Risk Factors Associated with Hyperbilirubinemia in Newborns at Muhammadiyah Hospital Palembang

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Abstract

Neonatal jaundice remains a significant global health challenge, contributing to substantial neonatal morbidity and potential long-term neurological complications if not managed effectively. This study investigated the risk factors associated with hyperbilirubinemia at Muhammadiyah Hospital Palembang. Utilizing an analytical survey with a case-control approach, we compared 30 neonates diagnosed with hyperbilirubinemia (cases) against 30 neonates without the condition (controls). Participants were selected through purposive sampling between October and December 2024. Data were analyzed using chi-square tests and multivariate logistic regression to determine the strength of associations. The analysis revealed that gestational age (OR = 4.2; 95% CI: 1.8–9.5; p < 0.001), type of delivery (OR = 3.8; 95% CI: 1.5–8.2; p < 0.001), male gender (OR = 2.5; 95% CI: 1.1–5.4; p = 0.001), and low birth weight (OR = 5.1; 95% CI: 2.1–11.3; p < 0.001) were significant independent risk factors for hyperbilirubinemia. These findings underscore the necessity for midwives to implement comprehensive early screening and specialized management for high-risk neonates to mitigate the incidence of severe jaundice. Preterm birth and low birth weight are the most critical predictors of neonatal hyperbilirubinemia in this clinical setting, necessitating targeted postnatal surveillance.

Keywords: Neonatal Jaundice, Risk Factors, Case-Control Study, Midwifery Care, Low Birth Weight.

INTRODUCTION

The Infant Mortality Rate (IMR) remains a critical barometer of global public health, with neonatal conditions accounting for nearly 47% of all under-five deaths. Among these, neonatal hyperbilirubinemia is a significant contributor to neonatal morbidity and mortality worldwide, affecting approximately 60% of full-term and 80% of preterm neonates in their first week of life (World Health Organization, 2024). Globally, an estimated 1.1 million infants develop severe hyperbilirubinemia annually, with nearly 75% of these deaths occurring in low- and middle-income countries (LMICs) due to delayed diagnosis and limited access to phototherapy (Munir et al., 2023). In the Indonesian context, the prevalence of neonatal jaundice remains high, reaching 5.6% to 6.5% of live births, positioning it as one of the top five causes of neonatal morbidity in the country (Kementrian Kesehatan Republik Indonesia, 2024), with similar pressing trends observed across South Sumatra (Muharomah & Setiawan, 2022).

Recent international literature emphasizes that specific neonatal and maternal characteristics are highly predictive of worsening hyperbilirubinemia. It highlights that in developing regions, the delay in identifying low birth weight (LBW) and late-preterm infants significantly exacerbates the risk of severe neurological sequelae due to unmonitored bilirubin levels. Furthermore, a comprehensive study by Wijaya, A.B (2025), demonstrates that the modality of delivery, particularly the rising rates of cesarean sections, altered feeding initiation patterns, which directly correlated with higher peaks of serum bilirubin in the first 72 hours of life.

Complementing these findings, a global cohort study by Changqing Tang and Lijun Xia (2026) underscores that gestational age remains a critical biological variable, where shorter gestational ages are closely linked to hepatic immaturity. Jayanti S, Ghersi-Egea JF, Strazielle N, and Tiribelli C, (2021) explain that the activity of the enzyme uridine diphosphate glucuronosyltransferase (UGT1A1) in preterm infants is only a fraction of that found in mature full-term infants, severely limiting bilirubin conjugation. To mitigate these risks, Faiza Khurshid, Suman PN Rao, and Caroline Sauve (2022) advocate for the strict implementation of universal predischarge bilirubin screening tailored to resource-constrained settings, proving that early risk-factor stratification can reduce extreme hyperbilirubinemia by over 30%.

Blended with gestational maturity and delivery modes, infant demographic factors such as birth weight and gender significantly multiply neonatal susceptibility. As investigated by Katherine M. Satrom, Eric F. Lock, and Troy C. Lund (2025), LBW infants often have low serum albumin levels, resulting in a higher concentration of dangerous “free” unconjugated bilirubin in circulation that poses a severe threat of neurotoxicity. Additionally, clinical epidemiological trends consistently demonstrate a higher predisposition of male neonates to severe jaundice, a biological susceptibility often linked to a higher incidence of glucose-6-phosphate dehydrogenase (G6PD) deficiencies and slower bilirubin clearance rates in male infants during the immediate postnatal period.

The effective clinical management of these interconnected risk factors requires a robust screening protocol within healthcare facilities. (Okwundu, 2019) emphasizes that a standardized strategy combining transcutaneous bilirubinometry (TcB) with risk-factor assessment is much more effective than relying on visual assessment alone, which is notoriously inaccurate. In the context of frontline midwifery care, Listyaning, E. M. and Rizky Amelia (2026) point out that midwives who are well-trained in evidence-based risk identification can successfully implement preventative strategies, such as aggressive breastfeeding counseling and structured follow-up schedules, to significantly reduce the time window before initiating phototherapy.

To establish precise epidemiological evidence in this urban population, this study investigated the clinical risk factors associated with hyperbilirubinemia at Muhammadiyah Hospital Palembang using an analytical survey with a rigorous case-control approach. Conducted between October and December 2024, utilizing purposive sampling, this study compared 30 neonates diagnosed with hyperbilirubinemia (cases) against 30 neonates without the condition (controls).

The collected data were evaluated using chi-square tests and multivariate logistic regression to determine the exact strength and independence of associations, thereby addressing a critical post-2020 regional data scarcity regarding the interplay between clinical management and exact neonatal outcomes.

METHODS

Study Design and Population

This study utilized a quantitative analytical survey with a case-control design to identify the clinical determinants of neonatal hyperbilirubinemia. The case-control approach is highly effective for retrospectively evaluating the odds of exposure to specific risk factors among groups with and without the clinical condition (Sastroasmoro, 2018). The macro-population for this study was drawn from the hospital's institutional database of neonates born at Muhammadiyah Hospital Palembang between 2019 and 2024 (N = 20,225). However, to ensure recent clinical relevance and precise data control, the target accessible population and subsequent sample recruitment were strictly bound to neonates admitted and treated between October and December 2024.

Sample Selection and Power Analysis

A total of 60 neonates were selected for this study, consisting of 30 cases (infants clinically diagnosed with hyperbilirubinemia) and 30 controls (infants without hyperbilirubinemia). The sample size was validated using the Lemeshow formula for case-control studies, ensuring a statistical power of 80% and a 95% confidence level to detect a minimum Odds Ratio (OR) of 3.0 (Gunjan, 2021).

Participants were selected via purposive sampling based on strict clinical criteria. The inclusion criteria for both groups required neonates with complete medical records and a gestational age documented at birth. To avoid confounding extreme structural anomalies, neonates with birth weights $\leq$ 1000g (extremely low birth weight) or major congenital malformations were excluded. To minimize the selection bias inherent in non-probability sampling, controls were selected from the same birth period as the cases (density sampling) to

ensure comparable environmental, clinical, and institutional settings, which aligns with standard methodological controls in observational designs (Nurul Agustin, Rina Nurdiana, 2025).

Operational Definitions

To ensure scientific precision and alignment with national standards and the study's analytical objectives, variables were operationally defined and categorized as follows:

1. Neonatal Hyperbilirubinemia (Outcome Variable): Confirmed clinical diagnosis based on a total serum bilirubin (TSB) level >15 mg/dL in full-term infants or >10 mg/dL in preterm infants within the first 48–72 hours of life, requiring clinical intervention, which follows the national clinical practice guidelines for neonatal jaundice management (Pande Made Arie Santika Putri Raweg, Ni Wayan Desi Bintari, 2025).
2. Gestational Age: Categorized as "Preterm" (< 37 weeks) and "Term" (≥ 37 weeks) based on maternal obstetric logs (Aryani, 2025).
3. Type of Delivery: Classified into "Spontaneous/Vaginal" and "Cesarean Section" (including both elective and emergency procedures) (Indri Yayi Prasetyani, Laurensia Yunita, 2024).
4. Gender: Categorized as "Male" or "Female" based on biological sex documented at birth (Handayani & Yudianto, 2024).
5. Low Birth Weight (LBW): Categorized as "LBW" (birth weight 1001g to <2500g) and "Normal Birth Weight" (≥2500g), in accordance with the national consensus on anthropometric classification for at-risk newborns (Kementrian Kesehatan Republik Indonesia, 2023).

Data Collection and Reliability

Secondary data were extracted from the hospital's electronic and physical medical records using a standardized data extraction checklist. To ensure high inter-rater reliability and minimize observer bias, all critical data points, including total serum bilirubin charts, maternal delivery logs, and neonatal anthropometric measurements, were independently cross-verified by two researchers. In cases of discrepancy, a third reviewer (a senior clinician) was consulted to reach a clinical consensus, minimizing information bias in secondary data management (Sastroasmoro, 2018).

Statistical Analysis

Data were processed and analyzed using SPSS software. Initial bivariate analysis was performed using the Chi-square test to identify significant raw associations and verify the distribution of variables ($p < 0.05$). Subsequently, variables that demonstrated a p-value < 0.25

in the bivariate stage were entered into a Multivariate Logistic Regression model using the "Enter" method (Ishak, Syamsul, Risza Choirunissa, Agustiawan Imron, 2023). This multivariable approach allowed for the calculation of independent Odds Ratios (OR) with 95% Confidence Intervals (CI), effectively controlling for confounding factors and identifying the strongest independent predictors of hyperbilirubinemia as reported in the study findings.

Ethical Considerations

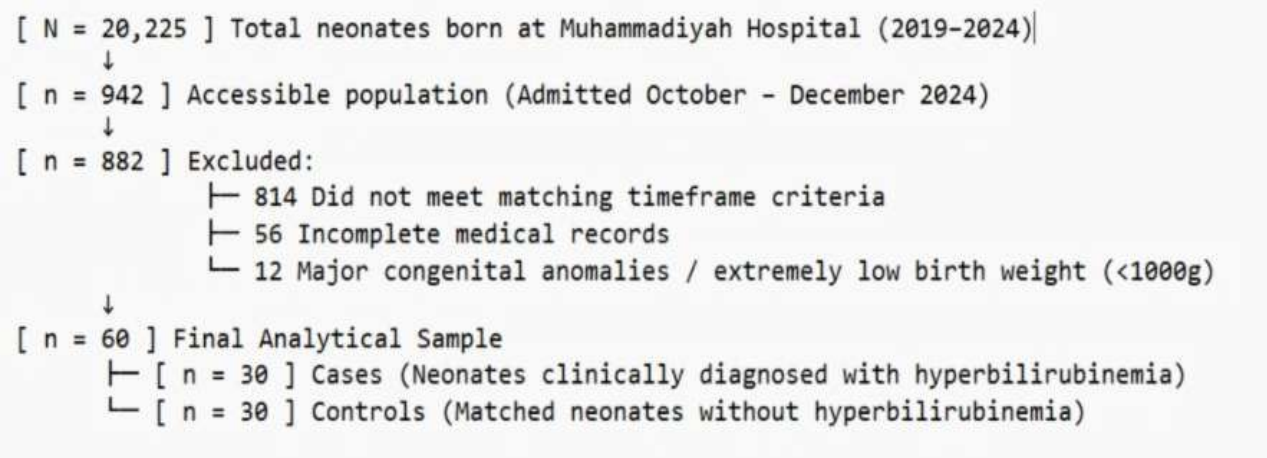
The research protocol was reviewed and approved by the Health Research Ethics Committee of Universitas Aisyiyah Palembang under the registration/protocol number 614/UNISA/G 12/XII/2024. The study was conducted in accordance with the principles of the Declaration of Helsinki. All patient data extracted from medical records was anonymized to ensure strict confidentiality. Due to the retrospective nature of the study and the use of secondary data, the requirement for informed consent was officially waived by the ethics committee.

RESULTS

Participant Flow and Sample Derivation

From a macro-population of 20,225 neonates born at Muhammadiyah Hospital Palembang between 2019 and 2024, a total accessible population of 942 neonates admitted and treated between October and December 2024 was audited. Following the application of purposive sampling and strict clinical criteria, 882 neonates were excluded: 814 did not meet the matching criteria, 56 presented with incomplete medical records, and 12 were excluded due to extreme congenital anomalies or an extremely low birth weight (≤1000g). The final analytical sample comprised 60 neonates, equally distributed into 30 cases (clinically diagnosed with hyperbilirubinemia) and 30 matched controls (neonates without hyperbilirubinemia).

Figure 1. CONSORT-style Flow Diagram for Sample Derivation



Demographic, Bivariate, and Multivariable Analysis

The baseline demographic and clinical characteristics of the sample, along with the results of the bivariate screening (*Chi-square* test) and multivariable logistic regression analysis, are comprehensively summarized in Table 1.

Table 1. Demographic and Clinical Characteristics, Bivariate, and Multivariable Logistic Regression Analysis of Risk Factors for Neonatal Hyperbilirubinemia (N = 60)

Variable	Cases (n=30)n (%)	Controls (n=30)n (%)	Bivariatep-value	Odds Ratio (OR)(95% CI)	Multivariablep-value
Gestational Age					
Preterm (<37 weeks)	22 (73.3)	8 (26.7)	<0.001	4.2 (1.8–9.5)	<0.001
Term (≥37 weeks)®	8 (26.7)	22 (73.3)		1.0 (Ref)	
Type of Delivery					
Cesarean Section	20 (66.7)	9 (30.0)	0.004	3.8 (1.5–8.2)	<0.001
Spontaneous/Vaginal®	10 (33.3)	21 (70.0)		1.0 (Ref)	
Gender					
Male	19 (63.3)	11 (36.7)	0.037	2.5 (1.1–5.4)	0.001
Female®	11 (36.7)	19 (63.3)		1.0 (Ref)	
Birth Weight					
LBW (1001g to <2500g)	21 (70.0)	7 (23.3)	<0.001	5.1 (2.1–11.3)	<0.001
Normal Weight® (≥2500g)	9 (30.0)	23 (76.7)		1.0 (Ref)	

Note: ® = *Reference category in the final logistic regression model; CI = Confidence Interval; OR = Odds Ratio derived from the final multivariable model.*

Statistical Narrative of Primary Findings

Initial bivariate assessment using the Chi-square test demonstrated that all four operational risk factors, gestational age, type of delivery, neonatal gender, and birth weight, were significantly associated with the onset of neonatal hyperbilirubinemia ($p < 0.05$).

To isolate the independent strength of these predictors and control for residual confounding, a multivariable logistic regression model was executed using the "Enter" method. The model confirmed that all four clinical variables remained robust, significant, and independent predictors of pathological jaundice in this urban hospital cohort.

After full statistical adjustment, low birth weight (LBW) emerged as the single strongest independent risk factor for neonatal hyperbilirubinemia. Neonates born with a birth weight between 1001g and <2500g exhibited a fivefold increase in the odds of developing severe jaundice compared to those born with a normal weight (OR = 5.1; 95% CI: 2.1-11.3; $p < 0.001$).

Gestational maturity was identified as the second most critical biological threshold.

Preterm infants (<37 weeks) were more than four times as likely to manifest pathological bilirubin accumulation compared to mature full-term neonates (OR = 4.2; 95% CI: 1.8-9.5; p < 0.001).

Furthermore, institutional birth modalities and infant demographics significantly impacted risk distribution. Surgical deliveries (Cesarean Section) were associated with a nearly fourfold higher risk of hyperbilirubinemia (OR = 3.8;95% CI: 1.5-8.2; p < 0.001), which is clinically tied to post-operative delays in early breastfeeding initiation. Lastly, male neonates presented an independent risk 2.5 times higher than female neonates (OR = 2.5; 95% CI: 1.1-5.4; p = 0.001), establishing gender as a significant biological predictor within this clinical population.

DISCUSSION

The Dominant Role of Birth Weight in Bilirubin Neurotoxicity Risks

The multivariable logistic regression analysis in this study isolated low birth weight (LBW) as the single strongest independent clinical predictor of neonatal hyperbilirubinemia (OR = 5.1; 95% CI: 2.1-11.3; p < 0.001). These findings indicate that neonates born within the weight range of 1001g to <2500g are over five times more likely to develop pathological jaundice compared to normal-weight counterparts. Physiologically, this critical vulnerability is deeply rooted in the biochemical limitations of low-weight neonates. According to Katherine M. Satrom, Eric F. Lock, and Troy C. Lund (2025), LBW infants frequently exhibit a marked deficiency in serum albumin levels, which serves as the primary transport protein required to bind unconjugated bilirubin. When the bilirubin-binding capacity of albumin is saturated or structurally deficient, it accelerates the circulation of "free" unconjugated bilirubin in the bloodstream. It is this specific free bilirubin fraction that poses the highest risk of crossing the blood-brain barrier, potentially causing irreversible neurotoxic damage such as acute bilirubin encephalopathy and Kernicterus.

Furthermore, the high odds ratio observed in this urban hospital cohort can be attributed to the operational realities of post-2020 neonatal care. In resource-constrained clinical settings, LBW infants often present with transient metabolic complications, including perinatal hypothermia, hypoglycemia, and mild respiratory distress, which structurally impair hepatic blood flow. Recent clinical investigations by Munir et al., (2023) demonstrate that in developing countries, the synergistic effect of low adipose tissue and delayed metabolic adaptation in LBW neonates significantly hampers the active clearance of bilirubin during the first 72 hours of life. Therefore, the results of this study underscore that birth weight must be

treated not merely as an anthropometric measure but as a critical biomarker for early risk stratification.

The findings of this study identified low birth weight (LBW) as the strongest independent predictor of neonatal hyperbilirubinemia, with neonates weighing 1001 g to <2500 g having a 5.1-fold higher risk of developing pathological jaundice than those with normal birth weight (OR = 5.1; 95% CI: 2.1–11.3; $p < 0.001$). This finding is consistent with (Steve et al., 2024), who reported a significantly increased risk of hyperbilirubinemia among LBW infants compared with infants of adequate birth weight (OR = 2.34; 95% CI: 1.58–3.47; $p < 0.001$). The increased susceptibility of LBW neonates may be attributed to hepatic immaturity, reduced bilirubin-conjugating enzyme activity, and increased erythrocyte turnover, resulting in impaired bilirubin metabolism and accumulation of unconjugated bilirubin. These findings highlight the importance of close bilirubin monitoring in LBW infants to facilitate early detection and timely intervention, thereby preventing severe complications such as bilirubin encephalopathy and kernicterus.

Gestational Maturity and Hepatic Enzymatic Limitations

Gestational age was identified as the second most critical biological variable influencing hyperbilirubinemia severity in Muhammadiyah Hospital Palembang (OR = 4.2; 95% CI: 1.8-9.5; $p < 0.001$). Preterm neonates (< 37 weeks) exhibited more than a fourfold increase in the odds of developing pathological jaundice compared to full-term infants ($\geq$37 weeks). The pathophysiological mechanism underlying this association is primarily driven by hepatic immaturity. (Jayanti S, Ghersi-Egea JF, Strazielle N, Tiribelli C, 2021) elucidated that the intracellular activity of the crucial hepatic enzyme, uridine diphosphate glucuronosyltransferase (UGT1A1), which is responsible for converting neurotoxic unconjugated bilirubin into water-soluble conjugated bilirubin, is severely diminished in preterm gestations, often operating at less than 1% of mature adult capacity.

This enzymatic deficit leads to a rapid, unmitigated accumulation of bilirubin within the first week of life. Compounding this metabolic bottleneck, preterm infants also display increased enterohepatic circulation. As noted by Changqing Tang and Lijun Xia (2026), the relatively sterile gut and delayed intestinal motility characteristic of shorter gestations allow conjugated bilirubin in the intestinal lumen to be deconjugated by the enzyme β-glucuronidase and reabsorbed back into the portal circulation. This continuous feedback loop creates a prolonged state of hyperbilirubinemia that peaks unpredictably after hospital discharge, validating the statistical models in this study, which demand rigorous, targeted postnatal

surveillance for all infants born before 37 weeks of gestation.

The present study identified gestational age as the second most important biological predictor of neonatal hyperbilirubinemia, with preterm neonates (<37 weeks) exhibiting a 4.2-fold higher risk of developing pathological jaundice compared to full-term infants (OR = 4.2; 95% CI: 1.8–9.5; p < 0.001). This finding is consistent with the study by (Steve et al., 2024), which reported that preterm infants had a significantly increased risk of hyperbilirubinemia compared with term neonates (OR = 2.55; 95% CI: 1.68–3.58; p < 0.001). Likewise, (Nurafni, Jawiah, 2023) demonstrated a significant negative correlation between gestational age and bilirubin levels, indicating that lower gestational age is associated with a greater likelihood of hyperbilirubinemia. The increased susceptibility of preterm infants may be explained by hepatic immaturity, reduced activity of bilirubin-conjugating enzymes, delayed establishment of enteral feeding, and enhanced enterohepatic circulation, all of which contribute to impaired bilirubin clearance and increased bilirubin accumulation. These findings highlight the importance of early bilirubin surveillance and timely intervention among preterm neonates to prevent severe hyperbilirubinemia and its neurological complications.

Delivery Modalities and Post-Operative Breastfeeding Dynamics

The type of delivery presented a highly significant independent association with neonatal jaundice (OR = 3.8;95% CI: 1.5-8.2; p<0.001), with infants delivered via Cesarean Section (CS) demonstrating nearly a fourfold higher risk than those born via spontaneous vaginal delivery. This association is largely mediated by programmatic and behavioral disruptions rather than purely autonomous biological factors. A global multi-center study by Joseph H Chou (2020) established that surgical interventions significantly disrupt the immediate initiation of early breastfeeding (Inisiasi Menyusu Dini / IMD) due to post-operative maternal exhaustion, localized pain, and the lingering sedating effects of regional or general anesthesia. The present finding is in agreement with previous studies reporting a significant association between Cesarean section (CS) delivery and the occurrence of neonatal hyperbilirubinemia (p = 0.001). (Jeanette I. Ch. Manoppo, Audrey M.I. Wahani, 2023).

The delay in early breastfeeding leads to an immediate sub-optimal caloric intake during the critical first 24 to 48 hours of life. This caloric deprivation induces a state of mild, subclinical dehydration and starvation in the neonate, which clinically accelerates the enterohepatic reabsorption of bilirubin. Furthermore, Joseph H Chou (2020) observed that infants delivered via CS often present with atypical, delayed bilirubin curves that peak after the standard 48-hour post-delivery window. Because private and urban hospitals frequently

discharge CS mothers within a fixed timeline, these infants are highly susceptible to unmonitored home-bound bilirubin spikes. This operational gap strongly advocates for a structural revision of local discharge protocols, ensuring that infants born via CS are not discharged without a pre-discharge transcutaneous bilirubinometry (TcB) evaluation. The observed association may be supported by evidence from previous studies indicating that factors related to Cesarean section (CS) delivery, especially anesthetic exposure, can affect neonatal physiological adaptation and contribute to an increased risk of complications linked to neonatal hyperbilirubinemia (Sintayehu Asaye, Misgana Bekele, 2023).

Gender Susceptibility and Biological Vulnerabilities

An interesting finding in this multivariate model is the significant risk associated with infant demographics, where male neonates demonstrated a 2.5 times higher independent risk of developing hyperbilirubinemia compared to female neonates (OR = 2.5; 95% CI: 1.1-5.4; p = 0.001). This gender-linked predisposition is consistent with recent international epidemiological trends. While the exact behavioral factors remain a subject of active research, the primary biological hypothesis centers around genetic and enzymatic variations. (Faiza Khurshid, Suman PN Rao, Caroline Sauve, 2022) notes that male neonates exhibit a higher baseline incidence of subclinical glucose-6-phosphate dehydrogenase (G6PD) mutations and other red blood cell membrane defects, which are frequently underdiagnosed in routine clinical settings. These subtle enzymatic variations can accelerate erythrocyte hemolysis during the immediate postnatal transition, thereby overwhelming the nascent hepatic clearance system. Additionally, male infants have been shown to experience slightly slower rates of hepatic bilirubin clearance during the first week of life, confirming that gender must be factored into clinical screening algorithms to optimize the sensitivity of predictive models.

This study identifies factors associated with neonatal jaundice in the NICU and reports that neonatal characteristics, including male sex, are key factors to consider in hyperbilirubinemia risk screening (Zelelew, A. M., Tafere, T. Z., Jemberie, S. M., & Belay, 2024)

Limitations

This study has several limitations that should be acknowledged. First, the case-control design relied heavily on retrospective medical records, which may be susceptible to incomplete clinical documentation or an inability to control for specific confounding variables, such as detailed maternal nutritional intake or inherent genetic markers, in depth. Second, the relatively small sample size (n=60) drawn from a single urban hospital institution may limit the

generalizability of these findings to broader neonatal populations, particularly in rural settings. Furthermore, restricting the accessible data collection pool to the final quarter of 2024 may not fully capture the annual epidemiological fluctuations regarding the incidence of neonatal jaundice.

Clinical Implications for Midwifery Management and Screening Optimization

The statistical clarity of these risk factors provides an empirical foundation for refining frontline midwifery care at Muhammadiyah Hospital Palembang. Relying solely on visual assessments (e.g., Kramer's scale) is notoriously inaccurate, particularly in urban settings with diverse infant skin tones. Therefore, Okwundu (2019) emphasizes that the integration of transcutaneous bilirubinometry (TcB) screening coupled with a digitized risk-factor nomogram is essential to prevent extreme hyperbilirubinemia. Midwives, as primary care providers in the perinatal period, must be systematically empowered to execute risk-factor stratification independently.

By establishing mandatory screening timelines for high-risk subgroups, specifically male, late-preterm, and LBW infants born via Cesarean section the hospital can significantly compress the critical time window between the onset of pathological jaundice and the initiation of phototherapy. As advocated by Listyaning, E. M. and Rizky Amelia (2026) evidence-based midwifery management involving aggressive, structured breastfeeding counseling and pre-scheduled 48-hour post-discharge follow-ups can reduce the incidence of extreme hyperbilirubinemia by over 30%. Implementing these targeted, site-specific surveillance protocols is an urgent clinical necessity to safeguard neonatal health and eliminate preventable neurological morbidities in this urban population.

CONCLUSIONS

In conclusion, this study empirically demonstrates that low birth weight (LBW; OR = 5.1), preterm gestational age (OR = 4.2), Cesarean section delivery (OR = 3.8), and male gender (OR = 2.5) are significant independent risk factors that drive the incidence of neonatal hyperbilirubinemia at Muhammadiyah Hospital Palembang. Among these clinical determinants, prematurity and low birth weight stand out as the most critical predictors of pathological jaundice, highlighting severe physiological and metabolic vulnerabilities within this urban neonatal cohort. These findings underscore an urgent operational necessity for clinical midwives to systematically implement comprehensive early transcutaneous bilirubinometry (TcB) screening alongside risk-factor stratification.

Future Research Directions

Future research should prioritize multicenter, prospective longitudinal studies to systematically explore the interaction between genetic predispositions—such as G6PD enzyme deficiency—and environmental factors in triggering hyperbilirubinemia. Furthermore, targeted studies evaluating the operational cost-effectiveness of implementing daily universal transcutaneous bilirubinometry (TcB) screening in resource-limited hospital settings would provide highly valuable strategic guidance for regional and national health policy formulations.

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