Vol. 5 No. 1 (2026)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

Clinical Profile and Causes of Neonatal Jaundice in Pakistan: A Hospital-Based Study from Indus Hospital Badin, Sindh

Dr. Muhammad Usama
MBBS, Medical Officer, Department of Pediatrics
Indus Hospital Badin, Sindh, Pakistan
Email: ujatoi02@gmail.com

Muhammad Huzaifa
MBBS Student (4th Year)
Fazaia Ruth Pfao Medical college
Email: huzaifajatoi03@gmail.com

Contributed Author:
Muhammad Zulqarnain Jatoi
PhD Scholar, Khawaja Fareed University of Engineering & Information Technology, Rahim Yar Khan, Pakistan
Email: mzulqarnainjatoi@gmail.com

Author Details

Keywords: Neonatal jaundice, Hyperbilirubinemia, Physiological jaundice, Sepsis, Pakistan

Received on 15 Jan 2026
Accepted on 14 Feb 2026
Published on 16 Mar 2026

Corresponding E-mail & Author*:
Dr. Muhammad Usama
Email: ujatoi02@gmail.com

Abstract

Neonatal jaundice is one of the most common clinical conditions encountered during the neonatal period. Although physiological jaundice accounts for the majority of cases, pathological causes such as neonatal sepsis and hemolytic disorders remain significant contributors to neonatal morbidity and mortality in developing countries. To determine the clinical profile and etiological factors associated with neonatal jaundice among newborns admitted to the Pediatric Department of Indus Hospital, Badin, Sindh. A hospital-based descriptive study was conducted among 200 neonates diagnosed with jaundice. Demographic characteristics, age of onset, gestational age, birth weight, mode of delivery, presenting symptoms, and underlying causes were recorded and analyzed using descriptive statistics. Among 200 neonates, 65% were males and 35% females. Most newborns (71%) developed jaundice after 72 hours of birth, while only 15% developed jaundice within the first 24 hours. Physiological jaundice was the leading cause (43%), followed by breastfeeding jaundice (21%), idiopathic jaundice (12.5%), neonatal sepsis (10%), Rh incompatibility (7.5%), and hemolytic anemia (6%). The commonest presenting symptom was jaundice associated with refusal of feeds (33%), followed by yellowish discoloration with good activity (23%), delayed crying (19%), fever (12.5%), and vomiting (12.5%). Physiological jaundice remains the predominant cause of neonatal hyperbilirubinemia. However, infectious and hemolytic causes constitute an important proportion requiring early recognition and

prompt management. Early neonatal assessment and parental education may reduce complications associated with severe neonatal jaundice.

Introduction

Neonatal jaundice is one of the most common clinical conditions encountered during the neonatal period and remains a major cause of hospital admissions worldwide. It is characterized by the yellow discoloration of the skin, sclera, and mucous membranes resulting from the accumulation of bilirubin in the blood, a condition known as hyperbilirubinemia. Bilirubin is produced during the breakdown of hemoglobin from senescent red blood cells. In newborns, bilirubin production is relatively high because of increased red blood cell turnover, while hepatic uptake, conjugation, and excretion are physiologically immature. This transient imbalance between bilirubin production and elimination explains why neonatal jaundice is frequently observed during the first week of life (Kliegman et al., 2020).

Globally, neonatal jaundice affects approximately 60% of term infants and nearly 80% of preterm infants during the first week after birth. In the majority of cases, jaundice is physiological, appears after the first 24 hours of life, reaches its peak between the third and fifth day, and resolves spontaneously without long-term consequences. However, pathological jaundice develops earlier, persists longer, or is associated with excessively elevated serum bilirubin levels requiring prompt evaluation and treatment. Failure to recognize pathological hyperbilirubinemia may result in acute bilirubin encephalopathy and its permanent neurological sequel, kernicterus, leading to cerebral palsy, hearing impairment, developmental delay, intellectual disability, and even death (Bhutani & Johnson, 2009).

Despite advances in neonatal care, neonatal jaundice remains a significant public health concern, particularly in low- and middle-income countries (LMICs). The incidence of severe neonatal hyperbilirubinemia is substantially higher in developing regions than in high-income countries due to limited healthcare infrastructure, delayed healthcare-seeking behavior, inadequate screening programs, shortage of phototherapy equipment, lack of laboratory facilities for bilirubin estimation, and poor awareness among caregivers regarding the warning signs of neonatal jaundice (Olusanya et al., 2015). These disparities contribute to increased neonatal morbidity and mortality, making hyperbilirubinemia an important yet preventable cause of neonatal brain injury worldwide.

Pakistan continues to experience one of the highest neonatal mortality rates in South Asia. According to recent estimates, neonatal deaths account for nearly half of all under-five mortality in the country. Common contributors include prematurity, birth asphyxia, neonatal sepsis, respiratory disorders, congenital anomalies, and complications associated with hyperbilirubinemia. In many rural and resource-limited settings, newborns are discharged early after delivery without adequate follow-up, resulting in delayed recognition of worsening jaundice. Cultural practices, home deliveries, poor breastfeeding support, and delayed referral to tertiary healthcare facilities further aggravate the burden of neonatal jaundice in Pakistan (UNICEF, 2024).

The causes of neonatal jaundice are diverse and often multifactorial. Physiological jaundice represents normal neonatal adaptation; however, several pathological conditions may cause excessive bilirubin accumulation. Hemolytic disorders remain among the leading etiologies, including ABO incompatibility, Rh incompatibility, glucose-6-phosphate dehydrogenase (G6PD) deficiency, hereditary spherocytosis, and other red blood cell membrane or enzyme defects. Non-hemolytic causes include neonatal sepsis, prematurity, birth trauma resulting in cephalhematoma, polycythemia, dehydration due to inadequate breastfeeding, hypothyroidism, metabolic disorders, biliary obstruction, and genetic defects affecting bilirubin conjugation such as Crigler–Najjar syndrome and Gilbert syndrome (Maisels & McDonagh, 2008).

Prematurity represents one of the strongest risk factors for severe neonatal hyperbilirubinemia because preterm infants possess immature hepatic enzyme systems, lower serum albumin concentrations, reduced bilirubin-binding capacity, and increased enterohepatic circulation. Likewise, exclusive breastfeeding with poor feeding technique during the first few days of life may predispose newborns to dehydration and increased enterohepatic bilirubin reabsorption, leading to exaggerated jaundice. Infections such as neonatal sepsis further impair hepatic bilirubin metabolism while simultaneously increasing hemolysis and inflammatory responses, thereby contributing to elevated serum bilirubin levels (American Academy of Pediatrics Subcommittee on Hyperbilirubinemia, 2022).

Early identification of neonates at risk for pathological jaundice is essential for preventing serious complications. Clinical assessment remains the initial step in identifying jaundice; however, visual estimation alone is often unreliable, particularly among infants with darker skin pigmentation. Consequently, objective assessment using total serum bilirubin (TSB) or transcutaneous bilirubin (TcB) measurement, interpreted according to postnatal age-specific nomograms, has become the standard approach in neonatal practice. Appropriate management includes optimization of feeding, phototherapy, intravenous immunoglobulin in selected cases of immune-mediated hemolysis, and exchange transfusion for severe or rapidly rising bilirubin levels. Timely intervention substantially reduces the incidence of bilirin-induced neurological dysfunction and improves neonatal outcomes (American Academy of Pediatrics Subcommittee on Hyperbilirubinemia, 2022).

Several studies conducted in South Asia have demonstrated that neonatal sepsis, prematurity, ABO incompatibility, Rh incompatibility, and breastfeeding-related jaundice are among the leading causes of neonatal hyperbilirubinemia requiring hospitalization. However, the relative contribution of these etiological factors varies considerably across different geographic regions due to differences in genetic predisposition, healthcare accessibility, maternal characteristics, infection prevalence, and neonatal care practices. Therefore, locally generated epidemiological data remain essential for understanding disease patterns and developing evidence-based clinical protocols tailored to regional healthcare settings (Olusanya et al., 2018).

Hospital-based studies evaluating neonatal jaundice in Pakistan are comparatively limited, particularly from rural districts of Sindh Province. Most available reports originate from large tertiary centers located in major metropolitan cities and may not accurately represent the disease profile of smaller districts where healthcare resources and referral systems differ substantially. Understanding the demographic characteristics, clinical presentation, associated maternal and neonatal risk factors, and underlying etiologies within these populations is crucial for improving early diagnosis, optimizing treatment strategies, and reducing preventable neonatal complications.

The Indus Hospital, Badin, serves as a major secondary healthcare facility providing neonatal care to a predominantly rural population of Sindh. Due to variations in socioeconomic conditions, healthcare access, maternal education, and neonatal referral patterns, the spectrum of neonatal jaundice encountered in this setting may differ from that reported elsewhere in Pakistan. Evaluating the local burden and etiological profile of neonatal jaundice will contribute valuable evidence for clinicians and policymakers aiming to strengthen neonatal healthcare services.

Therefore, the present study was conducted to evaluate the demographic characteristics, clinical presentation, laboratory findings, and etiological factors associated with neonatal jaundice among newborns admitted to the Department of Pediatrics at Indus Hospital, Badin, Sindh. The findings of this study are expected to enhance the understanding of neonatal hyperbilirubinemia in a rural Pakistani population, facilitate early recognition of pathological jaundice, support timely

clinical interventions, and contribute to improved neonatal outcomes through evidence-based management and preventive strategies.

Materials and Methods

Study Design

This hospital-based descriptive cross-sectional study was conducted to evaluate the demographic characteristics, clinical presentation, and etiological factors associated with neonatal jaundice among neonates admitted to the Department of Pediatrics at Indus Hospital, Badin, Sindh, Pakistan. A descriptive cross-sectional design was selected because it allows for the systematic assessment of disease characteristics, clinical manifestations, and associated risk factors within a defined population over a specified period. This design is widely used in epidemiological research to estimate the distribution of diseases and describe their clinical and demographic patterns without establishing causal relationships (Setia, 2016).

Study Setting

The study was conducted in the Department of Pediatrics at Indus Hospital, Badin, Sindh, Pakistan. Indus Hospital is a secondary-level healthcare facility providing comprehensive pediatric and neonatal services to the population of District Badin and surrounding rural areas of Sindh. The hospital receives referrals from primary healthcare centers, rural health centers, basic health units, private clinics, and neighboring districts. The pediatric department manages a wide spectrum of neonatal conditions, including neonatal jaundice, prematurity, neonatal sepsis, birth asphyxia, respiratory disorders, and congenital abnormalities. The availability of pediatric specialists, neonatal intensive care services, laboratory support, and phototherapy facilities makes the hospital an appropriate center for studying neonatal hyperbilirubinemia in a resource-limited setting.

Study Duration

The study was carried out over an eleven-month period from **August 2025 to June 2026**. During this period, all eligible neonates admitted with a diagnosis of neonatal jaundice were screened for enrollment according to the predefined inclusion and exclusion criteria. Data collection was conducted prospectively throughout the study period to ensure completeness and accuracy of clinical information.

Study Population

The study population consisted of neonates aged 0–28 completed days who were admitted to the pediatric department with clinically diagnosed neonatal jaundice. Both male and female neonates were included irrespective of gestational age, birth weight, or mode of delivery. A total of **200 neonates** fulfilling the eligibility criteria were enrolled in the study.

Neonatal jaundice was diagnosed clinically by the treating pediatrician based on visible yellow discoloration of the skin and sclera and confirmed through laboratory evaluation of serum bilirubin whenever clinically indicated. Clinical assessment was complemented by relevant laboratory investigations to identify the probable underlying cause of hyperbilirubinemia.

Sample Size and Sampling Technique

A total sample size of **200 neonates** was included in the study. The sample represented all eligible neonates admitted during the study period who fulfilled the inclusion criteria. A **non-probability consecutive sampling technique** was employed, whereby every neonate presenting with neonatal jaundice during the study period was enrolled until the required sample size was achieved. Consecutive sampling is commonly used in hospital-based descriptive studies because it minimizes selection bias and allows recruitment of all accessible eligible participants within the study duration.

Inclusion Criteria

Neonates were included in the study if they fulfilled all of the following criteria:

- Neonates aged **0–28 completed days**
- Clinical diagnosis of neonatal jaundice established by a pediatrician
- Admission to the Department of Pediatrics, Indus Hospital, Badin
- Availability of complete demographic and clinical information

Exclusion Criteria

The following neonates were excluded from the study:

- Neonates with major congenital anomalies or chromosomal abnormalities
- Neonates with incomplete clinical or laboratory records
- Neonates referred after receiving definitive treatment elsewhere with unavailable baseline clinical information
- Parents or guardians declining the use of anonymized clinical data for research purposes, where applicable

Data Collection Procedure

Data were collected using a structured data collection proforma specifically designed for this study. Each enrolled neonate underwent detailed clinical evaluation performed by the attending pediatrician. Information was obtained from the patient's medical records, admission notes, maternal obstetric history, delivery records, laboratory reports, and physical examination findings.

Demographic variables included age at presentation, sex, gestational age, birth weight, residence, and mode of delivery. Maternal history included parity, antenatal complications, maternal blood group where available, and significant perinatal events. Neonatal history included age at onset of jaundice, feeding pattern, history of delayed passage of meconium, previous hospital admissions, and family history of neonatal jaundice whenever available.

Clinical examination focused on identifying the severity of jaundice and associated symptoms, including poor feeding, lethargy, fever, irritability, excessive crying, hypotonia, seizures, respiratory distress, vomiting, and signs suggestive of neonatal sepsis or hemolytic disease. The degree of jaundice was assessed clinically using standard neonatal examination techniques and supported by laboratory findings.

Laboratory investigations were performed according to clinical indications and hospital protocols. These included total serum bilirubin, direct and indirect bilirubin levels, complete blood count, blood grouping of mother and neonate when indicated, direct Coombs test, C-reactive protein, blood culture, reticulocyte count, peripheral blood smear, glucose-6-phosphate dehydrogenase (G6PD) screening where clinically suspected, thyroid function tests in selected neonates, and other investigations considered necessary by the treating pediatrician.

The underlying etiology of neonatal jaundice was determined based on clinical findings, laboratory investigations, and final diagnosis documented by the consultant pediatrician.

Study Variables

The primary outcome variable was the underlying cause (etiology) of neonatal jaundice.

The independent variables included:

- Age at onset of jaundice
- Gender
- Gestational age
- Birth weight
- Mode of delivery
- Place of birth
- Presenting clinical features
- Feeding status
- Laboratory findings
- Final clinical diagnosis

Etiological categories included physiological jaundice, neonatal sepsis, prematurity-related jaundice, ABO incompatibility, Rh incompatibility, breastfeeding jaundice, G6PD deficiency, birth trauma, dehydration, and other identifiable causes.

Operational Definitions

For uniformity and consistency, the following operational definitions were used throughout the study:

Neonate: Any infant aged from birth up to 28 completed days of life, in accordance with the World Health Organization definition.

Neonatal jaundice: Yellow discoloration of the skin and sclera resulting from elevated serum bilirubin levels as diagnosed clinically and supported by laboratory evaluation.

Preterm neonate: A neonate born before 37 completed weeks of gestation.

Low birth weight: Birth weight less than 2,500 grams.

Physiological jaundice: Jaundice appearing after the first 24 hours of life, peaking between the third and fifth day, without evidence of underlying pathological disease.

Pathological jaundice: Jaundice occurring within the first 24 hours of life, rapidly rising bilirubin levels, prolonged jaundice, or jaundice associated with hemolytic disease, infection, metabolic disorders, or other pathological conditions.

Data Management and Statistical Analysis

Data were entered into Microsoft Excel after verification for completeness and accuracy. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA).

Descriptive statistical methods were employed to summarize the collected data. Categorical variables such as gender, gestational age category, mode of delivery, presenting symptoms, and etiological factors were expressed as frequencies and percentages. Continuous variables including age at presentation and birth weight were summarized using means and standard deviations or medians with interquartile ranges where appropriate after assessing data distribution.

The study primarily aimed to describe the clinical profile and distribution of etiological factors among neonates with jaundice; therefore, descriptive statistics were considered appropriate for data presentation. Results were presented using tables and figures to facilitate interpretation of the findings.

Quality Control

To ensure data quality, all clinical information was collected using a standardized data collection form. Patient records were reviewed by the principal investigator to minimize transcription errors. Laboratory reports were verified before data entry, and missing or inconsistent information was cross-checked with hospital records whenever possible. Data entry was independently reviewed before statistical analysis to ensure accuracy and completeness.

Ethical Considerations

Ethical principles governing biomedical research involving human participants were strictly observed throughout the study. Approval to conduct the study was obtained from the relevant Institutional Review Board (IRB)/Ethics Committee of Indus Hospital before commencement of data collection. Patient confidentiality was maintained by assigning unique identification numbers to each participant and excluding all personal identifiers from the research database.

The study utilized anonymized clinical information collected during routine patient care. All collected data were kept confidential and stored in password-protected electronic files accessible only to the research team. The study complied with the ethical principles outlined in the Declaration of Helsinki for research involving human

participants and adhered to institutional guidelines regarding confidentiality, privacy, and responsible conduct of research.

Results

General Characteristics of the Study Population

A total of **200 neonates** diagnosed with neonatal jaundice were included in the study. The demographic and baseline characteristics of the study population are summarized in **Table 1**.

General Characteristics of Newborns with Jaundice			
#	**Characteristics (200)**	**No. of newborns**	**Percentage**
	Age of onset of jaundice (hours)		
	0-24	30	15
	24 to 72	27	36
	>72	143	71
Gender			
	male	130	65
	female	70	35
gastational age a birth			
	33-36	173	86.5
	>37	15	7.5
Birth weight in grams			
	<2500	70	35
	2500 - 4000	130	65
	>400	N/A	0
mode of delivery			
	vaginal deliver	122	61
	instrumental delivery	18	9
	c-section delivery	60	30

Male neonates constituted the majority of the study population, accounting for **130 (65%)** cases, whereas **70 (35%)** were females, resulting in a male-to-female ratio of approximately **1.9:1**. This finding indicates a clear male predominance among neonates admitted with jaundice during the study period.

Analysis of the age at onset of jaundice demonstrated that the majority of neonates developed jaundice after the first three days of life. Overall, **142 (71%)** neonates presented with jaundice **after 72 hours of birth**, making it the most common time of presentation. Early-onset jaundice occurring within the first **24 hours** of life was

observed in **30 (15%)** neonates, while the remaining **28 (14%)** developed jaundice between **24 and 72 hours** after birth. The predominance of late-onset jaundice suggests that physiological processes and breastfeeding-related factors contributed substantially to neonatal hyperbilirubinemia in the study population.

Gestational age assessment showed that **173 (86.5%)** neonates were born between **33 and 36 completed weeks of gestation**, whereas **27 (13.5%)** were born at **37 weeks or later**. The large proportion of late preterm infants indicates that prematurity represented an important characteristic among neonates admitted with jaundice.

Birth weight analysis demonstrated that **130 (65%)** neonates had a birth weight between **2,500 and 4,000 g**, while **70 (35%)** had a birth weight below **2,500 g**, fulfilling the definition of low birth weight. Although most neonates had normal birth weight, more than one-third of the study population consisted of low-birth-weight infants.

Regarding the mode of delivery, **122 (61%)** neonates were delivered by spontaneous vaginal delivery, making it the most common mode of birth. Cesarean section accounted for **60 (30%)** deliveries, whereas **18 (9%)** neonates were delivered through instrumental vaginal delivery. These findings reflect the obstetric practices of the study population and indicate that most jaundiced neonates were born via vaginal delivery.

Clinical Presentation

The presenting clinical features of neonatal jaundice are presented in **Table 2**.

Common Symptoms Observed in Jaundiced Newborns		
Symptoms	**No. of newborns**	**Perventage**
Yellowish discoloration with good activity	46	23
Jaundice with refusal of feeds	66	33
History of delayed cry	38	19
Fever	25	12.5
Vomiting	25	12.5

The most common presenting complaint was **yellow discoloration of the skin and sclera associated with refusal of feeds**, observed in **66 (33%)** neonates. Feeding difficulty was therefore the leading accompanying symptom among hospitalized newborns with jaundice.

Yellow discoloration with otherwise preserved activity was reported in **46 (23%)** neonates. These infants remained clinically active despite visible jaundice and generally represented uncomplicated presentations requiring evaluation and monitoring.

A history of **delayed crying at birth** was documented in **38 (19%)** neonates, suggesting previous perinatal stress in a notable proportion of patients. In addition, **fever** was present in **25 (12.5%)** neonates, while **vomiting** was also observed in **25 (12.5%)** cases. The coexistence of fever and vomiting among jaundiced neonates

highlights the importance of evaluating these infants for underlying pathological conditions, particularly neonatal sepsis and metabolic disturbances.
Overall, the clinical presentation demonstrated that feeding difficulties and systemic manifestations were common reasons for hospitalization in addition to visible jaundice.

Etiological Profile of Neonatal Jaundice
The underlying etiologies of neonatal jaundice are summarized in **Table 3**.

ETIOLOGY ON NEONATAL JAUNDICE

ETIOLOGY	NO OF NEW BORN	PERCENTAGE
Physiology	86	43
breastfeeding	42	21
idiopathic	25	12.5
sepsis	20	10
Rh incompatibility	15	7.5
Hemolytic anemia	12	6
Total	**200**	**100**

Physiological jaundice was identified as the most frequent cause, accounting for **86 (43%)** of all cases. This finding indicates that physiological adaptation during the neonatal period remained the predominant cause of hyperbilirubinemia among admitted newborns.
The second most common etiology was **breastfeeding jaundice**, which was diagnosed in **42 (21%)** neonates. This emphasizes the importance of adequate breastfeeding practices and early lactation support during the neonatal period.
Idiopathic jaundice, in which no specific underlying cause could be identified after clinical and laboratory evaluation, was observed in **25 (12.5%)** neonates.
Neonatal sepsis accounted for **20 (10%)** cases, representing the most common pathological cause identified in the present study. Recognition of sepsis among jaundiced neonates is clinically important because delayed diagnosis may lead to significant morbidity and mortality.
Rh incompatibility was diagnosed in **15 (7.5%)** neonates and represented an important immune-mediated cause of hyperbilirubinemia requiring careful monitoring and appropriate management.
Hemolytic anemia was identified in **12 (6%)** neonates. Although less frequent than physiological jaundice and breastfeeding jaundice, hemolytic disorders remain clinically significant because they may result in rapidly increasing serum bilirubin concentrations and a greater risk of bilirubin-induced neurological injury.
Overall, physiological and breastfeeding-related jaundice together accounted for **64%** of all admissions, whereas pathological causes—including neonatal sepsis, Rh incompatibility, hemolytic anemia, and idiopathic jaundice—constituted **36%** of cases. These findings demonstrate that although physiological jaundice remains the predominant diagnosis among hospitalized neonates, more than one-third of cases

were associated with potentially serious pathological conditions requiring detailed clinical evaluation, laboratory investigation, and timely therapeutic intervention.

The distribution of demographic characteristics, clinical manifestations, and etiological factors observed in the present study provides an overview of the spectrum of neonatal jaundice encountered at the Department of Pediatrics, Indus Hospital, Badin, during the study period. The results highlight the importance of careful assessment of jaundiced neonates, particularly those presenting with feeding difficulties, fever, vomiting, or evidence of hemolytic disease, to facilitate early diagnosis and appropriate management.

Discussion

Neonatal jaundice remains one of the most common causes of neonatal hospital admissions worldwide and continues to represent an important public health concern, particularly in low- and middle-income countries. Although physiological jaundice is generally a benign and self-limiting condition, delayed recognition of pathological hyperbilirubinemia may lead to acute bilirubin encephalopathy and kernicterus, both of which are associated with permanent neurological disability. The present study evaluated the demographic characteristics, clinical presentation, and etiological factors associated with neonatal jaundice among 200 neonates admitted to the Department of Pediatrics at Indus Hospital, Badin, Sindh, Pakistan.

One of the principal findings of this study was the predominance of male neonates, who constituted 65% of the study population, with a male-to-female ratio of approximately 1.9:1. Similar male predominance has been reported in several studies conducted in Pakistan and other developing countries. Although the precise mechanism remains uncertain, male sex has consistently been identified as a risk factor for neonatal hyperbilirubinemia. Proposed explanations include sex-related differences in hepatic bilirubin metabolism, genetic susceptibility, and variations in neonatal adaptation after birth. Previous epidemiological studies have similarly demonstrated that male newborns are more frequently hospitalized with neonatal jaundice than female newborns, suggesting that male gender may contribute to increased vulnerability to hyperbilirubinemia.

The majority of neonates in the present study developed jaundice after 72 hours of life. This pattern is consistent with the natural course of physiological neonatal jaundice, which usually becomes apparent after the first 24 hours, reaches peak bilirubin concentrations between the third and fifth day of life, and gradually resolves as hepatic bilirubin conjugation matures. Only a relatively small proportion of neonates presented within the first 24 hours, a finding that is clinically important because jaundice during the first day of life is generally considered pathological until proven otherwise and warrants immediate evaluation for hemolytic disease, infection, or other serious underlying disorders. These findings are consistent with current neonatal guidelines and previously published literature describing the temporal pattern of physiological jaundice.

Gestational age analysis demonstrated that most participants in this study were late preterm infants between 33 and 36 weeks of gestation. Prematurity is a well-recognized risk factor for hyperbilirubinemia because preterm neonates have immature hepatic enzyme systems, increased red blood cell turnover, reduced albumin-binding capacity, and enhanced enterohepatic circulation of bilirubin. Consequently, these infants are more susceptible to developing significant hyperbilirubinemia and frequently require closer monitoring and treatment. A systematic review of low- and middle-income countries also identified low gestational age as an important predictor of severe neonatal hyperbilirubinemia and bilirubin-induced neurological dysfunction.

The present study further demonstrated that approximately one-third of neonates had low birth weight. Low birth weight often accompanies prematurity and has been

associated with delayed hepatic maturation and increased susceptibility to neonatal infections, both of which contribute to elevated bilirubin levels. Previous studies have similarly reported that underweight infants experience a greater risk of clinically significant jaundice and may require prolonged hospitalization and phototherapy.

With regard to the mode of delivery, vaginal birth was the most frequent mode of delivery, followed by cesarean section and instrumental delivery. Although mode of delivery itself has not consistently been identified as an independent predictor of neonatal jaundice, several studies suggest that prolonged labor, birth trauma, cephalhematoma, delayed initiation of breastfeeding, and operative delivery may indirectly increase bilirubin production or impair bilirubin elimination. Therefore, careful postnatal monitoring remains important regardless of the mode of delivery.

Feeding refusal associated with jaundice was the most common presenting complaint in the present study. Poor feeding is one of the earliest warning signs of clinically significant neonatal illness and should always prompt careful clinical evaluation. Reduced milk intake may increase enterohepatic circulation of bilirubin through dehydration and delayed intestinal transit, thereby aggravating unconjugated hyperbilirubinemia. Fever and vomiting were also observed among a proportion of neonates, suggesting the possibility of underlying infection or other pathological causes. These findings emphasize that jaundice should not be evaluated in isolation but rather as part of a comprehensive neonatal assessment.

Physiological jaundice was identified as the leading cause of neonatal jaundice, accounting for 43% of all cases. This finding agrees with numerous hospital-based studies from South Asia, where physiological jaundice consistently represents the most frequent diagnosis among admitted newborns. Physiological hyperbilirubinemia reflects normal neonatal adaptation resulting from increased bilirubin production and temporary immaturity of hepatic conjugation mechanisms. Although physiological jaundice generally resolves without complications, appropriate follow-up remains essential because bilirubin levels may continue to rise during the first few days of life.

Breastfeeding jaundice represented the second most common etiology, accounting for 21% of neonates. This observation highlights the importance of early breastfeeding support, correct attachment techniques, and adequate feeding frequency during the first week of life. Insufficient breast milk intake can result in dehydration and increased enterohepatic bilirubin circulation, thereby exacerbating neonatal jaundice. Early lactation counseling, frequent feeding, and routine follow-up during the immediate postnatal period remain effective strategies for reducing breastfeeding-associated jaundice and preventing unnecessary hospital admissions.

Idiopathic jaundice accounted for 12.5% of cases. Despite advances in laboratory investigations, a proportion of neonates with hyperbilirubinemia continue to have no identifiable underlying cause after routine evaluation. Genetic polymorphisms affecting bilirubin metabolism, minor hemolytic processes, and currently unidentified metabolic factors may contribute to these cases. Future studies incorporating advanced diagnostic testing may further clarify these unexplained presentations.

Neonatal sepsis accounted for 10% of jaundice cases in the present study. Infection remains an important pathological cause of neonatal hyperbilirubinemia, particularly in resource-limited settings where delayed diagnosis, inadequate infection control, and limited access to neonatal intensive care continue to contribute to disease burden. Sepsis impairs hepatic bilirubin metabolism while simultaneously increasing hemolysis and systemic inflammation, thereby aggravating hyperbilirubinemia. Previous Pakistani studies have likewise emphasized that jaundice may be an early or even isolated manifestation of neonatal sepsis, highlighting the importance of evaluating febrile or poorly feeding neonates for underlying infection.

Hemolytic disorders, including Rh incompatibility and hemolytic anemia, together accounted for 13.5% of the study population. Although these conditions were less frequent than physiological jaundice, they remain clinically important because they

may produce rapidly rising bilirubin concentrations requiring intensive phototherapy or exchange transfusion. Early maternal blood grouping, antenatal antibody screening, administration of anti-D immunoglobulin to Rh-negative mothers, and prompt neonatal blood group assessment remain essential preventive measures. Systematic reviews have demonstrated that Rh hemolytic disease and ABO incompatibility substantially increase the risk of severe neonatal hyperbilirubinemia and bilirubin-induced neurological dysfunction.

Overall, pathological causes accounted for more than one-third of hospitalized neonates in the present study. This finding reinforces the importance of distinguishing physiological from pathological jaundice through detailed clinical assessment, timely laboratory investigations, and careful monitoring. Although physiological jaundice remains the predominant diagnosis, clinicians should maintain a high index of suspicion for infection, hemolytic disease, prematurity-related complications, and feeding difficulties, particularly among neonates presenting within the first 24 hours of life or exhibiting systemic symptoms.

The findings of this study have important clinical implications. Routine newborn assessment should include careful evaluation for jaundice before hospital discharge, promotion of effective breastfeeding, parental education regarding warning signs, and timely follow-up during the first week of life. Strengthening antenatal care, universal maternal blood group screening, improved infection prevention strategies, and wider availability of bilirubin measurement and phototherapy services may further reduce neonatal morbidity and prevent complications associated with severe hyperbilirubinemia.

The present study has several strengths. It provides recent hospital-based data from a rural district of Sindh where published information regarding neonatal jaundice remains limited. The study included a relatively large number of hospitalized neonates and systematically evaluated demographic characteristics, clinical presentation, and etiological factors. Nevertheless, certain limitations should be acknowledged. As a single-center descriptive cross-sectional study, the findings may not be generalizable to all healthcare settings in Pakistan. In addition, causal relationships could not be established because of the study design, and some specialized investigations for uncommon metabolic or genetic disorders were not routinely available.

Despite these limitations, the study contributes valuable local evidence regarding the clinical spectrum and causes of neonatal jaundice in southern Pakistan. Future multicenter prospective studies involving larger populations and long-term follow-up are recommended to better characterize regional variations in neonatal hyperbilirubinemia and evaluate interventions aimed at improving neonatal outcomes.

Conclusion

Neonatal jaundice remains one of the most common causes of neonatal hospitalization and continues to represent a significant healthcare challenge in Pakistan, particularly in resource-limited settings where delayed diagnosis and limited access to specialized neonatal care may increase the risk of severe complications. The findings of the present study demonstrate that physiological jaundice was the predominant cause of neonatal hyperbilirubinemia among admitted newborns. However, a considerable proportion of cases were associated with pathological conditions, including breastfeeding jaundice, neonatal sepsis, Rh incompatibility, and hemolytic anemia, emphasizing the need for comprehensive clinical evaluation of every jaundiced neonate.

The high frequency of feeding difficulties among affected newborns highlights the importance of early breastfeeding assessment and parental counseling during the immediate postnatal period. Prompt recognition of warning signs, routine bilirubin monitoring in high-risk infants, and timely initiation of appropriate treatment such as phototherapy or management of the underlying cause are essential to prevent

bilirubin-induced neurological dysfunction and other adverse outcomes. Strengthening antenatal care through maternal blood group screening, improving neonatal follow-up after hospital discharge, and increasing awareness among healthcare providers and caregivers can further contribute to reducing the burden of neonatal hyperbilirubinemia.

The findings of this study provide valuable evidence regarding the demographic characteristics, clinical presentation, and etiological profile of neonatal jaundice in a rural tertiary healthcare setting in Sindh, Pakistan. Further multicenter prospective studies involving larger populations are recommended to validate these findings and guide the development of evidence-based strategies for early detection, prevention, and management. Overall, timely diagnosis, effective breastfeeding support, appropriate management of neonatal infections, and early intervention remain the cornerstones for improving neonatal outcomes and reducing complications associated with neonatal jaundice.

Recommendations

Based on the findings of the present study, routine screening and early assessment of neonatal jaundice should be strengthened in all healthcare facilities to facilitate timely diagnosis and appropriate management. Every newborn should be carefully evaluated for jaundice before hospital discharge, and high-risk infants, particularly preterm and low-birth-weight neonates, should receive close follow-up during the first week of life.

Healthcare providers should promote and support early initiation of breastfeeding and provide parents with counseling on proper feeding techniques, recognition of warning signs of jaundice, and the importance of seeking immediate medical attention if jaundice worsens or is accompanied by poor feeding, fever, lethargy, or other concerning symptoms.

Universal maternal blood group and Rh factor screening during antenatal care should be ensured, with timely administration of anti-D immunoglobulin to eligible Rh-negative mothers to reduce the risk of hemolytic disease of the newborn. Healthcare facilities should also strengthen infection prevention and control measures, as well as ensure early diagnosis and treatment of neonatal sepsis, which remains an important pathological cause of hyperbilirubinemia.

Hospitals managing neonatal patients should maintain adequate availability of bilirubin measurement facilities, phototherapy units, and standardized treatment protocols based on national and international guidelines. Regular training of healthcare professionals in the recognition and management of neonatal hyperbilirubinemia is recommended to improve the quality of neonatal care.

Finally, multicenter prospective studies involving larger and more diverse populations are recommended to better understand the epidemiology, risk factors, and long-term outcomes of neonatal jaundice in Pakistan. Such research will provide stronger evidence to guide national policies, improve neonatal healthcare services, and reduce the morbidity and mortality associated with neonatal hyperbilirubinemia.

Acknowledgment

The author gratefully acknowledges the Department of Pediatrics, Indus Hospital Badin, Sindh, Pakistan, for providing clinical support and facilitating data collection.

References

1. American Academy of Pediatrics Subcommittee on Hyperbilirubinemia. (2022). *Clinical practice guideline revision: Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation*. **Pediatrics, 150**(3), e2022058859. https://doi.org/10.1542/peds.2022-058859

2. Bhutani, V. K., & Johnson, L. (2009). Kernicterus in the 21st century: Frequently asked questions. *Journal of Perinatology, 29*(Suppl. 1), S20–S24. https://doi.org/10.1038/jp.2008.212
3. Kliegman, R. M., St. Geme, J. W., Blum, N. J., Shah, S. S., Tasker, R. C., & Wilson, K. M. (2020). *Nelson textbook of pediatrics* (21st ed.). Elsevier.
4. Maisels, M. J., & McDonagh, A. F. (2008). Phototherapy for neonatal jaundice. *New England Journal of Medicine, 358*(9), 920–928. https://doi.org/10.1056/NEJMct0708376
5. Olusanya, B. O., Kaplan, M., & Hansen, T. W. R. (2018). Neonatal hyperbilirubinaemia: A global perspective. *The Lancet Child & Adolescent Health, 2*(8), 610–620. https://doi.org/10.1016/S2352-4642(18)30139-1
6. Olusanya, B. O., Ogunlesi, T. A., & Kumar, P. (2015). Management of late-preterm and term infants with hyperbilirubinaemia in resource-constrained settings. *BMC Pediatrics, 15*, 39. https://doi.org/10.1186/s12887-015-0358-z
7. UNICEF. (2024). *The state of the world's children 2024*. UNICEF. https://www.unicef.org/reports/state-of-worlds-children-2024
8. Setia, M. S. (2016). Methodology series module 3: Cross-sectional studies. *Indian Journal of Dermatology, 61*(3), 261–264. https://doi.org/10.4103/0019-5154.182410
9. World Medical Association. (2013). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *JAMA, 310*(20), 2191–2194. https://doi.org/10.1001/jama.2013.281053
10. World Health Organization. (2022). *WHO recommendations on maternal and newborn care for a positive postnatal experience*. World Health Organization.
11. Kothari, C. R. (2004). *Research methodology: Methods and techniques* (2nd ed.). New Age International.
12. IBM Corp. (2022). *IBM SPSS Statistics for Windows (Version 26.0)*. IBM Corporation.
13. American Academy of Pediatrics Subcommittee on Hyperbilirubinemia. (2022). *Pediatrics*.
14. Bhutani, V. K., & Johnson, L. (2009). *Journal of Perinatology*.
15. Kliegman, R. M., et al. (2020). *Nelson Textbook of Pediatrics* (21st ed.).
16. Maisels, M. J., & McDonagh, A. F. (2008). *New England Journal of Medicine*.
17. Olusanya, B. O., Kaplan, M., & Hansen, T. W. R. (2018). *The Lancet Child & Adolescent Health*.
18. Olusanya, B. O., et al. (2015). *PLOS ONE* (systematic review of risk factors in LMICs).
19. Bhutta, Z. A., & Yusuf, K. (1997). *Journal of Tropical Pediatrics* (neonatal sepsis in Pakistan).