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ORIGINAL RESEARCH

Evaluating the Impact of Phototherapy on Serum Bilirubin Levels and Clinical Outcomes in Neonates: A Single-Center Retrospective Study in a Resource-Limited Setting in Somalia

Mohamed Nur Ali[1,2], Mohamed Mukhtar Kassim[1], Mustafa Gahnug[1], Ali Abdi Jama[1], Nur Adam Mohamed[3], Yasir Khalif Ali[1], Mohamed Yaqub Hassan[1], Farah Ali Ahmed[1], Abdisalam Ismail Hassan[4], Farah Abdullahi Ismail[1], İbrahim Abukar Abdi[5], Ismail Gedi Ibrahim[6], Abdullahi Mohamed Hassan Fujeyra[7], Abdirahman Mohamed Jimale[8], Said Abdirahman Ahmed[9]

[1]Department of Pediatrics, Mogadishu Somali-Turkish Training and Research Hospital, Mogadishu, Somalia; [2]Faculty of Medicine & Surgery, Al Hayat Medical University, Mogadishu, Somalia; [3]Department of Psychiatry, Mogadishu Somali-Turkish Training and Research Hospital, Mogadishu, Somalia; [4]Faculty of Medicine and Health Sciences, Jamhuriya University of Science and Technology, Mogadishu, Somalia; [5]Department of Emergency Medicine, Mogadishu Somali-Turkish Training and Research Hospital, Mogadishu, Somalia; [6]Department of Radiology, Mogadishu Somali-Turkish Training and Research Hospital, Mogadishu, Somalia; [7]Faculty of Medicine and Surgery, Somali National University, Mogadishu, Somalia; [8]Faculty of Health Science, Department of Public Health, University of Somalia (UNISO), Mogadishu, Somalia; [9]Department of Cardiology, Mogadishu Somali-Turkish Training and Research Hospital, Mogadishu, Somalia

Correspondence: Mohamed Nur Ali, Department of Pediatrics, Mogadishu Somali-Turkish Training and Research Hospital, Mogadishu, Somalia, Tel +252615734070, Email drnuur143@gmail.com

Background: Neonatal hyperbilirubinemia is a major cause of preventable morbidity and mortality in low- and middle-income countries. Phototherapy remains the primary treatment strategy; however, its real-world effectiveness and clinical outcomes in Somalia are poorly documented.

Objective: To evaluate the effectiveness of phototherapy in reducing serum bilirubin levels and to identify predictors of mortality among neonates treated for hyperbilirubinemia in a resource-limited Somali NICU.

Methods: This retrospective cohort study was conducted among neonates treated with phototherapy at Mogadishu Somali–Türkiye Recep Tayyip Erdoğan Training and Research Hospital between January 2023 and December 2024. Demographic, clinical, and laboratory data were extracted from NICU records. Paired t-tests and Wilcoxon signed-rank tests were used to compare pre- and post-treatment bilirubin levels. Independent t-tests and ANOVA were used to evaluate subgroup differences, and multivariable logistic regression was performed to identify predictors of mortality.

Results: A total of 110 neonates were included; 58.2% were male and 35.5% were preterm. Mean baseline total serum bilirubin(TSB) was 17.29 ± 7.91 mg/dL, which decreased to 9.10 ± 4.90 mg/dL following phototherapy(mean reduction 8.19 ± 7.09 mg/dL). Positive blood cultures were identified in 18(16.4%) cases. Effectiveness did not differ significantly by sex, gestational age group, duration of phototherapy, or feeding method. Overall all-cause in-hospital mortality was 16.4% (n=18). In multivariable analysis, only birth weight was independently associated with mortality(aOR 0.34; 95% CI: 0.12–0.97). Baseline bilirubin level and bilirubin reduction did not independently predict death.

Conclusion: Phototherapy significantly reduced serum bilirubin levels across all neonatal subgroups, supporting its effectiveness in resource-limited settings. However, mortality remained high and was primarily associated with low birth weight rather than bilirubin severity or treatment response. Strengthening neonatal intensive care services and improving early detection and management are essential to improve survival outcomes in Somalia.

Keywords: neonatal jaundice, phototherapy, hyperbilirubinemia, low birth weight, mortality, Somalia

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Introduction

Neonatal jaundice is one of the most common conditions encountered in the early neonatal period, affecting an estimated 60% of term and 80% of preterm infants worldwide.[1] It results from elevated serum bilirubin due to the newborn's limited hepatic conjugation capacity and increased hemolysis after birth.[2] Although physiologic jaundice is usually benign and self-limiting, severe hyperbilirubinemia can lead to acute bilirubin encephalopathy or kernicterus, causing irreversible neurodevelopmental impairment.[3] Despite major advances in neonatal care, the global burden of severe neonatal hyperbilirubinemia remains concentrated in low- and middle-income countries(LMICs),where early detection and timely treatment are often limited.[4]

Phototherapy remains the cornerstone of treatment for neonatal hyperbilirubinemia and is considered safe, effective and non-invasive.[5] However, its effectiveness depends on multiple factors, including irradiance level, device type, treatment duration and early initiation.[6] In resource-limited settings, these factors are frequently compromised by shortages of functioning phototherapy units, inadequate maintenance, inconsistent power supply and delayed diagnosis due to lack of laboratory capacity.[7,8] As a result,LMICs experience higher rates of severe jaundice, exchange transfusion, and bilirubin-induced neurologic dysfunction.[9]

Recent updates in the 2022 clinical practice guideline from the American Academy of Pediatrics emphasize risk-based management of neonatal hyperbilirubinemia and age-specific bilirubin thresholds for initiating phototherapy and exchange transfusion. These recommendations aim to improve early detection and prevent bilirubin-induced neurologic dysfunction through standardized screening and treatment protocols. However, implementation of such standards may be challenging in resource-limited settings due to limited diagnostic capacity, delayed]presentation, and shortages of reliable phototherapy equipment.[10]

Across sub-Saharan Africa, neonatal jaundice remains a significant cause of preventable morbidity and mortality, with reported prevalence ranging from 20% to over 60%, depending on population and diagnostic practices.[11] Many infants present late to hospitals, often with bilirubin levels exceeding treatment thresholds.[12] Challenges such as home births, poor awareness, limited access to serum bilirubin measurement, and inconsistent phototherapy quality contribute to these outcomes.[13] Although improvements in LED phototherapy technology have increased the feasibility of high-quality treatment in LMICs, adoption remains uneven due to cost and infrastructure limitations.[14]

In East Africa and the Horn of Africa, several studies highlight persistent gaps in neonatal jaundice management. Ethiopian hospital-based studies report that 70–80% of jaundiced neonates require phototherapy, while up to 20–25% still progress to exchange transfusion due to delayed presentation or insufficient phototherapy intensity.[15] Risk factors such as sepsis, prematurity, ABO incompatibility, and prolonged labour are repeatedly identified across the region.[16] Kenyan and Ugandan studies echo similar challenges, recognising that inadequate phototherapy devices and inconsistent monitoring limit treatment effectiveness.[17,18]

In neighbouring countries, such as Ethiopia, Djibouti and Kenya, emerging research since 2020 indicates gradual improvements in phototherapy access but continued variability in treatment outcomes.[19,20] Studies emphasise that resource constraints — including limited neonatal bed space, staff shortages and absence of routine bilirubin monitoring — remain the primary contributors to poor outcomes.[21] Even with improved LED devices, the reported rate of severe hyperbilirubinemia and readmission for rebound jaundice remains higher than in high-income settings.[22]

In Somalia, the burden of neonatal jaundice is significant but poorly documented. A recent NICU-based study from Mogadishu reported a neonatal jaundice prevalence of approximately 30%, with common risk factors including blood group incompatibility, sepsis, and maternal age.[23] However, there is almost no published data describing how effectively phototherapy reduces bilirubin levels, the average rate of bilirubin decline, duration of treatment, or the need for escalation to exchange transfusion in Somali hospitals.[24,] Given widespread resource limitations — including shortages of functioning phototherapy units, minimal laboratory capacity, and lack of standardised treatment protocols — evaluating real-world phototherapy performance is essential.[25]

A single-centre retrospective study offers an opportunity to quantify the effectiveness of phototherapy and associated clinical outcomes under routine conditions in a resource-limited Somali healthcare setting. In settings where neonatal data are scarce, such contextual evidence can help inform local clinical practice and guide improvements in neonatal care delivery.[26–30]

Methods

Study Design and Setting

This was a retrospective observational cohort study conducted at Mogadishu Somali–Türkiye Recep Tayyip Erdoğan Training and Research Hospital, a major national tertiary referral center in Somalia and one of the busiest neonatal units in the region. The study period covered two years, from 1 January 2023 to 31 December 2024. All data were obtained from neonatal intensive care unit (NICU) records, including both electronic records and paper-based charts. Data supporting the findings of this study are available from the corresponding author upon reasonable request.

Participants

Eligible participants included all neonates aged 0–28 days who were admitted to the NICU with clinically or laboratory-confirmed neonatal jaundice or hyperbilirubinemia and were treated with phototherapy during the study period. Inclusion required documentation of baseline total serum bilirubin (TSB) before initiation of phototherapy and sufficient follow-up laboratory data during treatment. Exclusion criteria included neonates requiring immediate exchange transfusion on presentation, those with major congenital anomalies affecting bilirubin metabolism (such as hepatic or biliary tract malformations), cases with incomplete bilirubin records, and neonates who had received phototherapy at another facility before admission.

Data Collection and Variables

A structured data extraction tool was used to retrospectively collect maternal, neonatal, laboratory, and clinical treatment variables. Maternal variables included age, parity, mode of delivery, and maternal blood group and Rh status. Neonatal variables included gestational age, birth weight, sex, Apgar scores, neonatal blood group and Rh status, presence of hemolysis as indicated by a Coombs test (when available), and the presence of clinically or laboratory-confirmed sepsis.

Phototherapy-related data included the type of phototherapy device (LED or fluorescent), whether single- or double-surface therapy was used, total duration of phototherapy exposure, and, when available, documented irradiance levels and the recorded distance between the infant and the light source. Laboratory variables included baseline total serum bilirubin (TSB) prior to phototherapy, serial TSB measurements at approximately 12, 24, and 48 hours of treatment when available, TSB at completion of phototherapy, and rebound bilirubin levels if measured after discontinuation.

Clinical outcomes of interest included the rate of bilirubin decline (mg/dL per hour), total duration of phototherapy, need for escalation to double-surface phototherapy, requirement for exchange transfusion, length of NICU stay, and all-cause in-hospital mortality prior to discharge. All neonates were evaluated and managed by the NICU team according to local neonatal care protocols. Phototherapy initiation and escalation followed treatment thresholds adapted from recommendations of the American Academy of Pediatrics (AAP) and adjusted to local resource availability. Bilirubin monitoring followed routine NICU practice.

Phototherapy Procedures

Phototherapy was administered according to routine neonatal intensive care unit (NICU) protocols adapted from established international treatment thresholds. When documented, information on the type of phototherapy device (LED or fluorescent), treatment duration, and distance between the infant and the light source was extracted from patient records. Phototherapy was initiated based on total serum bilirubin levels in relation to the infant's gestational age and clinical risk factors.

Bilirubin levels were monitored using routine hospital laboratory testing during treatment to assess response and guide clinical decision-making. All bilirubin measurements were performed in the hospital clinical laboratory using standard biochemical methods as part of routine neonatal care. Escalation of treatment, including extension of phototherapy duration or use of additional phototherapy units, was performed at the discretion of the attending neonatology team. Phototherapy was discontinued once bilirubin levels decreased below treatment thresholds according to local NICU practice.

Because this study was retrospective, some technical variables such as irradiance intensity and detailed device specifications were available only when documented in the medical records.

Statistical Analysis

Descriptive statistics were performed, and pre- and post-phototherapy bilirubin levels were compared using paired t-tests and Wilcoxon signed-rank tests. Subgroup comparisons utilized independent t-tests or one-way ANOVA as appropriate. Predictors of mortality were assessed using multivariable logistic regression, with results reported as adjusted odds ratios and 95% confidence intervals.A significance level of $p < 0.05$ was applied.

Ethical Approval

Ethical approval was obtained from the Mogadishu Somali Türkiye Training and Research Hospital Institutional Review Board (MSTH/21483). The study adhered to the principles of the Declaration of Helsinki and local ethical guidelines. Given the retrospective nature of the study, a waiver of informed consent was granted by the institutional review board.

Results

A total of 110 neonates who received phototherapy during the study period were included in the analysis. The demographic and clinical characteristics of the cohort are summarised in Table 1. The mean(±SD)birth weight was 2.47 ± 0.85 kg, and 39/110(35.5%)were preterm. The majority were male(58.2%),received enteral feeding(85.5%), and had a median hospital length of stay of 7 days(IQR 4–14). Positive blood cultures were identified in 18(16.4%)cases. Overall mortality was 16.4%(n=18).Because the number of deaths in the cohort was relatively small, the statistical power to identify additional independent predictors of mortality was limited.

Effect of Phototherapy on Serum Bilirubin

Mean TSB decreased from 17.29 ± 7.91 mg/dL before treatment to 9.10 ± 4.90 mg/dL after treatment(Table 2 and Figure 1), corresponding to a mean absolute reduction of 8.19 ± 7.09 mg/dL (median 6.76 mg/dL). When adjusted for treatment duration, the mean rate of bilirubin decline during phototherapy was approximately 0.17 mg/dL per hour, indicating a consistent treatment response over time. A statistically significant reduction was confirmed by both parametric and non-parametric testing (paired *t*-test $p < 0.0001$; Wilcoxon signed-rank $p < 0.0001$).Higher baseline

Table 1 Baseline Characteristics

Characteristic	Value
Total sample size	110
Male sex (%)	58.2%
Birth weight, mean ± SD (kg)	2.47 ± 0.85
Length of stay, median (IQR) (days)	7 (4–14)
Preterm (%)	35.5%
Culture positive (%)	16.4%

Table 2 Bilirubin Response Before and After Phototherapy

Measure	Mean	Median	SD
TSB Before (mg/dL)	17.29	15.17	7.91
TSB After (mg/dL)	9.07	8.36	4.89
Absolute Reduction (mg/dL)	8.19	6.76	7.09

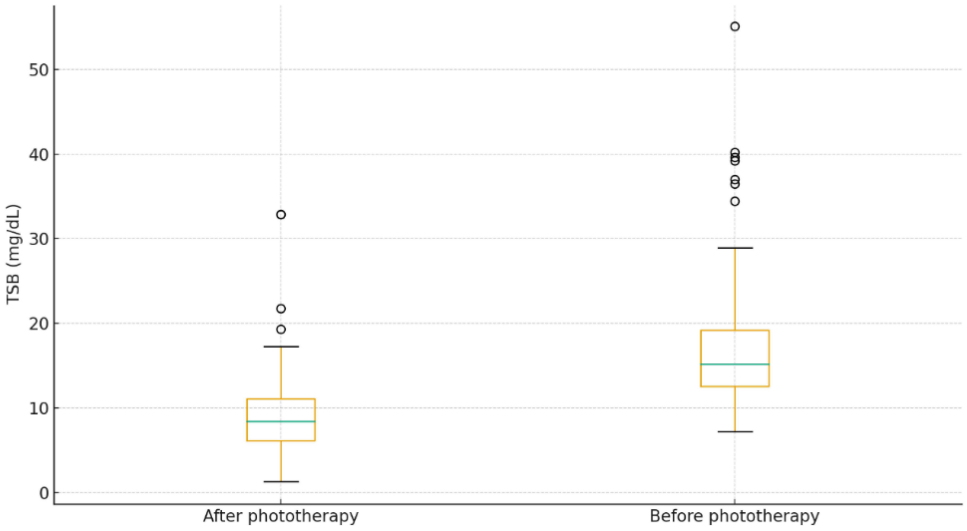

Figure 1 Distribution of total serum bilirubin (TSB) levels before and after phototherapy among neonates. A marked downward shift in bilirubin distribution is observed following treatment.

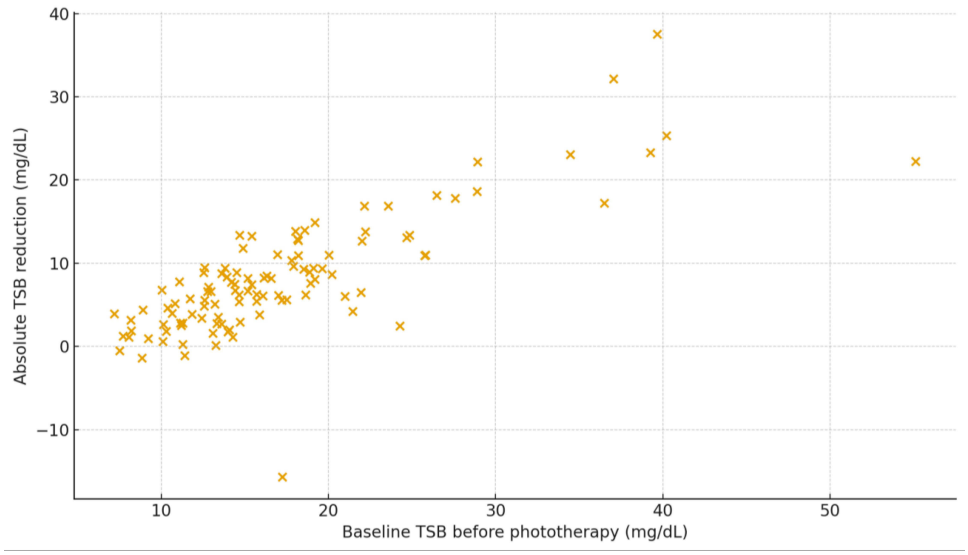

Figure 2 Relationship between baseline bilirubin levels and bilirubin reduction following phototherapy.

TSB was associated with greater absolute reductions(Figure 2), consistent with expected treatment responsiveness in infants presenting with more severe hyperbilirubinemia.

Subgroup Analyses

No statistically significant differences in bilirubin reduction were observed when stratified by sex ($p = 0.20$), gestational age group ($p = 0.98$), duration of phototherapy ($p = 0.81$), or feeding method ($p = 0.28$) (Table 3). Phototherapy therefore appeared similarly effective across neonatal subgroups, including in preterm infants (Figure 3).

Predictors of Mortality

A multivariable logistic regression model evaluated predictors of mortality including birth weight, prematurity, baseline TSB level, bilirubin reduction after phototherapy, and blood culture positivity (Table 4). Only birth weight was significantly associated with in-hospital mortality. Each 1 kg increase in birth weight reduced the adjusted odds of

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Table 3 Subgroup Comparisons for Bilirubin Reduction

Group	Mean Reduction Difference	p_value
Sex (F vs M)	1.79	0.196
Duration (≤1 vs >1 day)	−0.34	0.810
Feeding (Enteral vs Parenteral)	2.10	0.278

death by approximately 66% (aOR 0.34; 95% CI 0.12–0.97; p = 0.043). Baseline TSB level and magnitude of bilirubin reduction showed no independent association with mortality. Blood culture positivity demonstrated a non-significant trend toward higher mortality (aOR 1.71, 95% CI 0.09–31.5).

These findings suggest that overall neonatal vulnerability, particularly low birth weight, contributed more strongly to mortality risk than bilirubin severity or response to treatment.

Discussion

In this retrospective cohort from a major tertiary NICU in Somalia, phototherapy resulted in a significant reduction in serum bilirubin levels among jaundiced neonates.[31] The mean decline of 8.19 mg/dL observed in our study demonstrates that phototherapy remains an effective first-line therapy for hyperbilirubinemia, even under resource-constrained conditions.[32] Similar findings have been reported in other neonatal centers across sub-Saharan Africa.[33]

Higher baseline bilirubin levels were associated with larger reductions following phototherapy, indicating expected bilirubin kinetics and a greater treatment response in more severe cases.[34] Importantly, we observed no significant differences in bilirubin reduction by sex, gestational maturity, phototherapy duration, or feeding method, suggesting consistent effectiveness across neonatal subgroups.[35]

Despite these encouraging bilirubin responses, overall mortality in our cohort remained high at 16.4%.[36] This is comparable to mortality outcomes among jaundiced neonates in other low-income and fragile health systems.[37] In contrast, mortality related to hyperbilirubinemia has become exceedingly rare in high-income countries due to improved perinatal screening, advanced NICU care, and earlier intervention.[38]

Low birth weight was found to be the only independent predictor of mortality in the multivariable analysis (adjusted OR 0.34; 95% CI 0.12–0.97).[39] This indicates that higher birth weight was associated with a lower risk of death. The

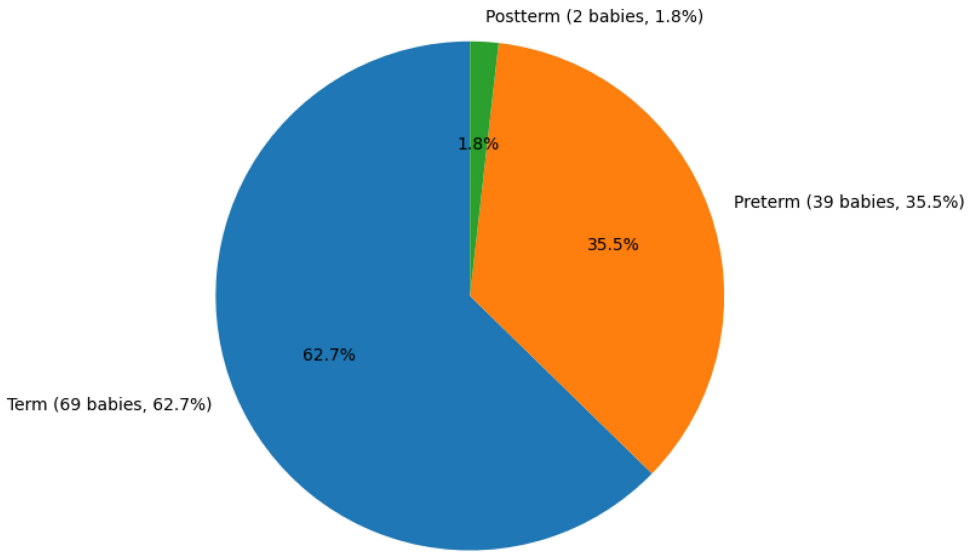

Figure 3 Gestational age distribution among neonates receiving phototherapy (N=110). Term infants represented 62.7% of the cohort, while 35.5% were preterm and 1.8% post-term.

Table 4 Multivariable Logistic Regression Model for Mortality

Variable	Adjusted OR	95% CI	p-value
Birth weight (kg)	0.34	0.12–0.97	0.043
Preterm (vs term/post-term)	0.85	0.16–4.47	0.848
Baseline TSB (per mg/dL)	1.06	0.96–1.18	0.254
TSB reduction (per mg/dL)	0.92	0.81–1.04	0.194
Culture positive	1.71	0.09–31.50	0.719

Notes: OR < 1 = protective effect; OR ≥ 1 = increased odds of death.Model adjusted for birth weight, preterm status, baseline TSB, bilirubin reduction, and culture positivity. Bold values indicate statistically significant results ($p < 0.05$).

confidence interval does not cross 1, suggesting a statistically significant association, although the relatively wide interval reflects some uncertainty, likely due to the limited number of death events in this cohort. This finding highlights the role of neonatal physiological vulnerability in determining survival outcomes rather than the severity of hyperbilirubinemia itself.[40] However, the relatively small number of death events in this cohort limits the statistical power to detect additional associations. Therefore, the absence of statistically significant relationships with prematurity, baseline bilirubin levels, or sepsis should be interpreted cautiously.

Although birth weight emerged as the only independent predictor of mortality in the multivariable analysis, this finding should be interpreted with caution given the relatively small number of death events. The absence of a significant association between baseline bilirubin levels or the magnitude of bilirubin reduction and mortality in this cohort suggests that outcomes are likely influenced by broader neonatal vulnerability rather than bilirubin severity alone. In resource-limited NICU settings, mortality is often multifactorial and may reflect the combined effects of prematurity, infection, low birth weight, and limitations in supportive care.

Neonatal mortality in this context is likely multifactorial and may reflect the combined effects of infection, prematurity, low birth weight, and limitations in neonatal care resources. In resource-limited NICU settings, sepsis frequently coexists with other neonatal conditions and may contribute to adverse outcomes even when it is not identified as an independent statistical predictor in small observational cohorts. Larger multi-centre studies may be required to more comprehensively evaluate predictors of mortality among jaundiced neonates in similar resource-limited settings.[41]

The high proportion of preterm and low-birth-weight infants requiring phototherapy reflects broader maternal and neonatal health challenges in Somalia, including limited antenatal care services, high infection burden, and constrained neonatal support capacity. Improving access to reliable phototherapy alone is insufficient without simultaneous investment in neonatal intensive care and infection prevention so strengthening maternal health strategies is also critical to reducing low birth weight and neonatal vulnerability.[42,43]

Our findings contribute essential local evidence to guide neonatal jaundice management in Somalia, where published data remain scarce. Strengthening early diagnosis, improving phototherapy device quality, and ensuring adequate monitoring may further enhance outcomes for jaundiced neonates. Improving routine monitoring of phototherapy devices, particularly through regular irradiance measurement, is essential to ensure optimal treatment effectiveness. In addition, strengthening early detection through improved neonatal screening and timely presentation may further reduce the risk of severe hyperbilirubinemia and associated complications.[44]

Conclusion

This study demonstrates that phototherapy remains an effective intervention for reducing serum bilirubin levels among neonates in a resource-limited Somali NICU setting. Treatment effectiveness was consistent across demographic and clinical subgroups, including preterm infants, indicating that phototherapy can be relied upon as first-line management for neonatal jaundice even where infrastructure challenges persist. However, the mortality rate of 16.4% highlights

ongoing neonatal survival challenges that extend beyond hyperbilirubinemia itself. Low birth weight emerged as the only independent predictor of death, suggesting that underlying neonatal physiological vulnerability, rather than bilirubin severity or therapeutic response, plays a dominant role in determining outcomes.

Although phototherapy effectively reduced serum bilirubin levels in this cohort, mortality outcomes should be interpreted cautiously due to the limited number of death events. Neonatal mortality in this setting is likely multifactorial and may reflect the combined effects of low birth weight, prematurity, infection, and broader health system limitations.

To further improve neonatal survival in Somalia, future priorities should include strengthening maternal health programs to prevent low birth weight, enhancing neonatal intensive care services, improving infection prevention and sepsis management, and expanding access to high-quality phototherapy devices with adequate monitoring capacity. Multi-center prospective studies and long-term neurological outcome follow-up are recommended to better define the burden of disease and assess improvements over time.

Study Limitations

This study has several limitations. First, its retrospective design relies on the accuracy and completeness of medical records, and some laboratory or clinical variables contained missing data. Second, the study was conducted in a single tertiary center, which may limit the generalizability of the findings to other healthcare settings in Somalia with fewer neonatal care resources.Third, because this study relied on retrospective clinical records, detailed technical parameters of phototherapy—such as irradiance intensity, device calibration, and exact treatment conditions—were not consistently documented, preventing a more precise evaluation of phototherapy dose–response relationships. Fourth, follow-up data on long-term neurodevelopmental outcomes were not available, meaning late bilirubin-related complications may be underestimated. Finally, the relatively small number of deaths may have reduced statistical power to detect additional predictors of mortality beyond birth weight.

Despite these limitations, this study provides essential real-world evidence from a fragile health system where published data remain scarce and can serve as a baseline for quality improvement and future research initiatives.

Data Sharing Statement

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

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Disclosure

The authors declare no competing interests in this work.

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