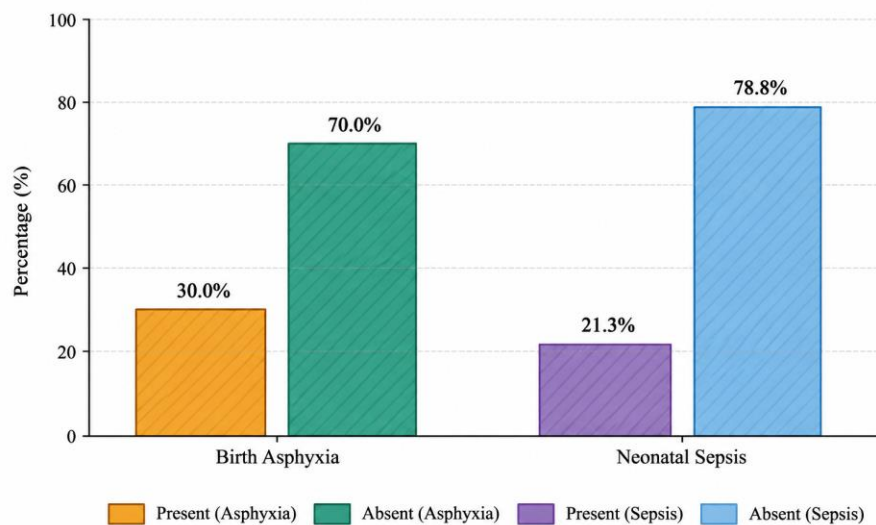
sepsis, while 126 neonates (78.8%) were free from sepsis.

As for the mode of delivery, 83 neonates (51.9%) were delivered by caesarean section, while 77 neonates (48.1%) were delivered.

Table 3. Clinical Characteristics of Neonates

Variable	Category	Frequency	Percentage
Birth Asphyxia	Absent	112	70.0%
	Present	48	30.0%
Neonatal Sepsis	Absent	126	78.8%
	Present	34	21.3%
Mode of Delivery	Vaginal Birth	77	48.1%
	Caesarean Birth	83	51.9%

Figure 2. Distribution of major neonatal clinical conditions



4.3 Factors Associated with Neonatal Mortality

Bivariate analysis was conducted to determine factors related to neonatal mortality. The association of neonatal death with maternal factors, neonatal factors, and healthcare factors was determined by Chi-square test. It was found that maternal education, neonatal resuscitation, birth asphyxia, and neonatal sepsis were significantly associated with neonatal mortality while the area of residence, equipment availability, and delivery mode were not significantly associated (Alizadeh et al., 2025).

Maternal education was found to be significantly associated with neonatal mortality ($p < 0.001$). Neonatal deaths were found more commonly in cases where mothers were uneducated and had only primary education than the cases where mothers had more education. Thus, the educational status of the mother played a significant role in determining neonatal survival. Another factor found to be significantly associated with neonatal mortality was neonatal resuscitation

($p < 0.001$). It was found that more neonatal deaths occurred among neonates requiring resuscitation than those who did not require resuscitation.

Asphyxia at birth had a statistically significant relationship with neonatal mortality ($p < 0.001$). Neonatal mortality was more prevalent in babies who were born with birth asphyxia than those who did not have it.

Likewise, neonatal sepsis had a statistically significant relationship with neonatal mortality ($p < 0.001$). More cases of deaths were reported among neonates with sepsis than those without sepsis (Lawn et al., 2014).

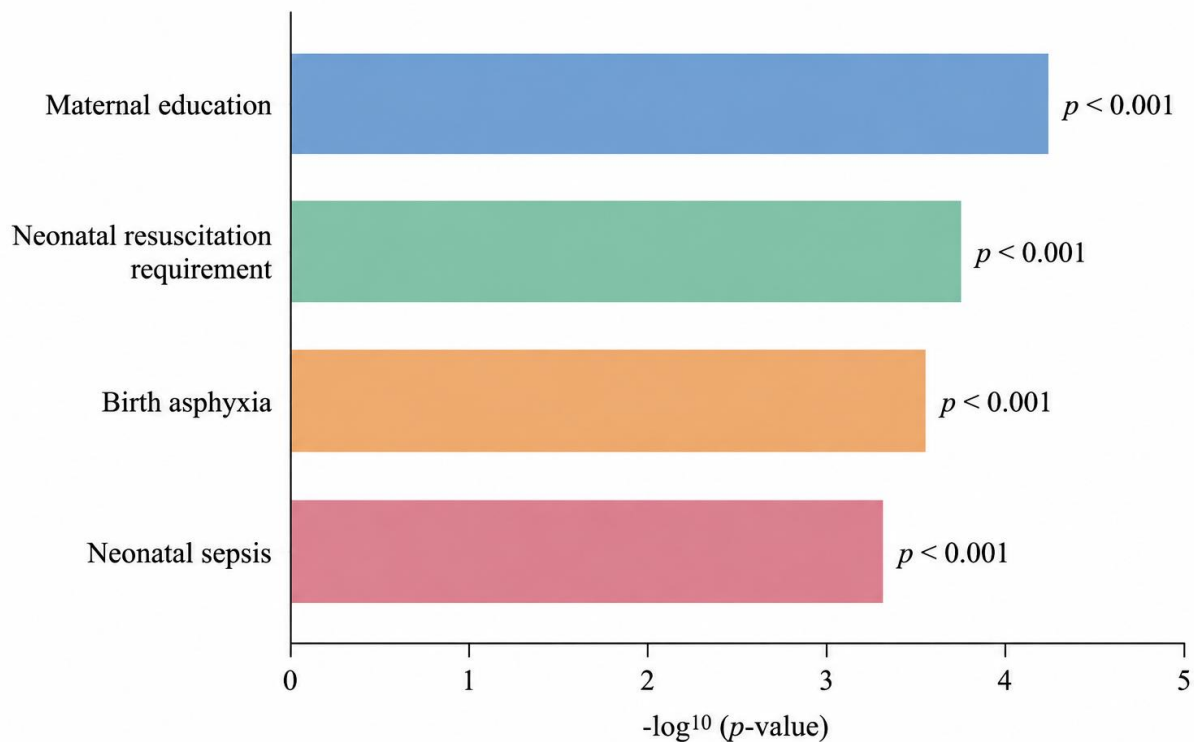
On the other hand, there was no statistically significant relationship between neonatal mortality and area of residence ($p = 0.989$), availability of equipment ($p = 0.132$), and mode of delivery ($p = 0.989$). Neonatal mortality was equally prevalent among babies born in urban and rural areas, and mode of delivery was not significantly related to neonatal mortality.

Table 4. Factors Associated with Neonatal Mortality (Bivariate Analysis)

Variable	p-value	Association with Neonatal Mortality
Area of residence	0.989	Not significant
Maternal education	<0.001	Significant
Equipment availability	0.132	Not significant

Variable	p-value	Association with Neonatal Mortality
Mode of delivery	0.989	Not significant
Need for neonatal resuscitation	<0.001	Significant
Birth asphyxia	<0.001	Significant
Neonatal sepsis	<0.001	Significant

Figure 3. Factors associated with neonatal mortality



4.4 Comparison of Continuous Variables Between Surviving and Deceased Neonates

An independent samples t-test was used to compare continuous variables between survived and non-survived neonates. As a result of this test, statistically significant differences were found in antenatal visits, birth weight, and APGAR score at one minute between these groups ($p < 0.001$). In contrast, there were no statistically significant differences regarding maternal age, parity, and postnatal visits between survived and non-survived neonates.

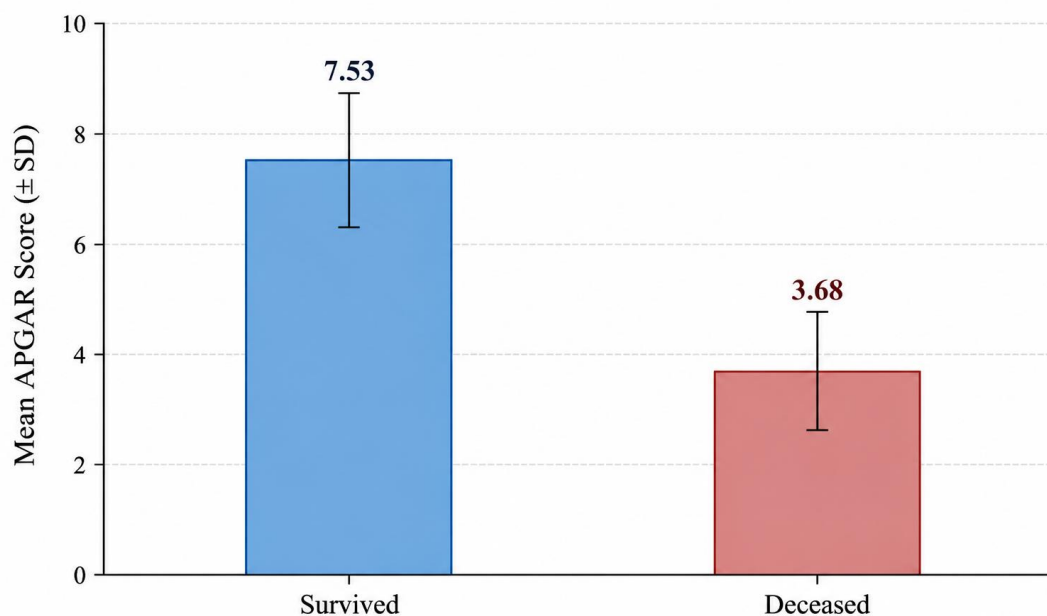
It can be seen that survived neonates received more antenatal visits on average (6.84 ± 3.60) than neonates who died (1.76 ± 1.92). Moreover, survived neonates had a higher mean birth weight (3004.41 ± 781.04 g) than neonates who died (1989.84 ± 655.96 g).

There was a statistically significant difference in APGAR scores at one minute between these two groups. Specifically, the mean APGAR score at one minute was 7.53 ± 2.20 in the group of survived neonates and 3.68 ± 2.10 in the group of dead neonates.

Table 5. Comparison of Continuous Variables Between Surviving and Deceased Neonates

Variable	Survived (Mean $\pm$ SD)	Died (Mean $\pm$ SD)	p-value
Maternal age (years)	29.86 $\pm$ 7.40	32.08 $\pm$ 7.70	0.173
Parity	3.91 $\pm$ 2.55	4.80 $\pm$ 2.61	0.113
Antenatal visits	6.84 $\pm$ 3.60	1.76 $\pm$ 1.92	<0.001
Postnatal visits	3.40 $\pm$ 1.62	3.80 $\pm$ 1.87	0.270
Birth weight (g)	3004.41 $\pm$ 781.04	1989.84 $\pm$ 655.96	<0.001
APGAR score at 1 minute	7.53 $\pm$ 2.20	3.68 $\pm$ 2.10	<0.001

Figure 4. Comparison of APGAR score between surviving and deceased neonates



4.5 Multivariable Logistic Regression Analysis

The multivariable binary logistic regression analysis was done to determine the independent factors affecting neonatal mortality after controlling other confounding variables. All clinically significant factors and those having significant associations during the bivariate analysis were included in the multivariate regression analysis. The entire regression model was statistically significant (Omnibus $\chi^2 = 57.207$, $p < 0.001$), meaning that all factors included in the model were significant predictors of neonatal mortality. The model was able to explain 30.1% of

the variation in outcomes using Cox and Snell R^2 while 51.9% using Nagelkerke R^2 .

After controlling all confounding factors, the analysis revealed that APGAR score at one minute and antenatal visits were still statistically significant independent predictors of neonatal mortality. Higher APGAR score is a factor reducing the odds of neonatal deaths (Adjusted Odds Ratio [AOR] = 0.652, $p = 0.027$), meaning that a good condition of the baby at birth increases chances of survival. An increased number of antenatal visits decreases the odds of neonatal mortality (AOR = 0.682, $p = 0.036$), which shows

the importance of antenatal care in reducing neonatal deaths (Mayer et al., 2022).

On the other hand, birth weight, birth asphyxia, and neonatal sepsis were not found to be independent predictors after adjustment in the regression analysis. Even though these factors had statistically significant relations in bivariate analysis, the independent relationships became

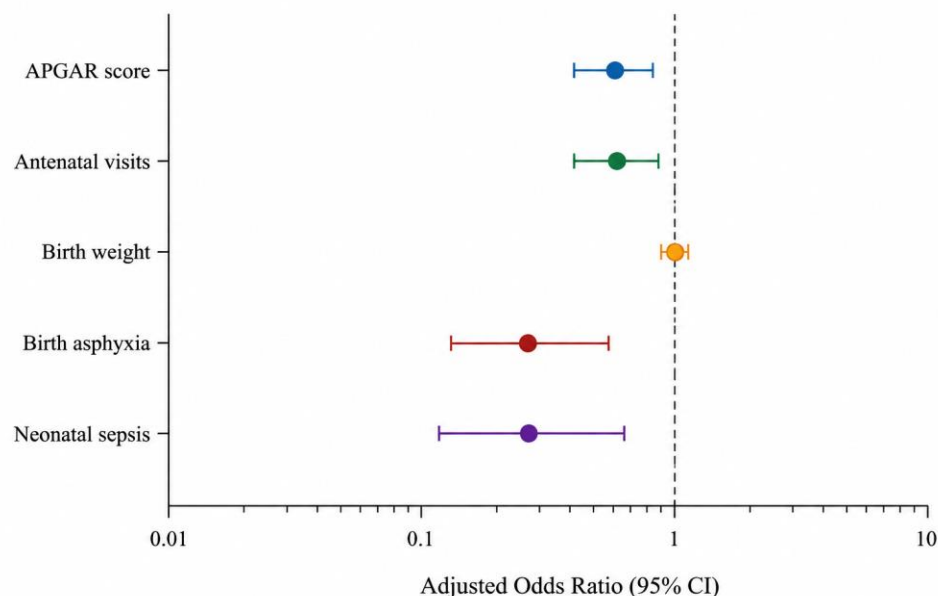
weak after adjusting for other variables used in the regression analysis. The relationship between birth weight and neonatal mortality was adjusted but still was not statistically significant ($p=0.115$). Similarly, birth asphyxia ($p=0.094$) and neonatal sepsis ($p=0.087$) were not independent predictors of neonatal mortality after adjustment.

Table 6. Multivariable Logistic Regression Analysis of Predictors of Neonatal Mortality

Predictor Variable	Adjusted Odds Ratio (AOR)	p-value
Birth Weight (g)	1.001	0.115
APGAR Score at 1 minute	0.652	0.027*
Antenatal Visits	0.682	0.036*
Birth Asphyxia (Yes vs No)	0.305	0.094
Neonatal Sepsis (Yes vs No)	0.320	0.087

*Statistically significant at $p < 0.05$

Figure 5. Independent Predictors of Neonatal Mortality



In general, the results have shown that neonatal mortality is highly dependent on a number of maternal and neonatal characteristics. Nevertheless, when all possible confounders were adjusted for, APGAR score at one minute and proper antenatal care attendance were found to be the main determinants of lower neonatal mortality

risk. The study findings highlight the significance of optimizing antenatal care access and enhancing newborn examination procedures.

5. Discussion

In the current cross-sectional study, neonatal mortality, associated factors for mothers and

infants, and the effect of neonatal resuscitation services were studied in neonates born in DHQ Hospital Pakpattan. Neonatal mortality is a significant index of maternal and infant health care because much neonatal mortality can be prevented through appropriate antenatal care, skilled delivery services, neonatal resuscitation and post-delivery services. As found out from the current study, both maternal use of health services and neonatal factors influenced neonatal survival. In multivariate analysis, antenatal care visits and one-minute APGAR score were identified as independent predictors of neonatal mortality.

The rate of neonatal mortality was rather high in the current study, being equal to 15.6%. This result might be due to the hospital-based design of the study because most DHQ hospitals treat complicated pregnancies, difficult deliveries and critical neonates. Such results are typical for hospital-based studies conducted in low- and middle-income countries because neonatal mortality rates in such studies are generally higher due to referral bias and more severe neonatal conditions (Baqui et al., 2016).

Utilization of antenatal care was revealed as a significant determinant of neonate survival rate. More visits of the mother during the period before delivery increased survival probability, and the antenatal care was an independent predictor of neonate survival in logistic regression (Mayer et al., 2022). Visits of the mother during antenatal care offer the possibility for early detection of potential complications, health counseling, infections, monitoring of the fetus development and referral of complicated pregnancies. These results show the necessity to provide access to quality antenatal care.

Maternal education level was identified as a significant factor of neonatal mortality. Neonates born from women with low educational level experienced increased mortality rates. It may be explained by various reasons including lower health literacy, awareness about danger signs during pregnancy and utilization of medical care services. Nonetheless, the maternal education level did not remain an independent factor in multivariate analysis.

There is a strong correlation between the condition of the neonate at birth and mortality outcomes. The neonates that have low APGAR scores were more prone to death, and even after adjustments, the APGAR score after one minute was an independent predictor of neonatal mortality. APGAR scoring provides immediate information about the condition of the newborns and helps in identifying the neonates that need immediate resuscitation (Muzzamil et al., 2022).

Birth asphyxia and neonatal sepsis were independently associated with neonatal mortality in the bivariate analysis, but the statistical significance of the association disappeared after multivariable adjustments. It might be caused by the tight relation of those factors with each other and with such factors as APGAR score, weight at birth, and general condition of the neonate. Nevertheless, both of them play an important role in causing neonatal mortality.

Low birth weight is also related to neonatal mortality in the univariate analysis (Soni et al., 2025). The mean birth weight of the dead neonates was significantly lower than that of the survivors. However, after multivariable adjustments, birth weight does not become an independent predictor.

Mortality was significantly correlated with the need for resuscitation in newborns, indicating their higher risk of being vulnerable due to breathing problems, childbirth complications, or maladjustment after birth. Nonetheless, having the required equipment was not significantly associated with mortality because, along with it, the availability of skilled practitioners, standard procedures, and regular training in skills is also an equally crucial element of good neonatal care (Hug et al., 2021).

Moreover, this study revealed that there was no significant correlation between mortality and either mode of delivery or place of residence. This means that neonatal health outcomes can be affected more by the clinical status of the baby or provided care than the mode of delivery or place of residence. First and foremost, the biggest advantage of this study was its consideration of multiple aspects such as maternal, neonatal, and

healthcare-related factors. Also, it made it possible to determine independent factors using multivariable logistic regression.

Nonetheless, some shortcomings must be addressed. First, the cross-sectional research design prevents establishing causal connections. Second, the small number of subjects and single-site hospital limit the study's capacity to generalize its results to the greater neonatal population of Pakistan. In addition, some crucial predictors like gestational age, nutrition, socioeconomic status, and breastfeeding practices cannot be taken into consideration (World Health Organization [WHO], 2022).

The obtained results point out that neonatal mortality is a complex phenomenon, which calls for improvement on the whole healthcare pathway of both the mother and the child. Improvements in antenatal care, early newborn examination, neonatal resuscitation, infection prevention, and quality care at the district hospitals can significantly affect the reduction in neonatal mortality.

6. Conclusion

In conclusion, the present study has found that neonatal mortality is a significant public health problem among neonates treated at DHQ Hospital Pakpattan. Over the course of the study, 15.6% of neonates have been found to suffer from neonatal mortality.

Several maternal and neonatal risk factors have been found to be correlated with neonatal mortality (Darmstadt et al., 2005). These include maternal education, neonatal resuscitation, birth asphyxia, neonatal sepsis, use of antenatal care, birth weight, and APGAR score. However, when controlling for all the above-mentioned factors through multivariable logistic regression, only two variables (number of antenatal visits and one-minute APGAR score) emerged as significant predictors of neonatal mortality.

High APGAR scores and antenatal visits were found to be correlated with lower levels of neonatal mortality. Even though such neonatal risk factors as birth weight, birth asphyxia, and neonatal sepsis did not emerge as significant predictors in the adjusted model, their clinical

importance cannot be overestimated (World Health Organization [WHO], 2022).

These results emphasize the importance of improving the continuum of care for maternal and neonatal health services through expanding the reach of antenatal care services, providing skilled intrapartum care, encouraging neonatal resuscitation in a timely manner, infection prevention measures, and enhancing neonatal care service delivery. The effective delivery of these interventions can be quite beneficial in preventing neonatal deaths.

7. Study Limitations and Recommendations

However, there are various weaknesses associated with this study that need to be noted before discussing the results. First of all, the cross-sectional nature of the research made it impossible to identify causal relationship between the risk factors determined and neonatal mortality. As this research was carried out in a single hospital, DHQ Hospital Pakpattan, it cannot be generalized to the other hospitals and neonates in Pakistan.

Secondly, the sample size ($n = 160$) might not be sufficient for identifying weak predictors associated with the phenomenon under discussion. Finally, the information provided by hospital records may have contained certain inaccuracies, while data collected as a result of mothers' interviews could be influenced by their recall bias.

Moreover, there were some important determinants of neonatal mortality, such as gestational age, prematurity, maternal nutrition, socioeconomic factors, maternal infection, and NICU factors, that were not included in this study. Besides, the evaluation of neonatal resuscitation service was mostly confined to the assessment of equipment, but not to the healthcare workers' competency and quality of the provided care.

Despite the limitations, the results of this study will offer some significant insights into the determinants of neonatal mortality at the healthcare facilities of the districts. From the results, there are several recommendations that can be derived. First, the quality of antenatal care

services needs to be improved and more women encouraged to attend antenatal clinics during their pregnancy period to detect and handle any risky pregnancies.

Newborn screening needs to be done, including proper APGAR score, and timely intervention should be done for those infants that require special handling. There is need for neonatal resuscitation equipment in healthcare facilities, and regular training for doctors, nurses, midwives, and other health workers should be done. There is need to enhance infection prevention and control by practicing proper hygiene, use of aseptic delivery techniques, early detection, and proper management of neonatal infections.

Community-based maternal health education programs should also be encouraged to educate communities about the significance of antenatal care, delivering babies in institutions, neonatal danger signs, breastfeeding, and healthcare seeking behavior. Neonatal mortality surveillance and audit programs should also be instituted in healthcare facilities to detect the preventable causes of neonatal deaths and come up with quality improvement programs.

Multicentre prospective studies with larger sample sizes from various parts of Pakistan need to be conducted in the future in order to identify factors that determine neonatal mortality rates and determine whether preventive interventions work effectively.

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