RESEARCH ARTICLE

Neonatal hypernatraemic dehydration: clinical spectrum, risk factors and immediate outcomes at a tertiary care center, Karachi, Pakistan

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Abstract

Objective: To determine the prevalence, clinical manifestations, risk factors and acute consequences of neonatal hypernatremic dehydration in late preterm and term newborns with or without dehydration.

Method: The retrospective, cross-sectional study was conducted from December 2020 to May 2022 at Aga Khan University Hospital, Karachi, and comprised data of neonates aged 1-28 days with diagnosis of neonatal hypernatraemic dehydration admitted to the neonatal intensive care unit and step-down unit between June 10, 2015, and June 9, 2020. Demographic and clinical data along with risk factors, test results and outcomes, was retrieved from the medical records, and correlations were explored. Data was analysed using SPSS 25.

Results: Of the 6,525 admissions during the period, there were 84(1.28%) cases of hypernatraemia; 47(56%) boys, 37(44%) girls, 71(84.5%) term neonates and 13(15.5%) late-term. The overall with mean gestational age was 37±2.6 weeks. Exclusive breastfeeding was observed in 61(72.6%) cases, primigravida mothers in 54(64.3%) cases, and early postnatal discharge in 27(32.1%) cases. Clinical presentations included poor feeding 48(57.1%), lethargy 43(51.2%), and fever 41(48.8%). Complications occurred in 19(22.6%) cases, with acute kidney injury being the most common complication 16(19%). Mortality was the outcome in 6(7.1%) cases, while 76(90.5%) cases were discharged in a stable condition. The severity of neonatal hypernatraemic dehydration correlated significantly with serum creatinine, glucose, prothrombin time, and length of hospital stay ($p<0.05$).

Conclusion: Among neonatal hypernatraemic dehydration, early recognition and management are crucial to combat morbidity and mortality.

Key Words: Hypernatremic dehydration, Neonates, Exclusive breastfeeding, Risk factors, Neonatal outcomes.
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Introduction

Hypernatraemic dehydration (HD) is a rare condition that can lead to severe complications in neonates. These include seizures, cerebral oedema, intracranial haemorrhage, hydrocephalus, renal failure, disseminated intravascular coagulation (DIC) and even death.[1-4] Hypernatraemia is a condition when the serum sodium level is >150mmol/L which becomes severe Hypernatraemia at >160 mmol/L.[1,5] HD is frequently seen in neonates with postnatal excessive weight-loss, inadequate breastfeeding, improperly prepared formula feeding, and early discharge from the hospital.[6,7] HD is suspected in neonates with weight-loss exceeding 10% of birthweight by the end of the first week of life. Clinical signs of dehydration with hypernatraemia, particularly in late preterm and term neonates, also raise suspicion.[8] Because of regional variations in climate and culture, the incidence of neonatal HD (NHD) varies. A study in Turkiye reported it in 1% of all deliveries, while it causes 1.8% of all neonatal admissions.[9,10] Initially, NHD was thought to be an uncommon complication of breastfeeding, but during the past 20 years, the numbers have substantially risen in exclusively breastfed newborns.[11] NHD often presents clinically between the postnatal day 3 and day 21. Early diagnosis may be challenging because of variable clinical presentations. Some may be alert, hungry and emaciated, while others may present with lethargy, irritability and altered sensorium.[12] In the case of delayed identification and treatment of these neonates, significant and potentially harmful complications of NHD may occur. Along with the complications of the condition itself, treatment may also lead to considerable damage if not done properly.

The literature about NHD in the region, to our knowledge, is insufficient. The current study planned to add to the existing literature by determining the prevalence, clinical manifestations, risk factors and acute consequences of hypernatraemia in late preterm and term newborns with or without dehydration.

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Materials and Methods

The retrospective, cross-sectional study was conducted from December 2020 to May 2022 at Aga Khan University Hospital (AKUH), Karachi, and comprised data of neonates aged 1-28 days with HD diagnosis admitted to the neonatal intensive care unit (NICU) and step-down unit (SDU) between June 10, 2015, and June 9, 2020.

After approval from institutional ethics review committee, files of all the relevant neonates were retrieved using consecutive sampling technique. HD was defined as significant weight-loss of >10% of birthweight during the first 7-10 days of life, or if there were significant clinical signs of dehydration present with hypernatraemia.[8] Data of neonates with metabolic/endocrine disorders, like diabetes insipidus, any source of water-loss or on-tube feeding (ostomy; nasogastric, orogastric, or ventricular drainage) and incomplete records was excluded. Data, including demographics, risk factors, clinical and laboratory characteristics with perinatal history, complications and immediate outcomes, was recorded using a predesigned proforma by a trained doctor.

Data was analysed using SPSS 25. Categorical variables were presented as frequencies and percentages. Continuous variables were expressed as mean ± standard duration or as median with interquartile range IQR. Parametric tests were applied when data was normally distributed, whereas non-parametric tests were applied when data was skewed. Kolmogorov-Smirnov test was applied to all continuous variables to assess distribution. Chi-square and Fisher's exact test were applied based on whether the cell expected frequency was <five, and to determine the significant association between categorical variables. For comparative analysis, the neonates were divided into three serum sodium severity categories: mild (150-160mmol/L), moderate (161-170mmol/L) and severe (>171mmol/L). Analysis of variance (ANOVA) or Kruskal-Wallis test was applied to compare the groups against the laboratory parameters to determine whether abnormalities in renal function, electrolytes, haematological indices, and coagulation profiles differed significantly with increasing severity of hypernatraemia. Two-tailed $p<0.05$ was considered statistically significant.

Results

Of the 6,525 NICU and SDU admissions during the period, there were 84(1.28%) cases of hypernatraemia; 47(56%) boys, 37(44%) girls, 71(84.5%) term neonates and 13(15.5%) late-term. The overall with mean gestational age was 37±2.6 weeks. Mean age at presentation was 6.76±4.79 days (range: 3-24 days). Exclusive breastfeeding

Table-1: Demographic characteristics and risk factors of the neonates (n=84).

Variables	Description	n (n%)
Gender	Male	47 (56.0%)
	Female	37 (44.0%)
Gestational Age in terms	Term	71 (84.52%)
	Late Preterm	13 (15.47%)
Gestational Age (weeks)	Mean ± SD	37 ± 2.6
Place of birth	Hospital	82 (97.6%)
	Home	2 (2.4%)
Mode of delivery	LSCS	40 (47.6%)
	SVD	44 (52.4%)
Gravida	Multigravida	30 (35.7%)
	Primigravida	54 (64.3%)
Early postnatal discharge (<24 hours)	Yes	27 (32.1%)
	No	57 (67.9%)
Delay Postnatal Follow-up (>7days)	Yes	11 (13.1%)
	No	73 (86.9%)
Seasonal variation	Autumn	27 (32.1%)
	Spring	23 (27.4%)
	Summer	26 (31.0%)
	Winter	8 (9.5%)
Age at presentation (days)	Mean ± SD	6.76 ± 4.79
Type of feed		
	Exclusive Breast feed	61 (72.61%)
	Formula feed	7 (8.33%)
	Mixed feed	16 (19.04%)
Age group at presentation	< 5 days	44 (52.38%)
	5 - 10 days	25 (29.76%)
	> 10 days	15 (17.9%)
Birth weight (kg)	Mean ± SD	2.79 ± 0.46
Birth weight (kg)		
Birth weight classification	Low Birth Weight (< 2.5 kg)	20 (23.8%)
	Normal Birth Weight (2.5-3.5kg)	64 (76.2%)
Weight loss (%)	Mean ± SD	11.01 ± 7.06
Weight loss	Yes	70 (83.3%)
	No	14 (16.7%)
Weight loss classification (%)	< 7	9 (12.85%)
	7 – 10	18 (25.71%)
	> 10	43 (61.42%)
Duration of hospital stay (days)	Median (IQR)	3 (2-7)

LSCS: Lower segment caesarean section, SVD: Spontaneous vaginal delivery, IQR: Interquartile range, SD: Standard deviation.

Table-2: Clinical spectrum and complications.

Variables	Description	n (n%)
Diarrhoea	Yes	9 (10.7%)
	No	75 (89.3%)
Vomiting	Yes	4 (4.8%)
	No	80 (95.2%)
Fever	Yes	41 (48.8%)
	No	43 (51.2%)

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Jaundice	Yes	29 (34.5%)
	No	55 (65.5%)
Lethargic	Yes	43 (51.2%)
	No	41 (48.8%)
Irritable	Yes	20 (23.8%)
	No	64 (76.2%)
Poor feeding	Yes	48 (57.1%)
	No	36 (42.9%)
Seizures (at admission)	Yes	12 (14.3%)
	No	72 (85.7%)
Dehydration	Yes	38 (45.2%)
	No	46 (54.8%)
Complication (Y/N)	Yes	19 (22.6%)
	No	65 (77.4%)
CVST	Yes	1 (1.2%)
	No	83 (98.8%)
DIC	Yes	4 (4.8%)
	No	80 (95.2%)
AKI	Yes	16 (19.0%)
	No	68 (81.0%)
Shock	Yes	4 (4.8%)
	No	80 (95.2%)
Sepsis	Yes	6 (7.1%)
	No	78 (92.9%)

DIC: Disseminated intravascular coagulation, CVST: Cerebral venous sinus thrombosis, AKI: Acute kidney injury.

Table-4: Outcomes of the neonates.

Variables	Description	n(n%)
Discharge	Yes	76 (90.5%)
	No	8 (9.5%)
Death	Yes	6 (7.1%)
	No	78 (92.9%)
LAMA	Yes	2 (2.4%)
	No	82 (97.6%)

LAMA: Leave against medical advice.

70(83.3%) cases, with 43(61.42%) losing >10% of their birthweight (Table 1).

Clinical presentations included poor feeding 48(57.1%), lethargy 43(51.2%), and fever 41(48.8%). Complications occurred in 19(22.6%) cases, with acute kidney injury (AKI) being the most common complication 16(19%). The clinical spectrum of NHD and its accompanying consequences were noted in detail (Table 2).

HD severity correlated significantly with serum creatinine, glucose, prothrombin time, and length of hospital stay (LOS) ($p<0.05$) (Table 3).

Mortality was the outcome in 6(7.1%) cases, while

Table-3: Laboratory characteristics with respect to severity of neonatal hypernatraemic dehydration (NHD).

Group of Sodium NHD		Mild NHD 150 to 160mmol/L (n=62)	Moderate NHD 161 TO 170mmol/L (n=9)	Severe NHD > 171mmol/L (n=13)	P - value
Serum Potassium		4.86 ± 0.99	4.3 ± 0.77	5.83 ± 1.64	0.004*
Bicarbonate		17.81 ± 4.32	20.91 ± 4.1	14.68 ± 6.25	0.010*
BUN		28.86 ± 14.92	53.11 ± 39.91	132.44 ± 72.91	<0.001*
Creatinine		0.99 ± 0.59	1.22 ± 0.57	5.4 ± 3.33	<0.001*
Serum Calcium		8.52 ± 1.25	8.43 ± 0.6	8.63 ± 2.73	0.968
Serum Glucose /Reflo		74.68 ± 24.53	87 ± 45.45	172.62 ± 116.89	<0.001*
Hb		16.09 ± 2.3	15.06 ± 2.47	16.53 ± 3.74	0.410
HCT		47.93 ± 8.3	47.5 ± 8.11	53.27 ± 11.09	0.129
TLC		13.32 ± 4.66	11.79 ± 4.22	17.75 ± 5.41	0.005*
Platelet		330.53 ± 149	343.78 ± 199.72	176.92 ± 155.29	0.006*
PT		18.06 ± 10.94	14 ± 1.65	41.06 ± 13.19	0.045*
APTT		39.51 ± 19.61	32.5 ± 8.8	55.26 ± 40.22	0.110
Hospital stay (days)		3 (5.25 – 2.00)	4.00 (7.50 – 2.00)	7.00 (8.00 – 3.00)	0.026*
Percentage of Weight Loss		10.35 ± 6.39	14.89 ± 9.74	12.16 ± 8.63	0.287
Range of Weight loss %	<7	19 (30.6%)	0.0	4 (30.8%)	0.381
	7-10	13 (21.0%)	2 (22.2%)	3 (23.1%)	
	>10	30 (48.4%)	7 (77.8%)	6 (46.2%)	
Seasonal Variation	Autumn	23 (37.1%)	1 (11.1%)	3 (23.1%)	0.078
	Spring	14 (22.6%)	3 (33.3%)	6 (46.2%)	
	Summer	20 (32.3%)	2 (22.2%)	4 (30.8%)	
	Winter	5 (8.1%)	3 (33.3%)	0 (0.0%)	

BUN: Blood urea nitrogen. Hb: Haemoglobin, HCT: Haematocrit, TLC: Total leucocyte count, PT: Prothrombin time, APTT: Activated partial thromboplastin time *p<0.05.

was observed in 61(72.6%) cases, primigravida mothers in 54(64.3%) cases, and early postnatal discharge in 27(32.1%) cases. Weight-loss was documented in

76(90.5%) cases were discharged in a stable condition, and 2(2.4%) were taken away by parents against medical

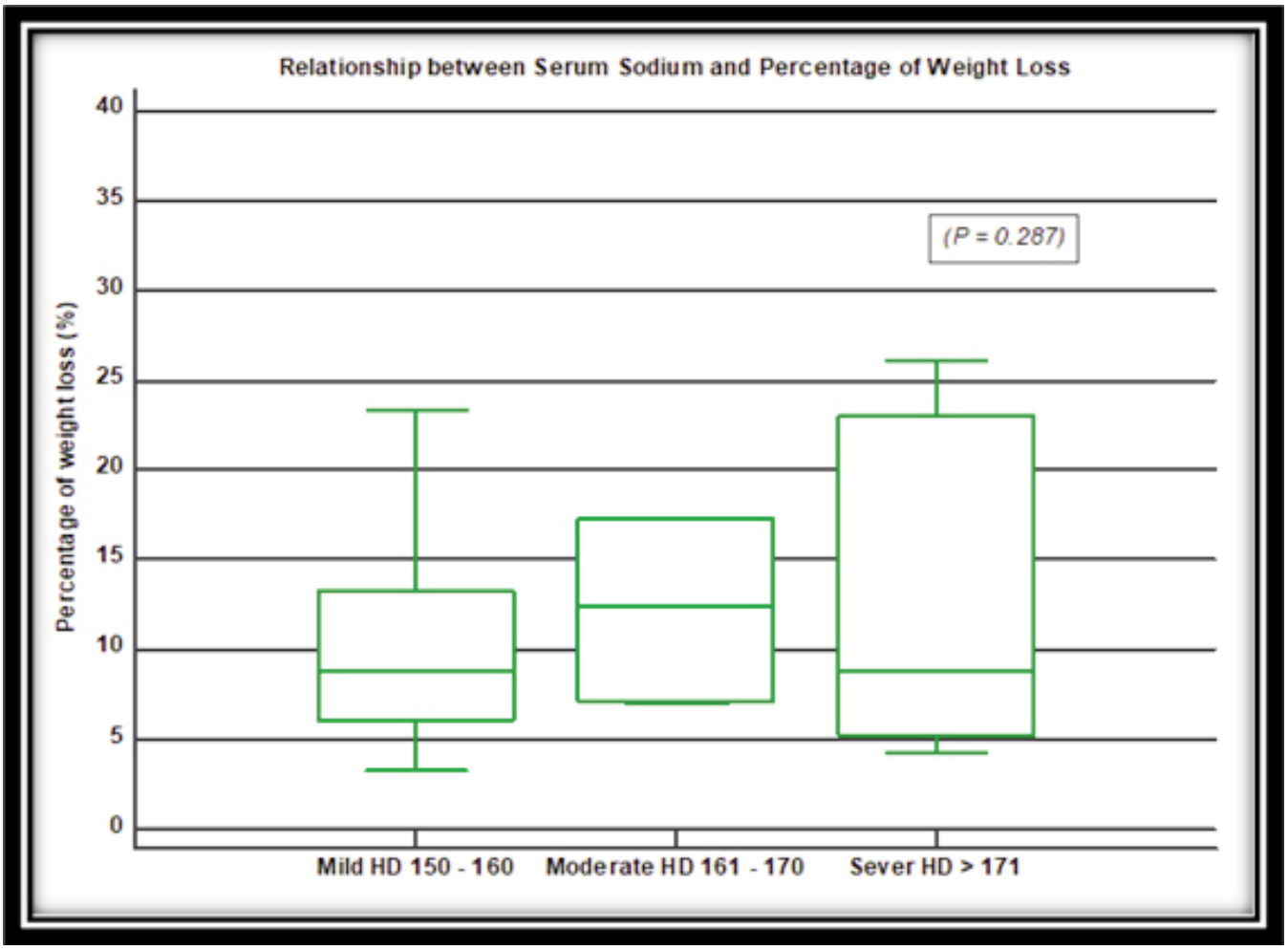

Figure-1: Relationship between serum sodium and weight-loss percentage.

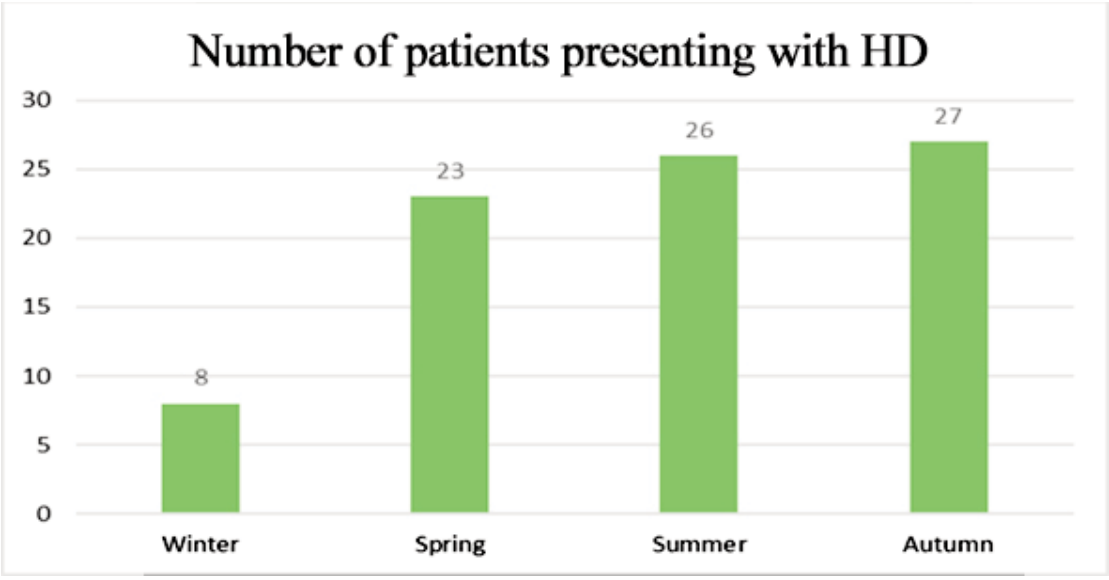

Figure-2: Relationship between hyperntraemic dehydration (HD) patients and seasonal variation.

advice (Table 4).

There was no significant association between serum sodium and percentage of weight-loss (p=0.28) (Figure 1). Very few cases were reported in winter compared to those reporting in spring, summer and autumn (Figure 2).

Discussion

The current study provides critical insights into the clinical spectrum, risk factors and immediate outcomes of HD. Early identification and appropriate management are the keys to improved survival and better prognosis.

In the current cohort, 84 cases of HD were identified out of 6,525 total admissions, yielding a prevalence of 1.28%. This aligns closely with findings from two regional studies, one reporting a 1.3% prevalence over a similar timeframe, and the other showing a prevalence of 1.2%.[2,12] However, other studies in India indicated a higher prevalence of 3.4% and 4.7%, suggesting geographical variability in HD.[13,14] The increasing recognition of this condition in recent years may reflect improved awareness among healthcare providers, or changes in infant feeding practices.[15,16] Although HD has been increasingly reported worldwide, published data from Pakistan remain extremely limited. To date, only a single case of complicated HD in an exclusively breastfed neonate has been documented in national literature, reflecting a substantial gap in national evidence. This scarcity of data underscores the under-recognition of the condition, and highlights the importance of the current study in providing one of the first comprehensive descriptions of its clinical spectrum, risk factors and immediate outcomes in a tertiary-care setting in Pakistan.[17] This limited reporting may reflect a lack of awareness among physicians in the region or the nonspecific clinical manifestations of this condition.

The current study noted no significant seasonal variation in occurrence, except that fewer cases were identified in winter. In a case series, most of NHD cases were seen in the summer months.[18]

in terms of clinical manifestations, the most common symptoms were lethargy (51.2%), poor feeding (58.2%) and dehydration (45.2%) in the current study. These nonspecific findings often obscure early recognition, as affected neonates may initially appear well despite significant underlying pathology. Findings from other studies highlight variability in presentation. One study reported that the predominant symptoms included poor feeding (85.71%), fever (45.71%), loose stools (42.8%) and decreased urine output (8%).[19] Another study identified excessive weight-loss (88.2%), lethargy (58.8%), jaundice (52.9%) and fever (41.1%).[14] In contrast to the current study, fever was a common finding at presentation in several studies.[20] These differences emphasise the need for heightened clinical vigilance and thorough assessment to ensure early detection and management of NHD.

In the current study 43(61.4%) neonates had weight-loss >10% of their birthweight. One study reported 88.2% weight-loss.[14] However, no significant relation was found between weight-loss and HD severity. Although the current study was conducted in an urban tertiary-care setting and did not include formal rural-urban comparisons, differences in health-seeking behaviour may have influenced how and when HD neonates presented to healthcare services. Variability in access to immediate postnatal follow-up, differing levels of awareness regarding early feeding difficulties, and delays in recognising concerning symptoms can all contribute to late presentation even within an urban population. These contextual factors, although not directly assessed in the study, may partially explain the range of clinical severity observed at admission.

The risk factors identified in the current study included being born to primigravida mothers (64.3%), early postnatal discharge (32.1%) and exclusive breastfeeding (72.6%). Primiparous without adequate lactation support and monitoring is the risk factor identified in many studies from different regions of the world, establishing its significance as the main culprit.[14,18,21] In contrast, a recent study has identified no significant relation between exclusive breastfeeding and hypernatraemia.[2] The association between identified risk factors and HD occurrence highlights the need for a more structured approach to breastfeeding support and early postnatal care. Beyond educating mothers, effective preventive strategies should include access to skilled lactation support, early follow-up visits within 48-72 hours after discharge, and routine post-discharge weight checks to detect inadequate milk transfer at an early stage. Where feasible, extending postnatal observation or delaying discharge until effective breastfeeding is firmly established can further reduce the likelihood of feeding-related complications. Implementing these measures in routine newborn care may help identify at-risk infants earlier, and prevent avoidable morbidity.

Complications arising from NHD were observed in 22.6% of the current cases, with AKI being the most prevalent (19%). In earlier studies renal injury has been reported to be 11%[19] and 8% .[22] This highlights the potential severity of NHD and its impact on neonatal health outcomes.

Most of the current neonates (90.5%) were discharged in

a stable condition. However, the mortality rate of 7.1% indicates that early intervention is crucial to preventing adverse outcomes. Severe hypernatraemia is likely to increase case fatality.[23] Statistical analysis revealed a significant association between hypernatraemia severity and laboratory findings, such as serum creatinine level and prothrombin time, reinforcing the need to monitor these parameters during treatment.

The current study has certain limitations. Being a single-centre study, the results may not fully represent practices and population characteristics across other healthcare settings. The retrospective design also relies on the accuracy and completeness of medical records, which may have introduced documentation-related bias. Additionally, some potentially relevant maternal or perinatal variables could not be assessed due to limited availability of standardised data. Finally, only univariate analyses were performed, as the sample size was insufficient to support a reliable multivariate regression model. Despite thee constraints, however, the study provides valuable insight into the burden, risk factors and clinical outcomes of HD in late-preterm and term neonates, highlighting areas where improved feeding support and structured follow-up can make a meaningful difference.

Future work should include prospective, multicentre studies to better define the true HD burden, and identify early markers that can guide timely recognition. Developing standardised feeding assessment tools and implementing validated post-discharge follow-up pathways may allow earlier detection of at-risk infants. Integrating structured breastfeeding support, both hospital-based and community-based, into routine newborn care could strengthen early intervention. Evaluating the effectiveness of safe discharge policies and quality-improvement initiatives will also help inform system-level changes. Continued research in these areas is essential to build more consistent prevention strategies and improve neonatal outcomes.

Conclusion

The HD burden was significant in late-preterm and term neonates, highlighting its clear association with early discharge, insufficient breastfeeding support, and delayed follow-up. Prompt recognition and timely management remain essential to preventing severe complications, such as AKI and shock.

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AUTHORS' CONTRIBUTIONS:
NS: Concept.
VK: Drafting.
SN: Data analysis.
MS: Data collection and interpretation.
HMH: Agreement to be accountable for all aspects of the work.
HZ: Review and final approval.