Published by
Saidu Medical College

OPEN ACCESS

Original Article

Frequency of Neonatal Jaundice in Polycythemic Infants Admitted to the Intensive Care Unit: A Cross-Sectional Study

Saman Gul[1], Muhammad Mujtaba[1], Mejeeb ur Rehman[2], Saima Ali[3], Farida Sherazi[1] & Khawar Saeed[4]

[1]Naseer Teaching Hospital, Peshawar, Pakistan
[2]Civil Hospital Manglawar, Swat, Pakistan
[3]Hayatabad Medical Complex, Peshawar, Pakistan
[4]Northwest General Hospital & Research Centre, Peshawar, Pakistan

https://doi.org/10.52206/jsmc.2025.15.4.1037

Abstract

Background: Neonatal jaundice, characterized by yellow discoloration of the skin and sclera due to bilirubin deposition, remains one of the most common neonatal problems. Polycythemia in neonates increases red blood cell mass, leading to accelerated breakdown and hyperbilirubinemia, which can progress to severe complications such as kernicterus.

Objective: To determine the frequency of neonatal jaundice among polycythemic infants admitted to the neonatal intensive care unit (NICU).

Methodology: A cross-sectional study was conducted at the Department of Pediatrics, Hayatabad Medical Complex, Peshawar, from July 2020 to January 2021. A non-probability consecutive sampling technique was used, and a total of 167 neonates were enrolled based on WHO sample size calculation. Inclusion criteria were neonates less than one month old, gestational age between 31–40 weeks, weight 1500–4600 g, and diagnosed with polycythemia. Neonates with blood disorders, syndromic features, or jaundice developing after three weeks were excluded. Data were collected through structured questionnaires, clinical assessment, and laboratory investigations. Analysis was done using SPSS v20.

Results: Among 167 neonates, 108 (65.7%) were male and 59 (35.3%) female, with a mean age of 14.5 ± 7.22 days. Neonatal jaundice was present in 78 (46.7%) infants, and 45 (26.9%) developed kernicterus. Jaundice was significantly associated with male gender, neonatal age <15 days, high hemoglobin levels (>22 g/dL), elevated serum bilirubin, obstetric complications, birth asphyxia, and cephalohematoma ($p < 0.05$), but not with gestational age.

Conclusion: Nearly half of the polycythemic neonates admitted to the NICU developed jaundice, with a considerable proportion progressing to kernicterus. Male gender, higher hemoglobin concentration, and perinatal complications emerged as major risk factors. These findings highlight the importance of early screening and timely intervention in polycythemic infants to prevent severe neurological outcomes.

Keywords: Bilirubin, Birth asphyxia, Kernicterus, Neonatal jaundice, Polycythemia.

ISSN (P): 1819-4583
ISSN (E): 3007-9470

Copyright © Copyright (c) 2025 The authors retain the copyrights. Authors are permitted and encouraged to post their work online (e.g. in institutional repositories or on their website), as it can lead to productive exchanges, as well as greater citation of published work.

Citation:
Gul S, Mujtaba M, Rehman M, Ali S, Sherazi F, Saeed K. Frequency of neonatal jaundice in polycythemic infants admitted to the intensive care unit: a cross-sectional study. J Saidu Med Coll. 2025;15(4):608–614.

Corresponding Author:
Dr. Saman Gul
Senior Registrar,
Naseer Teaching Hospital, Peshawar, Pakistan
mannu.gul.50@gmail.com

Funding:
The authors received no external funding for this study.

Conflicts of Interests:
The authors have declared that no competing interests exist.

Data Sharing Statement:
The data that support the findings of this study are available on request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

Received: August 15, 2024
1st Revision: August 29, 2024
2nd Revision: July 04, 2025
3rd Revision: September 22, 2025
Accepted: September 27, 2025

Introduction

Jaundice is defined as the yellow discoloration of mucosa and skin due to deposition of excessive bilirubin, and it is a cause of concern for physicians as well as a source of anxiety for parents [1]. Elevated bilirubin levels are potentially toxic to the central nervous system, and may result in permanent neurological impairment even in term newborns. Globally, neonatal jaundice is a common clinical condition, affecting approximately 60% of term newborns and up to 80% of preterm newborns in the first week of life [2,3]. It is also one of the leading causes of hospital readmissions during the neonatal period [4].

Jaundice may be classified as physiological or pathological. Physiological jaundice typically appears after 24 hours of birth and is predominantly unconjugated bilirubin, whereas pathological jaundice occurs within the first 24 hours of life and is usually conjugated, often requiring aggressive medical intervention [5–7]. Severe hyperbilirubinemia is a preventable condition but, if untreated, can lead to kernicterus and lifelong neurodevelopmental impairment [8].

Polycythemia in neonates is defined as a hemoglobin level above 22 g/dL or a hematocrit greater than 65% [9]. Its reported prevalence ranges from 2–15% in normal gestational age infants and is higher among preterm neonates [10,11]. Several risk factors contribute to polycythemia, including maternal conditions (hypertension, cyanotic congenital heart disease, diabetes mellitus) and neonatal factors (intrauterine growth retardation, hypoxia, congenital abnormalities, and chromosomal disorders) [12,13]. Increased erythropoiesis, secondary to hypoxia, further contributes to high hematocrit levels in affected neonates. Clinical features of neonatal polycythemia are often nonspecific and include ruddy complexion, irritability, tremors, poor feeding, apnea, and seizures [14].

Despite the global burden, there is limited evidence from Pakistan regarding the association between neonatal jaundice and polycythemia. No prior study has been conducted in District Peshawar to determine the frequency of jaundice in polycythemic neonates admitted to the NICU. Therefore, this study was undertaken to bridge this gap, provide local data, and guide future preventive and management strategies.

Methodology

Study Design:

This study was designed as a cross-sectional observational study, employing a non-probability consecutive sampling technique. The approach was chosen to capture the frequency of neonatal jaundice among polycythemic infants admitted to the neonatal intensive care unit (NICU), providing a snapshot of the burden of disease within the defined study period.

Ethics:

Ethical approval for the study was obtained from the Institutional Ethical Committee of Hayatabad Medical Complex, Peshawar (Ref. No. 302/HEC/B&PSC/2020). Written informed consent was taken from the parents or legal guardians of all neonates enrolled. Confidentiality of patient data was ensured, and participation was voluntary without any undue pressure.

Setting:

The study was conducted in the Department of Pediatrics, Neonatal Intensive Care Unit (NICU) of Hayatabad Medical Complex, Peshawar, over a six-month duration from July 12, 2020, to January 12, 2021. This is a tertiary care facility that caters to a wide catchment area, thus ensuring inclusion of neonates from diverse demographic and clinical backgrounds.

Participants:

A total of 167 neonates were included, meeting the inclusion criteria of being below one month of age, diagnosed with polycythemia (hemoglobin >22 g/dL or hematocrit >65%), with a gestational age between 31 and 40 weeks, and a birth weight ranging from 1500 g to 4600 g. Only those neonates whose parents or guardians consented were included. Exclusion criteria comprised neonates with blood disorders (ABO/Rh incompatibility, G6PD deficiency), syndromic features such as trisomies, those developing jaundice after three weeks of age, and cases where guardians declined consent.

Variables:

The primary outcome variable was neonatal jaundice, defined clinically by yellow discoloration of skin and sclera, and confirmed through serum bilirubin levels. Independent variables included demographic data (age, gender, gestational age, birth weight, head circumference), clinical factors (mode of admission, birth asphyxia, cephalohematoma, obstetric complications), and laboratory parameters (hemoglobin levels, serum bilirubin levels).

Data Sources/Measurement:
Data were collected using a structured questionnaire developed by the Pediatrics Unit of Hayatabad Medical Complex. Clinical examination assessed visible jaundice, while laboratory confirmation was obtained through complete blood count (CBC), serum bilirubin estimation, cross-match testing, and G6PD screening. Polycythemia was confirmed via hematological indices. Data were entered into SPSS version 20.0 for analysis.

Bias:
To minimize selection bias, consecutive sampling was applied so that all eligible neonates within the study period were included. Measurement bias was reduced by using standardized laboratory techniques for bilirubin and hemoglobin estimation. Observer bias was minimized by training the data collection team and cross-verifying laboratory results with clinical findings.

Study Size:
The sample size of 167 neonates was calculated using the WHO sample size calculator, considering a 95% confidence interval, a precision level of ±5.51%, and an estimated prevalence of polycythemia at 15.6%. This ensured sufficient statistical power to detect associations between neonatal jaundice and risk factors.

Quantitative Variables:
Continuous variables such as age, gestational age, weight, head circumference, hemoglobin level, and serum bilirubin levels were measured and presented as mean ± standard deviation (SD). Categorical variables such as gender, jaundice presence, kernicterus, birth asphyxia, cephalohematoma, and treatment modalities were expressed in frequencies and percentages.

Statistical Methods:
Data were analyzed using SPSS version 20.0. Descriptive statistics (means, SD, frequencies, percentages) summarized baseline characteristics. Stratification of neonatal jaundice was performed by age, gender, gestational age, hemoglobin, serum bilirubin level, kernicterus, phototherapy, and exchange transfusion to assess effect modification. Associations between categorical variables were tested using Chi-square test, and a p-value <0.05 was considered statistically significant.

Results

Participants
A total of 167 neonates fulfilling the inclusion criteria were enrolled in this study. The mean age of participants was 14.50 ± 7.22 days, with the majority (62.3%) being within the first 15 days of life. Among the neonates, 108 (65.7%) were male and 59 (35.3%) were female, demonstrating a male predominance. The gestational age ranged from 31 to 40 weeks, with a mean of 36.73 ± 2.50 weeks. Most infants (79.0%) were born at term (36–40 weeks), whereas 21.0% were late preterm (31–35 weeks).

Descriptive Data
The mean birth weight of the neonates was 3.18 ± 0.74 kg, while the average occipitofrontal circumference (OFC) was 35.2 ± 1.3 cm, and the mean length was 80.65 ± 11.79 cm. Hemoglobin levels ranged widely, with a mean of 20.49 ± 5.85 g/dL; notably, 78 (46.7%) of the neonates had Hb levels >22 g/dL, fulfilling the criteria for polycythemia. The mean serum bilirubin level was 23.58 ± 9.17 mg/dL. Regarding admission status, 53.3% of neonates were admitted electively while 46.7% were admitted on an emergency basis. Conservative treatment was administered in 75.4% of cases.

Outcome Data
Neonatal jaundice was observed in 78 (46.7%) infants, while 89 (53.3%) had no evidence of jaundice. Among those affected, 45 (26.9%) developed kernicterus, highlighting the severity of hyperbilirubinemia in this cohort. Phototherapy was administered to 28.1% of neonates as part of management. Furthermore, birth asphyxia was present in 17.4% of neonates, and cephalohematoma was documented in 12%. Obstetric complications were reported in 28.1% of cases.

Main Results
Analysis revealed significant associations between neonatal jaundice and several variables. Jaundice was more common among male neonates ($p = 0.05$) and in those younger than 15 days ($p = 0.01$). A strong relationship was also found between jaundice and elevated serum bilirubin levels, with the majority of affected neonates having bilirubin >16 mg/dL. Polycythemic neonates with hemoglobin >22 g/dL were all jaundiced ($p < 0.001$), indicating a direct link between polycythemia and hyperbilirubinemia. Kernicterus was significantly associated with the presence of jaundice ($p < 0.001$), as were obstetric complications ($p < 0.001$), birth asphyxia ($p < 0.001$), and cephalohematoma ($p < 0.001$). However, no statistically significant relationship was observed between jaundice and gestational age ($p = 0.25$).

Table No. 1: Frequency and percentages of the variables		
Variable		**Frequency & percentage (%)**
Gender	**Male**	108 (64.7%)
	Female	59 (35.3%)
Age	**0-15 days**	104 (62.3%)
	16-29 days	63 (37.7%)
Gestational age	**31-35 weeks**	35 (21.0%)
	36- 40 weeks	132 (79.0%)
Mode of admission	**Elective**	89 (53.3%)
	Emergency	78 (46.7%)
Conservative treatment	**Yes**	126 (75.4%)
	No	41 (24.6%)
Hemoglobin	**>22 mg/dl**	78 (46.7%)
	<22mg/dl	89 (53.3%)
Serum Bilibriubin	**>16 mg/dl**	108 (64.7%)
	<16 mg/dl	59 (35.3%)
Jaundice	**Yes**	78(46.7%)
	No	89(53.3%)
Kernicterus	**Yes**	45(26.9%)
	No	122(73.1%)
Obstetric complication	**Yes**	47(28.1%)
	No	120(71.9%)
Birth asphyxia	**Yes**	29(17.4%)
	No	138(82.6%)
Cephalohematoma	**Yes**	20(12%)
	No	147(88%)

Table No. 2: Relationship between neonatal Jaundice and other variables				
	Variable	Jaundice		p-value
		Yes	No	
Gender	**Male**	44	64	0.05
	Female	34	25	
Age	**0-15 days**	57	47	0.01
	16-29 days	21	42	
Gestational age	**31-35 weeks**	13	22	0.25
	36- 40 weeks	65	67	
Mode of admission	**Elective**	25	64	0.00
	Emergency	53	25	
Hemoglobin	**>22 mg/dl**	78	-	0.00
	<22mg/dl	-	89	
Kernicterus	**Yes**	43	2	0.00
	No	35	87	
Obstetric complication	**Yes**	46	1	0.00
	No	35	85	
Birth asphyxia	**Yes**	29	-	0.00
	No	89	49	
Cephalohematoma	**Yes**	20	-	0.00
	No	58	89	

Discussion

The objective of this study was to determine the frequency of neonatal jaundice among polycythemic neonates admitted to the NICU. Our findings revealed that jaundice was present in nearly half of the infants, with a significant proportion developing kernicterus. The results showed a strong association of jaundice with male gender, younger age, elevated serum bilirubin, high hemoglobin concentration, obstetric complications, birth asphyxia, and cephalohematoma, whereas no significant relationship was observed with gestational age.

Our results are consistent with previous studies highlighting polycythemia as an important risk factor for neonatal jaundice. A case-control study conducted in Ethiopia demonstrated a strong association between polycythemia and neonatal jaundice [15], while other reports have emphasized that an increased red blood cell load in polycythemic neonates leads to accelerated hemolysis and hyperbilirubinemia [16].

Gender differences also emerged as significant in our study, with males being more affected. This observation is supported by studies in Tehran [17], Kelantan [18], and Ethiopia [19], which reported a higher incidence of jaundice among male neonates due to delayed hepatic maturation. Birth asphyxia was another major determinant in our findings, consistent with studies conducted in India [20], Nigeria [21,22], Patiala [23], and Umbu Rara Meha Hospital [24]. These studies concluded that hypoxic insult reduces glycogen availability and impairs bilirubin conjugation, thereby aggravating hyperbilirubinemia.

The significance of neonatal age in the development of jaundice was also demonstrated in our study, in line with the work of Imoudu IA [25], who reported strong associations between neonatal jaundice, early neonatal age, and gender. Similarly, Boskabadi et al. [26] also confirmed polycythemia as a key risk factor for hyperbilirubinemia. Cephalohematoma was identified in our results as a contributor to jaundice, corroborating findings from Zeleke BA and colleagues [27], who demonstrated that scalp bruising and extravasated blood serve as an additional bilirubin source.

Other studies such as those by Selvam S [28], Asaye S [29], Warsame HA [30], and Sisay BD [31] also reported significant associations between perinatal complications and neonatal jaundice, further supporting our findings. These studies highlighted the multifactorial pathways, including hypoxia-induced impairment of bilirubin conjugation and renal dysfunction, which contribute to hyperbilirubinemia.

In addition, studies from Ethiopia [32,33] and India [34] confirmed the association of neonatal jaundice with gender and perinatal risk factors. Interestingly, Dahat A et al. [34] reported a higher frequency of jaundice among female neonates in their population, which contrasts with our results, indicating that regional or genetic differences may influence gender predisposition.

Although gestational age was not found to be significantly associated with jaundice in our study, conflicting evidence exists. For instance, Imoudu IA [25] reported gestational age as a significant factor, while our findings suggest otherwise, possibly due to differences in sample characteristics or confounders. This emphasizes the need for larger, multicenter studies in Pakistan to validate these associations.

The concordance of our findings with a wide range of international studies highlights the global relevance of neonatal jaundice in polycythemic infants, while also underlining the need for context-specific data to guide interventions in local settings.

Conclusion

This study showed that jaundice was the most frequent clinical manifestation among polycythemic neonates admitted to the NICU, with nearly half developing hyperbilirubinemia and a significant proportion progressing to kernicterus. Male gender, early neonatal age, elevated hemoglobin and bilirubin levels, obstetric complications, birth asphyxia, and cephalohematoma were strongly associated with jaundice, whereas gestational age showed no significant association. These findings underscore the importance of vigilant monitoring and timely intervention in polycythemic neonates to prevent severe outcomes such as kernicterus. Future studies on larger populations across multiple centers are warranted to further explore these associations and guide preventive strategies.

Authors' Contributions

All authors meet the ICMJE criteria for authorship. They have reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Author 1: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.

Author 2: Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 3: Analysis and interpretation of data, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 4: Analysis and interpretation of data, critical revision, final approval, agreed to be accountable for all the work.
Author 5: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 6: Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work

References

1. Johnston M, Ravindran RR. Jaundice. *Surgery (Oxford).* 2023 Jun 1;41(6):334-41. https://doi.org/10.1016/j.mpsur.2023.02.019
2. Slusher TM, Angyo IA, Bode-Thomas F, Akor F, Pam SD, Adetunji AA, et al. Transcutaneous bilirubin measurements and serum total bilirubin levels in indigenous African infants. *Pediatrics.* 2004;113(6):1636-41. https://doi.org/10.1542/peds.113.6.1636.
3. Hansen TW. The epidemiology of neonatal jaundice. *Pediatr Med.* 2021;5(18):18. https://doi.org/10.21037/pm-21-4.
4. Obeagu EI, Katya MC. A systematic review on physiological jaundice: diagnosis and management of the affected neonates. *Madonna Univ J Med Health Sci.* 2022 Sep 26;2(3):25-41.
5. Owaymir ADA, Aseeri RMA, Albariqi MAA, Alalyani MS, Almansaf JAA, Albalwi ABK, et al. An overview on diagnosis and management of neonatal jaundice. *Arch Pharm Pract.* 2021;12(2):99-102. https://doi.org/10.51847/1TWl2LWtPn.
6. Kamal AN, Hassan AF. Comparative study of liver function and Rh blood group between physiological and pathological neonatal jaundice. *Iraqi J Pharm Sci.* 2021 Jun 15;30(1):101-9. https://doi.org/10.31351/vol30iss1pp101-109.
7. Liu Y, Sun X, Wang Y, Xing C, Li L, Zhou S. Evaluation of associated markers of neonatal pathological jaundice due to bacterial infection. *Iran J Public Health.* 2021 Feb;50(2):333-40. https://doi.org/10.18502/ijph.v50i2.5394
8. Alkén J, Håkansson S, Ekéus C, Gustafson P, Norman M. Rates of Extreme Neonatal Hyperbilirubinemia and Kernicterus in Children and Adherence to National Guidelines for Screening, Diagnosis, and Treatment in Sweden. *JAMA Netw Open.* 2019;2(3):e190858. https://doi.org/10.1001/jamanetworkopen.2019.0858
9. Bashir BA, Othman SA. Neonatal polycythaemia. *Sudan J Paediatr.* 2019;19(2):81-83. https://doi.org/10.24911/SJP.106-1566075225.
10. Barros TM, Gavilanes ER, Barros JM. Polycythemia in the newborn: Prevalence and associated factors. *Rev Cubana Pediatr.* 2021;1:1-6. https://doi.org/10.52011/0090
11. Mostefa AM. A Study of Prevalence and Risk Factors of Polycythemia in Neonatal Nursery in Duhok. *Methodology.* 2015.
12. Chaudhari AR, Phalak AM, Chauhan PG, Goriya AN, Prajapati BS. Neonatal polycythemia: incidence and associated factors. *International Journal of Contemporary Pediatrics.* 2023 Feb;10(2):168–73. https://doi.org/10.18203/2349-3291.ijcp20230115
13. Al-Zahiri J, Kumar A, Nair A, Watts T. Prevalence of neonatal polycythemia and an assessment of its related risk factors. *J Pediatr Rev.* 2022;10(4):297-304. https://doi.org/10.32598/jpr.10.4.1053.1.
14. Barros TM, Gavilanes ER, Barros JM. Polycythemia in the newborn: Prevalence and associated factors. *Rev Cubana Pediatr.* 2021;1:1-6. https://doi.org/10.52011/0090
15. Asefa GG, Gebrewahid TG, Nuguse H, Gebremichael MW, Birhane M, Zereabruk K, et al. Determinants of neonatal jaundice among neonates admitted to neonatal intensive care unit in public general hospitals of Central Zone, Tigray, Northern Ethiopia, 2019: a case-control study. *Biomed Res Int.* 2020;2020:4743974. https://doi.org/10.1155/2020/4743974.
16. Bizuneh AD, Alemnew B, Getie A, Wondmieneh A, Gedefaw G. Determinants of neonatal jaundice among neonates admitted to five referral hospitals in Amhara region, Northern Ethiopia: an unmatched case-control study. *BMJ Paediatr Open.* 2020;4(1). https://doi.org/10.1136/bmjpo-2020-000830
17. Tavakolizadeh R, Izadi A, Seirafi G, Khedmat L, Mojtahedi SY. Maternal risk factors for neonatal jaundice: a hospital-based cross-sectional study in Tehran. *Eur J Transl Myol.* 2018 Jul 10;28(3):7618. https://doi.org/10.4081/ejtm.2018.7618.
18. Awang H, Ja'afar SM, Ishak NA, Dollah Z. Determinants of neonatal jaundice among newborns in Pasir Puteh district, Kelantan. *International Journal of Public Health and Clinical Sciences.* 2020 Jan 3;6(6):109-22.
19. Kassa RT, Gudeta H, Assen ZM. Neonatal hyperbilirubinemia: magnitude and associated etiologic factors among neonates admitted at Tikur Anbessa Specialized Hospital, Ethiopia. *J Pregnancy Child Health.* 2018;5:1000384. https://doi.org/10.4172/2376-127X.1000384.
20. Devi DS, Vijaykumar B. Risk factors for neonatal hyperbilirubinemia: a case-control study. *Int J Reprod Contracept Obstet Gynecol.* 2017;6:198-202. https://doi.org/10.18203/2320-1770.ijrcog20164657.
21. Kolawole SE, Obueh HO, Okandeji Barry OR. Prevalence of neonatal jaundice in Eku Baptist community hospital in Delta State, Nigeria. *J Public Health Epidemiol.* 2016;8:87-90. https://doi.org/10.5897/JPHE2015.0779.

22. Omekwe DE, Duke GM, Kennis BT. Survey and management outcome of neonatal jaundice from a developing tertiary health centre, Southern Nigeria. *IOSR J Dent Med Sci.* 2014;13:35-9. https://doi.org/10.9790/0853-13413539.
23. Rai S, Sood M, Kaur A. Is perinatal asphyxia associated with an increase in serum bilirubin in neonates? A case-control study. *J Family Med Prim Care.* 2022 Jul 1;11(7):3840-3. https://doi.org/10.4103/jfmpc.jfmpc_1018_21
24. Liawat FH, Andriyanti A, Utomo B. The association between asphyxia and neonatal pathological jaundice incidence in Umbu Rara Meha Hospital, East Sumba Regency. *Blantika Multidiscip J.* 2024 Jun 25;2(8). https://doi.org/10.57096/blantika.v2i8.188.
25. Imoudu IA, Yusuf MO, Aro AT, Akpabio PE, Waziri ZM. Severe perinatal asphyxia and risk of neonatal jaundice at a tertiary hospital in Northern Nigeria. *Asian J Pediatr Res.* 2021 Mar 23;5(3):17-22. https://doi.org/10.9734/ajpr/2021/v5i330176.
26. Boskabadi H, Sezavar M, Zakerihamidi M. Evaluation of neonatal jaundice based on the severity of hyperbilirubinemia. *J Clin Neonatol.* 2020 Jan-Mar;9(1):46-51. https://doi.org/10.4103/jcn.JCN_81_19
27. 2Zeleke BA, Ersado TL, Hanjelo HW, Zeleke GA. Determinants of neonatal jaundice among neonates admitted to neonatal intensive care unit in hospitals of Gurage zone, Southern Ethiopia. *BMC pediatrics.* 2025 May 28;25(1):427. https://doi.org/10.1186/s12887-025-05772-9
28. Selvam S, Taksande A. Risk factors of hyperbilirubinemia—a case-control study in a tertiary level hospital in rural central India. *Journal of Evolution of Medical and Dental Sciences.* 2021;10(25):1904–9. https://doi.org/10.14260/jemds/2021/395
29. Asaye S, Bekele M, Getachew A, Fufa D, Adugna T, Tadese E. Hyperbilirubinemia and associated factors among neonates admitted to neonatal care unit in Jimma Medical Center. https://doi.org/10.21203/rs.3.rs-1805402/v1
30. Warsame HA, Theuri C, Abdullahi NM, Keynan AM, Ahmed MA. Prevalence and risk factors for neonatal jaundice: a multicentre analytical cross-sectional study at neonatal intensive care units, Mogadishu, Somalia. *BMJ open.* 2025 Mar 1;15(3). https://doi.org/10.1136/bmjopen-2024-096692
31. Sisay BD, Abebe RF, Kassie AA, Wondimu MG, Kassie GA. Determinants of neonatal jaundice among neonates admitted to neonatal intensive care unit in public hospitals of Sidama Region, Sidama, Ethiopia, 2022: an unmatched case-control study. *Pan African Medical Journal.* 2023;45(1):33. https://doi.org/10.11604/pamj.2023.45.33.39373
32. Abiti H, Dedefo A, Lemma L. Prevalence and associated factors of hyperbilirubinemia among neonates admitted to neonatal intensive care unit of Saint Peter Specialized Hospital, Addis Ababa, Ethiopia. *Science.* 2023;11(3):56-63. https://doi.org/10.11648/j.sjph.20231103.12
33. Adugna A, Ado D. Determinants of jaundice among neonates admitted to neonatal intensive care unit of Mizan Tepi University Teaching Hospital, Southwest Ethiopia, 2021: unmatched case control study. *Global Pediatric Health*. 2023 Dec;10: https://doi.org/10.1177/2333794X231218193
34. Dahat A, Turkhede J, Korde S. Etiological profile of neonatal hyperbilirubinemia in neonates in nicu at tertiary care centre in india–a cross-sectional study. *Int j acad med pharm.* 2025;7(3):540-4. https://doi.org/10.47009/jamp.2025.7.3.101