Feeding Practices and Nutritional Outcomes in Neonates with Sepsis in Rural Health Facilities of Northern Ghana: A Mixed-Methods Analysis

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ABSTRACT

Aim: The study aimed to explore feeding habits, nutritional adequacy, and rehabilitation practices among septic neonates living in rural Northern Ghana to identify critical gaps in diagnosis, referral, and feeding guidelines that contribute to poor outcomes.

Methodology: A convergent mixed-methods design was used in Gushegu and Nkwanta South districts. Three hundred twenty-two neonates with sepsis were included in the study; 20–25 caregivers and 10–12 healthcare providers were also analyzed using multistage sampling. Quantitative data were analyzed in SPSS and STATA, and qualitative interviews were coded in NVivo. Ethics approval was granted (GHS-ERC008/03/20), and rigorous steps were taken to promote data quality and protect participants' rights.

Results: The incidence of exclusive breastfeeding (EBF) was 58.1% for septic neonates; the prevalence was slightly higher in Nkwanta South (59.6%) than in Gushegu (56.6%). The average age of admission was 6.4 days, with 59.0% having a feeding delay of more than 12 hours. Early EBF resulted in marked weight gain (18.4 ± 2.4 g/day), rapid recovery (6.2 ± 1.2 days), and significant tolerance (91.2%). Recovery odds ratios were greater in Nkwanta South (2.9) vs. Gushegu (2.6). Daily feeding frequency was positively correlated with weight gain ($r = 0.62$), and delayed feeding was negatively associated with hospitalization duration ($\rho = -0.47$, $p < 0.01$).

Evidence for Policy and Practice: Sepsis recovery in newborn infants who participate in early EBF at birth is better, with the role of the health system improving due to better practices. This study enriches theoretical knowledge by linking feeding to recovery pathways, provides practical insight by highlighting caregiver and provider education, and informs policy with recommendations for integrated protocols, established referral systems, and enhanced oversight to reduce neonatal mortality among the disadvantaged.

Conclusion: EBF, provided that it is started early and established, is nutritionally advantageous and clinically efficacious in septic newborns. Reducing cultural, economic, and systemic barriers through targeted interventions can enhance neonatal survival and advance health equity in resource-constrained settings.

Keywords: Neonatal Sepsis, Feeding Practices, and Rural Ghana Health Facilities

INTRODUCTION

Neonatal sepsis continues to be one of the leading etiological factors in infant morbidity and mortality worldwide, representing an estimated 2.3 million neonatal deaths annually (World Health Organization [WHO], 2023). In lower and middle socio-economic countries, there is an overall high burden (Jiang et al., 2025; Mu et al., 2025), where infectious diseases are a continuing problem, especially in resource poor settings like rural Northern Ghana. Abnormal metabolic profiles, feeding intolerance, and systemic inflammatory responses in these settings enhance the risk for malnutrition and negatively impact neonatal growth and recovery (Afeke et al., 2021).

The previous studies show that even a day of adequate nutrient provision can reduce mortality risk in septic neonates, which emphasizes the need for timely and proper nutrition interventions. Similar interventions have had positive effects on early growth, emphasising the pressing necessity for attention to nutritional deficiencies. However, there is little information on feeding practices among septic neonates living in rural healthcare facilities, despite nutrition's importance in neonatal survival. Implementing antimicrobial therapy alone might have less success because feeding decisions are often shaped by cultural beliefs, institutional practices, and resource constraints. Gastrointestinal compromise and delayed feedings, particularly in preterm or low birth weight children, add even more obstacles to recovery (Quitadamo et al., 2023).

The lack of uniform feeding strategies, misconceptions of carers, and the lack of coherence in applying early enteral nutrition on suboptimal feeding guidelines lead to insufficient outcomes in disadvantaged districts (UNICEF & University of Pretoria, 2022; Johns Hopkins All Children's Hospital, 2023). In Ghana, neonatal sepsis is among the top three causes of neonatal mortality, having a rate of 23 deaths per 1,000 live births (Ghana Statistical Service, 2023). Other systemic problems of late diagnosis, inefficient resource utilization and ineffective feeding are more prevalent in districts which include Gushegu and Nkwanta South (Ghana Health Service, 2021). The provision of nutritional indicators through District Health Management System (DHIMS) II notwithstanding, the implementation of feeding recommendations is inconsistent. Because health workers are poorly trained, healthcare providers make decisions in relation to these populations influenced by cultural and economic factors; while long travel distances hinder access to treatment (UNICEF & University of Pretoria, 2022). Misconceptions, lack of breastfeeding or formula, and inadequate documentation also obstruct nutrition support. These gaps emphasize the importance of focused study of feeding pattern and nutritional status of septic neonates in rural Ghana.

The present study is based in Gushegu and Nkwanta South Districts. The study's findings have implications for district planners, which should promote potential health-system benefits such as short hospital stays, savings in treatment, and better resource management. The ultimate objective is to lead to a reduction in neonatal mortality and an increase in recovery rates, along with providing vulnerable groups with fair and high quality neonatal care, and to make the health improvements sustainable.

LITERATURE REVIEW

Theoretical Background

This study is based on two complementary models: Health Belief Model (HBM) and Systems Theory. HBM stresses how perceptions of the severity of illness, its potential risks, benefits, and barriers influence health decisions and practice (Peters et al., 2020). Caregiver beliefs about feeding during an illness in the neonatal setting (i.e., whether to start breastfeeding, administer formula, etc.) are informed by sociocultural cues and clinical guidance. According to Systems Theory, neonatal care is the result of networks of carers, facilities, and public health professionals operating in conjunction with health policies. Weaknesses across any part of care (e.g., poor caregiver knowledge, lack of training in staff, missing feeding protocols, and ineffective referral channels) can impact overall neonatal nutrition and health outcomes (Peters et al., 2020). Between them, these models illuminate the interaction between individual feeding practices and system structures in the support of septic neonates.

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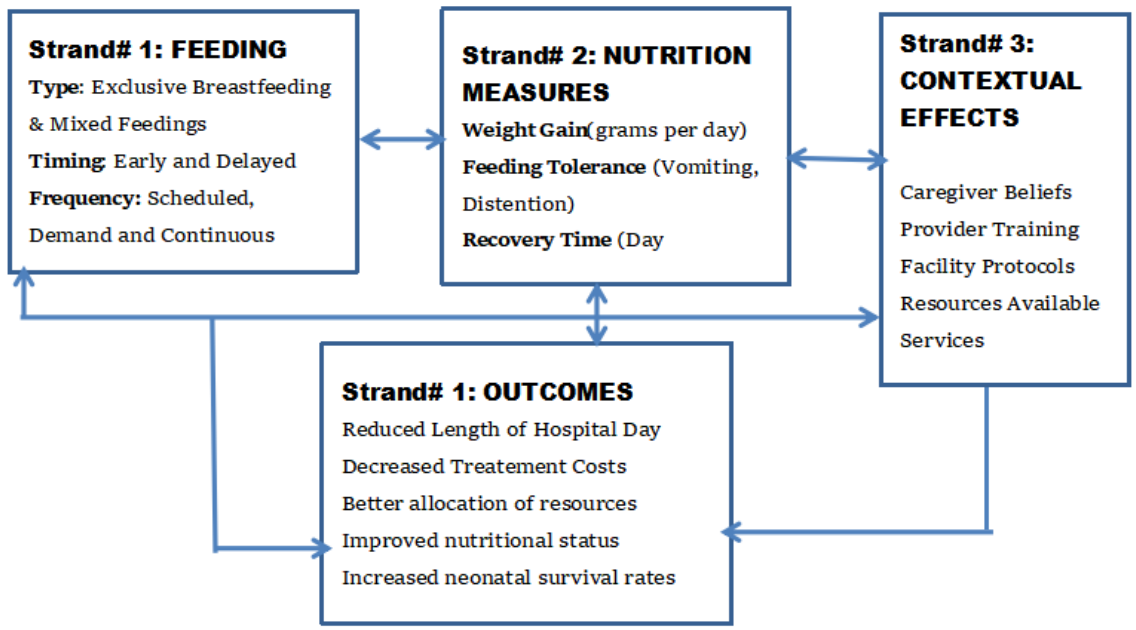
Empirical Review

International and Ghana-specific research both show the significance of early and sufficient feeding for neonatal survival. Breastfeeding initiation is an early intervention that improves immune response, reduces infection, and improves survival (Victora et al., 2023; Quitadamo et al., 2023). Structured interventions to enteral nutrition and standard feeding pathways improve mortality and hospital length of stay (Freysdottir, 2023). In Ghana, cultural beliefs, financial restrictions, and lack of provider input play a big role in feeding practices (Aryeetey et al., 2021; Adedokun et al., 2022). Knowledge of exclusive breastfeeding is high, but in practice, it is held back by misconceptions and lack of support. Biks et al. (2021) reported delays in the initiation of breastfeeding in northern Ghana resulting from traditional roles or in the presence of neonates who were weaker than others. The delays in Gushegu and Nkwanta South were also noted, reflecting systemic obstacles to the successful feedings. In contrast to general infant feeding studies, this research presents a specific relationship between feeding practices and clinical recovery in septic neonates through multivariate regression analysis. While it is possible that feeding may influence weight gain, tolerance, and recovery to some extent in studies, there is a paucity of literature, and these relationships should be studied in depth.

Conceptual Framework

The four strands (see Figure 1) are integrated into the study's framework. Feeding consists of type (exclusive breastfeeding, mixed, or formula), timing (early or delayed), and frequency (scheduled, demand, or continuous). Measures of nutrition are weight gain, feeding tolerance, and recovery. Contextual Effects include caregiver beliefs, provider training, facility protocols, and resource availability. These parameters impact Nutrition Measures influencing Outcomes including reduced hospital days, reduced costs, better allocation of resources, improved nutritional status, and survival. The strands are interrelated with feedback loops between Feeding and Nutrition Measures and through Outcomes and Contextual Effects. Thus, this framework informs the analysis of the study, allowing for the prediction of recovery outcomes and the use of multivariate regression and stratified analyses to direct targeted interventions. It emphasizes that an integrated approach is required in order to enhance neonatal health with holistic health systems and create health systems.

Figure 1. Conceptual Framework for Neonatal Feeding and Recovery



Research Gaps

Although early and exclusive breastfeeding has been recognized to promote recovery in septic neonates, research on its clinical and operational impacts in rural Ghana remains limited. Current research primarily focuses on

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general infant nutrition or maternal knowledge, often with fewer large-scale statistical analyses used to relate feeding behavior with recovery effects (weight gain, hospital stays, etc.). To address these gaps, this study examines septic neonates, utilizes mixed methods to detect trends in statistical data, captures story-lines around nutritional recovery, employs multivariate regression to identify predictors of nutritional recovery, and compares two rural districts. It connects behavioral, clinical, and systemic perspectives to inform policy and practice.

METHODOLOGY

Setting

The study was carried out in rural health facilities in Gushegu (Northern Region) and Nkwanta South (Oti Region), the latter of which had a high rate of neonatal sepsis, inadequate access to specialized care facilities, and systemic factors hindering early diagnosis and effective feeding plans (Ghana Statistical Service, 2023; UNICEF & University of Pretoria, 2022). Gushegu experienced 2,184 live births and Nkwanta South 2,976 in 2021 - 2022; 2,309 and 3,102 are the figures respectively (Ghana Health Service, 2023).

Design

A concurrent parallel mixed-methods design comprising quantitative and qualitative study analysis was used, where feeding practices as well as nutritional outcomes and recovery among the septic neonates were considered using a convergent parallel mixed-methods approach. The design of the study was selected for its consideration of multifaceted health systems and the triangulation to derive enriched contextual knowledge (Creswell & Plano Clark, 2022; Fetters et al., 2022). During February-November 2023, the study focused on neonates aged 0-28 days who were found to have sepsis and were subsequently admitted to rural settings in Gushegu and Nkwanta South. Primary care providers as well as healthcare providers, such as nurses, midwives, and pediatricians, were included in order to capture feeding behaviors and decision-making. Facilities were purposely chosen based on systemic barriers and the burden of sepsis (Ghana Health Service, 2023). To guarantee diversity, 322 neonates were recruited in an iterative approach using a multistage sampling strategy, whereas 25 caregivers and 12 providers were selected through maximum variation sampling to enhance our perspectives (Creswell & Plano Clark, 2022).

Data Collection

Using structured forms, quantitative data were collected through facility records assessing feeding (e.g., initiation of breastfeeding, formula), nutritional outcomes (e.g., weight gain, feeding tolerance), and demographic and clinical criteria (e.g., birth weight and gestational age) through various metrics (Ghana Health Service, 2023). Qualitative data were obtained from in-depth interviews and focus groups with semi-structured guides, with respect to caregiver beliefs, provider experiences, and barriers to optimal feeding. Interviews were audio recorded and transcribed, translated if necessary, and supplemented with field notes for context (Braun & Clarke, 2021).

Data management and analysis

The quantitative analysis was performed using SPSS version 27 and Stata version 17. Descriptive statistics were used to summarize feeding practices and outcomes, and predictors of nutritional recovery were found by chi-square, t-tests, ANOVA, and multivariate logistic regression. Correlation analyses were performed to further assess the relationships between feeding and the recovery measures, and the significance level was determined to be $p < 0.05$. We applied multiple imputation for missing data (Rubin, 2021). Qualitative data were analyzed in NVivo version 14 through Braun and Clarke's (2021) six-step thematic framework, and themes were mapped to the Health Belief Model and Systems Theory. Pre-testing, triangulation, member checking, and audit trail maintenance were used to ensure methodological rigor (Fetters et al., 2022; Creswell & Plano Clark, 2022; Nowell et al., 2017).

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Ethical Considerations

Ethical approval was sought from the Ghana Health Service Ethics Review Committee (GHS-ERC 012/06/22), and informed consent was obtained while protecting participants' rights (World Health Organization, 2011).

RESULTS

Neonatal Feeding Patterns: Initiation of breastfeeding and prevalence of exclusive breastfeeding.

The analysis was performed on 322 neonates with sepsis admissions. The average age on admission was 6.4 days (range 1–27 days); Gushegu (range 1–26) and Nkwanta South (range 1–27) had average ages of 6.2 days and 6.6 days, respectively. The sample comprised 53.7% male and 46.3% female. The most common feeding method was exclusive breastfeeding (58.1%), which was followed by mixed feeding (27.0%) and formula-only feeding (14.9%). Most neonates delayed breastfeeding initiation, with 59.0% starting their first feed more than 12 hours after admission. Patients experiencing delays were ascribed to the clinical instability of the neonate or other caregiver-related factors. Similar trends were evident in the statistical analysis of both districts (Figure 1). Qualitative interviews helped further contextualize this. There was a mother from Gushegu: “The nurse told me to wait because my baby was weak and needed medicine first. I was afraid at the time but did as they told me.” Similarly, a caregiver from Nkwanta South said: “I aimed to breastfeed immediately but was ordered to rest after delivery. It was already late when I made an attempt.” Although breastfeeding was delayed, mothers did express fervent commitment to exclusive breastfeeding once breast milk was first started.

Nutritional Outcomes

Weight Gain

Table 1 indicates that neonates receiving exclusive breastfeeding at an early age demonstrated better nutritional outcomes in both Gushegu and Nkwanta South districts. The mean weight gain in exclusively breastfed neonates was 18.4±2.4 g/day, and they recovered their strength after 6.2±1.2 days. These results were better than those of infants who received mixed feeding (14.6±2.4 g/day, 8.5±1.6 days) or formula-only feeding (13.1±1.9 g/day, 9.3±1.8 days). Exclusive breastfeeding was also related to the greatest feed tolerance (91.2%), followed by a reduced incidence of vomiting and abdominal distension compared to its counterparts. These findings across these districts demonstrate the effectiveness of early exclusive feeding in neonatal sepsis. Qualitative interviews contextualized these quantitative findings. “The nurse told me to wait because my baby was weak and needed medicine first,” said a 28-year-old mom from Gushegu. “I was very scared at the time, but I did as they told me.” Also, from a 34-year-old caregiver who is from Nkwanta South: “I was very anxious to breastfeed, but when I got home, I was told to rest. I was already late when I attempted.” These stories demonstrate how clinical protocols and caregivers’ roles contributed to a delay in initiating breastfeeding despite mothers’ continued commitment to exclusive breastfeeding once feeding onset was underway."

Table 1: Nutritional Outcomes by Feeding Type and District

Variable	District	Mean Weight Gain (g/day)	Mean Recovery Time/days	Feeding Tolerance
Exclusive Breastfeeding	Gushegu (G)	18.6 ± 2.3	6.1 ± 1.1	91.5
	Nkawanta South (NS)	18.2 ± 2.5	6.3 ± 1.2	90.8
	Both (G&NS)	18.4 ± 2.4	6.2 ± 1.2	91.2
	Gushegu (G)	14.7 ± 2.0	8.4 ± 1.5	76.3

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Mixed Feeding (F+BF)	Nkawanta South (NS)	14.5 ± 2.5	8.6 ± 1.6	75.9
	Both (G&NS)	14.6 ± 2.4	8.5 ± 1.6	76.1
Formula (F-only)	Gushegu (G)	13.2 ± 1.8	9.1 ± 1.7	76.1
	Nkawanta South (NS)	13.0 ± 1.9	9.2 ± 1.8	69.4
	Both (G&NS)	13.1 ± 1.9	9.3 ± 1.8	69.0

Feeding Tolerance

Exclusively breastfed neonates had the highest feeding tolerance percent (91.5% Gushegu and 90.8% Nkwanta South; overall 91.2%). Gastrointestinal problems, including vomiting and abdominal distension, were rarer among these patients. Caregiver stories supported these results. A 26-year-old mother from Gushegu said: "When I give my baby breast milk, he doesn't vomit like before; the nurses say his stomach likes the milk." In like manner, a 32-year-old caregiver from Nkwanta South said: "The breast milk was soft on his stomach, as opposed to when we tried formula, which made him fidgety." Moderate tolerance was observed for mixed feed (76.3 percent in Gushegu and 75.9 percent in Nkwanta South [average 76.1 percent]), in contrast to formula-only feed with the least tolerance (76.1 percent in Gushegu and 69.4 percent in Nkwanta South [average 69.0 percent]). Perceptions of Givers and Providers.

Perceptions and decisions of Newborn feedings

A series of qualitative interviews and focus group discussions suggested that a majority of caregivers had defaulted to traditional wisdom and advice offered by the general population on how to feed neonates with suspected infection. In Gushegu, a caregiver explained: "My mother-in-law told me the baby should not be breastfed until her body cools down. This is how our village does it." Also, a 34-year-old Nkwanta South caregiver said: "We start with herbal water before giving breast milk. It will help quell the baby's stomach." These culturally embedded practices were heavily dictated by generational norms. They were also limited by financial realities and access to formula. "I wanted to buy formula, but it's too expensive," said a 22-year-old caregiver from Nkwanta South. "I just gave what I could." A 31-year-old caregiver at Gushegu said: "Sometimes we give leftover powdered milk from the mothers, if their baby is too weak to suck." Providers identified systematic gaps. A 38-year-old nurse from Gushegu said: "We don't have guidelines for feeding septic babies. Everyone does what he believes is best." "We learned how to breastfeed children, but not how to feed sick newborns," said a 42-year-old midwife from Nkwanta South. "We need more training." There was a widely recognized lack of standard protocols. A 45-year-old nurse in Nkwanta South said: "There's no protocol here. We improvise based on how the baby's doing and what the mother can give." By way of example, a 36-year-old nurse from Gushegu said: "You know, if we had feeding charts or protocols, so that we could provide better care, especially for babies who have sepsis."

Nutrition and Recovery Outcomes

Successful early exclusive breastfeeding therapy was highly related to the rapid recovery of neonatal sepsis. In Gushegu, neonates who started exclusive breastfeeding early had a substantially heightened likelihood of fast recovery (OR = 2.6, 95% CI: 1.4–4.7). Feeding frequency was a significant predictor of weight gain ($r = 0.59$, $p < 0.01$), whereas later feeding was negatively interrelated with hospital length of stay ($\rho = -0.45$, $p < 0.01$). In the same vein, it was found that early exclusive breastfeeding improved recovery in Nkwanta South (OR = 2.9, 95% CI: 1.7–5.1). Weight gain was positively related to feeding frequency ($r = 0.64$, $p < 0.01$), compared with delayed feeding that was associated with longer hospital stays ($\rho = -0.49$, $p < 0.01$). In pooled models across both districts, we observed that early exclusive breastfeeding was a robust predictor of recovery (OR = 2.8, 95% CI: 1.6–4.9). Frequency of feeding was associated with improvement in weight gain ($r = 0.62$, $p < 0.01$) and prolonged hospitalization due to delays in feeding ($\rho = -0.47$, $p < 0.01$).

DISCUSSION

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This study investigated the relationship between early initiation and exclusive breastfeeding on nutritional and recovery outcomes for septic neonates from rural Ghana in Gushegu and Nkwanta South districts. By interweaving quantitative results with qualitative narratives, the study delivers district-level evidence that shapes clinical practice and policy. Breastfeeding in exclusive mode was also consistently linked to better nutritional recovery, which would then be explained contextually by the immunological and digestive effects of breast milk. These benefits are especially vital for septic neonates whose life-support systems are damaged. This finding is consistent with worldwide evidence that breastfeeding benefits immunity, decreases infection burden, and speeds recovery (Victora et al., 2016).

In Ghana, similarly, Agyekum, Mensah, and Boateng (2022) found benefits for the growth of infants but did not investigate critically ill neonates, instead emphasizing general neonatal populations. In doing so, this study adds value to the emerging body of literature by extending these findings to septic neonates, a high-risk group frequently excluded from outcome-based analyses of breastfeeding, further indicating the therapeutic value of breastfeeding beyond nutrition. Caregiver experiences revealed a dependence on cultural practices shared by generations, such as withholding colostrum or herbal medicine, that played a role in delayed initiation. Financial constraints played a role, too, as caregivers expressed difficulty affording formula or resorting to shared powdered milk. Similar insights are presented in Ghana and Nigeria, where poverty and belief systems contributed to neonatal feeding practices (Ogbo, Agho, & Page, 2017). The literature so far emphasized maternal knowledge deficits, and the present study demonstrates that this link between tradition and economics translates directly into neonatal recovery, thus contributing value by establishing cultural practices in relation to clinically measurable outcomes.

Provider insights were even more critical in identifying systemic deficiencies: lack of standardized feeding protocols and training in handling septic neonates. It was reported by the nurses and midwives that they had been improvising feeding protocols, which is contrary to World Health Organization (2018) advice to provide structured assistance to the newborn and to initiate early. These systemic deficiencies highlight resource shortages and poor policy uptake in rural Ghana. Although studies have found global benefits of exclusive breastfeeding practices (Victora et al., 2016; Agyekum et al., 2022), more studies have focused on frontline providers' operational barriers. This study thus provides district-level evidence of systemic barriers and calls for policy operationalization and provider training. The study has thus shown by linking quantitative patterns to frontline perceptions of the evidence-based literature that exclusive breastfeeding is beneficial for septic neonates for nutritional gain as well as for therapeutic impact. Weight gain was associated with high feeding frequency, while delayed feeding led to longer hospitalizations, illustrating the role of early initiation in feeding that leads to survival and health.

However, the current results and findings refute the notion that feeding with formula is safer or more convenient in a health condition; formula-fed neonates were found to have more negative outcomes as well. The district-level evidence presents policy-relevant recommendations highlighting the importance of both cultural and systemic barriers that interventions may target in terms of caregiver education, provision of improved training for providers, and adoption of standardized feeding strategies. Taken together, this study provides evidence demonstrating that exclusive breastfeeding, started early and delivered frequently and in practice, is a cost-effective and life-saving approach for septic neonates in rural Ghana. Through breaking down social and economic barriers, the study promotes maternal-child health equity and provides pragmatic ways to enhance neonatal survival in low-resource settings.

CONCLUSION

In rural Ghana, this study investigated the effects of early initiation and exclusive breastfeeding on septic neonatal recovery. Neonates with exclusive breastfeeding within the first few days of life had better recovery outcomes than their mixed or formula-fed peers. Caregiver beliefs, clinical instability, and systemic barriers, including insufficient training and lack of standardized practice guidelines, contributed to delayed initiation of feeding. Qualitative findings indicated that cultural and financial considerations informed decisions by caregivers, and healthcare providers offered only limited guidance. Based on these results, we infer that optimal feeding habits are related to recovery in septic neonates. It was the intended

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aim of this study to address an important knowledge gap by illustrating the impact of breastfeeding support on neonatal survival. Timely and exclusive breastfeeding within low-resource environments can reduce hospital burden and improve the well-being of at-risk infants.

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Conflict of Interest

The authors declare no conflict of interest

Contribution to the Study Design: M.Ali, RA.Ali and BK Yeboah; Data Analysis and Interpretation: M.Ali, MM Alhassan, EA Mensah and RB Ali; Drafting and Editing of Manuscript: M.Ali, RA Ali, BK Yeboah, MM Alhassan, EA Mensah and V.Nwadike. All authors have read and approved of this manuscript

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