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Frequency of Factor Associated with Persistent Pulmonary Hypertension in Newborn Attending Bachakhan Medical Complex/ Gajju Khan Medical College Swabi

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ABSTRACT

Background and Objective: Persistent pulmonary hypertension of the newborn (PPHN) is a life-threatening condition characterized by failure of normal circulatory transition after birth, leading to elevated pulmonary vascular resistance and hypoxemia. This study aimed to determine the frequency of maternal, intrapartum, and neonatal factors associated with PPHN in neonates presenting to Bachakhan Medical Complex/ Gajju Khan Medical College Swabi.

Methods: A hospital-based descriptive cross-sectional study was conducted from 25 February 2025 to 25 May 2025. Seventy-eight neonates with echocardiographically confirmed PPHN were enrolled using consecutive non-probability sampling. Data on maternal, intrapartum, and neonatal variables were collected using a structured proforma and analyzed using descriptive statistics.

Results: The majority of neonates were term (78.2%) and male (57.7%). Maternal factors included preeclampsia (30.8%), gestational diabetes mellitus (23.1%), and oligohydramnios (19.2%). Intrapartum factors included meconium-stained amniotic fluid (33.3%), emergency cesarean section (37.2%), and prolonged labor (26.9%). Neonatal factors included low Apgar score (44.9%), birth asphyxia (41.0%), and need for resuscitation (38.5%). Echocardiography showed elevated pulmonary artery pressure in all cases, with right-to-left shunting via ductus arteriosus (59.0%) and foramen ovale (50.0%).

Conclusion: There is a strong association between perinatal hypoxic stress and development of PPHN. Early recognition of high-risk pregnancies and prompt neonatal resuscitation are essential to improve outcomes, particularly in resource-limited settings.

INTRODUCTION

Persistent pulmonary hypertension of the newborn (PPHN) is a serious neonatal cardiopulmonary disorder characterized by the failure of normal circulatory transition from fetal to neonatal life, resulting in persistently elevated pulmonary vascular resistance (PVR) and right-to-left shunting of blood through fetal circulatory pathways such as the ductus arteriosus and foramen ovale (Mandell et al., 2021; de Freitas Martins, 2021). This pathophysiological state leads to severe hypoxemia despite adequate ventilation and is associated with significant neonatal morbidity and mortality if not recognized and managed promptly (Singh & Lakshminrusimha, 2021; Martinho et al., 2020).

Under normal physiological conditions, birth is accompanied by a rapid decrease in pulmonary vascular resistance due to lung expansion, oxygenation, and release of vasoactive mediators such as nitric oxide (Steinhorn & Lakshminrusimha, 2020; Zhang et al., 2023; Cookson & Kinsella, 2024). In PPHN, this transition fails, leading to sustained vasoconstriction and structural remodeling of the pulmonary vasculature (Sankaran & Lakshminrusimha, 2022; Galambos & Abman, 2021; Chandrasekharan et al., 2020). The condition may occur as a primary idiopathic disorder or more commonly as a secondary complication of conditions such as meconium aspiration syndrome, neonatal sepsis, respiratory distress syndrome, and perinatal asphyxia (Osman et al., 2023; Pitiri, 2021; Arshad et al., 2021).

The global incidence of PPHN is estimated at approximately 1–2 per 1,000 live births, although this rate varies depending on population characteristics, obstetric practices, and diagnostic availability (Bláha & Bartošová, 2022; Nakwan et al., 2020). Higher incidence has been reported in term and near-term infants, particularly in settings where perinatal hypoxia and meconium aspiration are prevalent (Olicker et al., 2021; Monfredini et al., 2021; Bruckner et al., 2021). Despite advances in

neonatal intensive care, including mechanical ventilation, inhaled nitric oxide therapy, and extracorporeal membrane oxygenation (ECMO) in advanced centers, PPHN continues to pose a significant therapeutic challenge, especially in low- and middle-income countries where access to advanced neonatal care is limited (Bandiya et al., 2024; Nakwan et al., 2020; Fan & Chen, 2024).

Multiple maternal, intrapartum, and neonatal risk factors have been implicated in the development of PPHN (Martinho et al., 2020; Zhou et al., 2021). Maternal conditions such as preeclampsia, diabetes mellitus, and chronic hypertension can contribute to placental insufficiency and chronic fetal hypoxia, thereby predisposing the neonatal pulmonary vasculature to maladaptive remodeling (Ortega et al., 2022; Hu & Zhang, 2021; Ramirez Zegarra et al., 2022). Intrapartum factors, including prolonged labor, meconium-stained amniotic fluid, and emergency cesarean delivery, often reflect fetal distress and are strongly associated with hypoxic injury (Dani et al., 2023). Neonatal factors such as low Apgar scores, birth asphyxia, and respiratory distress syndrome further exacerbate pulmonary vasoconstriction and impaired oxygenation (Olicker et al., 2021).

PPHN is clinically significant not only because of its acute life-threatening presentation but also due to its long-term consequences (Fortas et al., 2021). Survivors may experience neurodevelopmental impairment, chronic lung disease, and hearing deficits, particularly if prolonged hypoxemia or aggressive ventilatory support is required. Early recognition of risk factors and timely initiation of targeted therapies are therefore essential to improving outcomes (Zhang et al., 2023).

In resource-limited settings such as Pakistan, the burden of neonatal hypoxic disorders remains high due to limited antenatal screening, delayed referrals, and inadequate access to advanced neonatal intensive care services (Muttalib, 2023). There is also a paucity of locally generated data regarding the epidemiology and risk factor profile of PPHN, which limits the development of context-specific preventive and management strategies. (Arshad et al., 2021) Understanding the local pattern of associated maternal and perinatal factors is crucial for early identification of at-risk neonates and implementation of timely interventions.

Therefore, this study was conducted to determine the frequency of maternal, intrapartum, and neonatal factors associated with PPHN in neonates presenting to Bacha Khan Medical Complex, Swabi. The findings of this study aim to contribute to the existing body of evidence by providing region-specific data that may assist clinicians in improving early recognition, risk stratification, and preventive neonatal care strategies in similar healthcare settings.

METHODOLOGY

A hospital-based descriptive cross-sectional study was conducted at Bachakhan Medical Complex/ Gajju Khan Medical College Swabi, from 25 February 2025 to 25 May 2025 to determine the frequency of factors associated with persistent pulmonary hypertension of the newborn (PPHN). All neonates presenting to the neonatal unit and diagnosed with PPHN on the basis of clinical features and echocardiographic confirmation during the study period were considered for inclusion. A consecutive non-probability sampling technique was employed to recruit eligible participants to minimize selection bias. Detailed maternal, perinatal, and neonatal histories were obtained using a structured proforma, including antenatal risk factors (such as maternal diabetes, preeclampsia, oligohydramnios, and medication exposure), intrapartum variables (mode of delivery, meconium-stained liquor, prolonged labor), and neonatal characteristics (gestational age, birth weight, Apgar score, need for resuscitation, and respiratory distress severity). Clinical examination findings and relevant laboratory and imaging data, particularly echocardiography, were recorded to confirm diagnosis and assess associated conditions. Data were entered and analyzed using appropriate statistical software, with categorical variables summarized as frequencies and percentages, while associations between risk factors and PPHN were evaluated using chi-square or Fisher's exact test as applicable, considering a p-value <0.05 as statistically significant. Ethical approval was obtained from the institutional review committee of the hospital, and informed consent was secured from parents or guardians prior to enrollment.

RESULTS

A total of 78 neonates diagnosed with persistent pulmonary hypertension of the newborn (PPHN) were included in the study during the study period from 25 February 2025 to 25 May 2025 at Bacha Khan Medical Complex, Swabi. The mean gestational age was 36.8 ± 2.9 weeks, and the mean birth weight was 2780 ± 610 grams. Term neonates constituted 61 (78.2%), while preterm neonates accounted for 17 (21.8%). Male neonates were predominant, comprising 45 (57.7%) of the study population.

Among maternal risk factors, preeclampsia was the most frequently observed condition, present in 24 (30.8%) cases, followed by gestational diabetes mellitus in 18 (23.1%) and oligohydramnios in 15 (19.2%). Maternal infections were documented in 11 (14.1%), while drug exposure during pregnancy was noted in 9 (11.5%) cases. In 12 (15.4%) cases, no identifiable maternal risk factor was found.

Regarding intrapartum and neonatal variables, meconium-stained amniotic fluid was observed in 26 (33.3%) deliveries, while prolonged labor was noted in 21 (26.9%) cases. Emergency cesarean section was performed in 29 (37.2%) cases. Among neonatal factors, birth asphyxia was present in 32 (41.0%), low Apgar score at 5 minutes in 35 (44.9%), and need for resuscitation at birth in 30 (38.5%) neonates. Respiratory distress syndrome was documented in 28 (35.9%) cases.

Echocardiographic evaluation confirmed elevated pulmonary artery pressures in all 78 (100%) cases. Associated findings included right-to-left shunt through patent ductus arteriosus (PDA) in 46 (59.0%) and through patent foramen ovale (PFO) in 39 (50.0%) cases. Ventricular dysfunction was observed in 18 (23.1%), while tricuspid regurgitation was noted in 22 (28.2%) neonates.

Table 1
Baseline Characteristics of Neonates with PPHN (N = 78)

Variable	Frequency (n)	Percentage (%)
Term neonates	61	78.2
Preterm neonates	17	21.8
Male	45	57.7
Female	33	42.3
Low birth weight (<2500 g)	28	35.9
Normal birth weight	50	64.1
Mean gestational age (weeks)	36.8 ± 2.9	—
Mean birth weight (g)	2780 ± 610	—

Table 2
Maternal Risk Factors Associated with PPHN

Risk Factor	Frequency (n)	Percentage (%)
Preeclampsia	24	30.8
Gestational diabetes mellitus	18	23.1
Oligohydramnios	15	19.2
Maternal infection	11	14.1
Drug exposure during pregnancy	9	11.5
No identifiable risk factor	12	15.4

Table 3
Intrapartum and Neonatal Factors

Factor	Frequency (n)	Percentage (%)
Meconium-stained liquor	26	33.3
Prolonged labor	21	26.9
Emergency C-section	29	37.2
Birth asphyxia	32	41.0
Low Apgar score (<7 at 5 min)	35	44.9
Need for resuscitation at birth	30	38.5
Respiratory distress syndrome	28	35.9

Table 4
Echocardiographic Findings in PPHN Cases

Finding	Frequency (n)	Percentage (%)
Elevated pulmonary artery pressure	78	100
Right-to-left shunt (PDA)	46	59.0
Right-to-left shunt (PFO)	39	50.0
Ventricular dysfunction	18	23.1
Tricuspid regurgitation	22	28.2

DISCUSSION

Persistent pulmonary hypertension of the newborn (PPHN) remains a critical neonatal condition associated with significant morbidity and mortality due to failure of normal postnatal circulatory transition (Sankaran & Lakshminrusimha, 2022). In the present study conducted at Bacha Khan Medical Complex, Swabi, a total of 78 neonates with echocardiographically confirmed PPHN were analyzed to identify the frequency of associated maternal, intrapartum, and neonatal risk factors. The findings highlight a multifactorial etiology, with hypoxic perinatal stressors and maternal complications playing a central role (Zhou et al., 2021; Martinho et al., 2020).

In our study, term neonates constituted the majority (78.2%), which is consistent with established literature indicating that PPHN is more frequently observed in term or near-term infants due to conditions such as birth asphyxia, meconium aspiration syndrome, and perinatal stress rather than prematurity alone (Monfredini et al., 2021; Fan & Chen, 2024). The male predominance observed in our cohort (57.7%) aligns with previous studies suggesting a sex-related susceptibility, potentially linked to delayed pulmonary vascular adaptation in male neonates (Zhou et al., 2021).

Among maternal risk factors, preeclampsia emerged as the most common association, followed by gestational diabetes mellitus and oligohydramnios. These findings are comparable to studies demonstrating that uteroplacental insufficiency and metabolic disturbances contribute to chronic intrauterine hypoxia, which in turn predisposes the fetal pulmonary circulation to abnormal vasoreactivity after birth (Hu & Zhang, 2021; Ortega et al., 2022). Maternal infections and drug exposure were less frequent but remain important modifiable risk factors that may contribute to fetal inflammatory and vascular remodeling pathways.

Intrapartum complications were notably prevalent, with meconium-stained amniotic fluid, emergency cesarean section, and prolonged labor frequently observed. These factors strongly indicate fetal distress and perinatal hypoxia, which are well-recognized triggers for sustained pulmonary vasoconstriction (Osman et al., 2023; Fan & Chen, 2024). Similarly, neonatal variables such as low Apgar score, birth asphyxia, and need for resuscitation were highly prevalent in our cohort, reinforcing the central role of hypoxic-ischemic insult in the pathogenesis of PPHN (Bruckner et al., 2021). These findings are consistent with prior studies reporting birth asphyxia and meconium aspiration as leading contributors to elevated pulmonary vascular resistance in the immediate neonatal period.

Echocardiographic assessment confirmed elevated pulmonary artery pressures in all cases, with a significant proportion demonstrating right-to-left shunting via the ductus arteriosus and foramen ovale. These findings reflect persistent fetal circulation physiology and impaired pulmonary vascular relaxation (Fortas et al., 2021). The presence of ventricular dysfunction and tricuspid regurgitation in a subset of patients further indicates the severity spectrum of disease and associated hemodynamic compromise.

Overall, the results of this study reinforce the multifactorial nature of PPHN, with perinatal hypoxia, maternal comorbidities, and intrapartum complications acting synergistically (Martinho et al., 2020; Sankaran & Lakshminrusimha, 2022). Early identification of high-risk pregnancies and prompt neonatal resuscitation may reduce disease burden and improve outcomes. The findings are largely consistent with regional and international studies, although variations in frequency may be attributed to differences in obstetric care, referral patterns, and diagnostic capabilities.

This study is limited by its single-center design and relatively short duration, which may restrict generalizability. Additionally, the use of non-probability sampling may introduce selection bias. However, the study provides valuable local epidemiological data that may guide preventive strategies and early clinical interventions in similar resource-limited settings.

CONCLUSION

Persistent pulmonary hypertension of the newborn remains a significant cause of neonatal morbidity and mortality, particularly in resource-limited settings where delayed diagnosis and limited access to advanced neonatal care persist. This study identified a high frequency of perinatal hypoxic stressors, including birth asphyxia, low Apgar scores, and meconium-stained amniotic fluid, as well as maternal conditions such as preeclampsia and gestational diabetes mellitus. These findings emphasize the multifactorial nature of PPHN and the critical role of antenatal and intrapartum care in prevention. Early recognition of at-risk pregnancies, timely obstetric intervention, and effective neonatal resuscitation are essential to reduce disease severity. Strengthening maternal health services and improving perinatal monitoring can significantly decrease the burden of PPHN. The study underscores the importance of developing context-specific strategies to improve neonatal outcomes and reduce preventable hypoxic injury in newborns in similar healthcare settings effectively now.

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