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ORIGINAL RESEARCH



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Point-of-Admission Hypothermia and Its Correlates Among Hospitalised Neonates at the Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria

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Abstract

Background: Neonatal hypothermia is a preventable cause of mortality, but its burden is poorly researched.

Objective: To determine the prevalence of point-of-admission hypothermia, causes and outcomes among hospitalised neonates.

Methods: This is a retrospective study conducted among neonates aged 0–28 days admitted to the Usmanu Danfodiyo University Teaching Hospital, Sokoto, from 1st January to 30th June 2025. Data were extracted from the case folders using a structured proforma; the data included socio-demographic information, gestational age and anthropometrics. Admission axillary temperature was measured using a low-reading axillary mercury thermometer and was classified according to WHO thresholds.

Results: Of the 258 neonates admitted within the study period, 230 (89.1%) had records of temperature measurement. They comprised 149 (64.8%) males and 81 (35.2%) females. The mean admission temperature was 37.0±1.2°C (range: 33.0-42.0°C). Point-of-admission hypothermia was recorded in 68 (29.6%) neonates, of which 44 (64.7%) were mild, 24 (35.3%) were moderate, but none were severe. Common diagnoses associated with hypothermia included birth asphyxia (34; 43.0%), prematurity (19; 50%) and neonatal sepsis (6; 9.5%). Hypothermia was significantly associated with low birth weight (p = 0.03), diagnosis at admission (p = 0.001) and poor outcome (p = 0.002). There were 5 (2.2%) mortalities, and all of them had hypothermia.

Conclusion: Point-of-admission hypothermia occurred in about a third of neonates admitted. Asphyxia and prematurity were the leading conditions associated with hypothermia. Hypothermia was also associated with increased risk of mortality.

Keywords: Hospitalisation, Low Birth Weight, Neonatal sepsis, Perinatal asphyxia, Preterm care, Thermoregulation.

Introduction

Neonatal hypothermia, defined by the World Health Organisation as a core body temperature below 36.5°C, is a major but under-recognised contributor to neonatal morbidity and mortality, particularly in low- and middle-income countries

(LMICs).[1] The transition from intrauterine to extrauterine life is a critical physiological period during which effective thermoregulation is essential for survival. Failure to maintain thermal stability significantly increases the risk of respiratory distress, hypoglycaemia, metabolic acidosis, sepsis, and death, especially among preterm and low-birth-weight infants. [2,3] Neonatal hypothermia remains a widespread global health concern, with prevalence ranging from 32% to over 80% in hospital settings and even higher in community studies. An estimated 17 million newborns develop hypothermia annually, with sub-Saharan Africa bearing a disproportionate burden. [4,5] In Nigeria, neonatal mortality remains high at approximately 36 per 1,000 live births, [6] and hypothermia contributes significantly to preventable deaths. Recent studies from northern Nigeria reported admission hypothermia rates up to 72.9% among preterm infants, strongly associated with low birth weight and out-of-facility deliveries.[7]

Newborns lose heat through evaporation, conduction, convection, and radiation.[8] Preterm infants are particularly vulnerable due to immature thermoregulatory mechanisms.[3] Established risk factors for hypothermia include prematurity, low birth weight, delayed breastfeeding, absence of skin-to-skin care, and poor adherence to WHO "warm chain" practices.[1,3] Studies from sub-Saharan Africa have reported similarly high prevalence rates, including 60.9% in Ethiopia and over 60% in Uganda.[5,9]

Despite this burden, there is limited context-specific data on neonatal hypothermia in North-Western Nigeria. Furthermore, gaps in clinical documentation, including admission clerking practices, may hinder early detection and management of hypothermia. A recent audit conducted in the neonatal unit of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto reported suboptimal documentation of key clinical parameters, including vital signs such as body temperature.[10] This study, therefore, aimed to determine the prevalence and correlates of neonatal hypothermia at admission into the SCBU of UDUTH, Sokoto.

Methods

Study design and setting

This was a hospital-based, retrospective study conducted at the Special Care Baby Unit (SCBU) of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto, Nigeria. Sokoto State is located in the north-western region of Nigeria, between latitude 12°-14°N and longitude 4°- 6°E.[11,12] It has a Sudano-Sahelian climate characterized by a prolonged dry season and high ambient temperatures.[12] The population is predominantly Hausa and Fulani, with socioeconomic and environmental factors influencing healthcare access and neonatal outcomes.[11,13]

The SCBU has 30 beds and is equipped with incubators, radiant warmers, phototherapy units, oxygen delivery systems, and there are provisions for Kangaroo Mother Care (KMC) in the unit when indicated. The unit manages approximately 500 neonatal admissions annually, including both inborn and outborn or referred neonates.[14]

Ethical approval for the study was obtained from the Ethics and Research Committee of the hospital. Confidentiality of patient information was ensured with coded identifiers, and all data were securely stored to prevent unauthorised access.

Study population

Neonates aged 0–28 days who were admitted to the SCBU from 1st January to 30th June 2025 and met the inclusion criteria were included.

Inclusion criteria:

1. Neonates.
2. Documented admission temperature.
3. Complete clinical and demographic data.

Exclusion criteria:
Neonates with missing temperature records or incomplete key variables such as mode of delivery, place of birth, pregnancy status, etc., were excluded.

Sample size and sampling technique
A consecutive sampling technique was used. A total of 230 neonates met the inclusion criteria.

Data collection
Data for the study were extracted using a structured proforma from case files. The variables collected comprised both socio-demographic and clinical characteristics. Socio-demographic variables included age, sex, birth weight, and gestational age, while clinical variables encompassed mode of delivery, place of birth, diagnosis, admission temperature, and patient outcome. Admission temperature was measured using skin temperature probes attached to incubators and radiant warmers, or digital axillary electronic thermometers and was recorded. Neonatal temperatures are measured immediately at presentation and during the course of admission in the unit. Temperature at admission was classified according to World Health Organisation (WHO) criteria. [1] Normothermia was defined as a temperature range of 36.5–37.5°C, mild hypothermia as 36.0–36.4°C, moderate hypothermia as 32.0–35.9°C, and severe hypothermia as a temperature below 32°C. The outcome measures for the study included both primary and secondary endpoints. The primary outcome was the prevalence of admission hypothermia among the study population. Secondary outcomes included the severity of hypothermia, associated risk factors, and mortality. Admission temperature measured in the morning (7:30 am-2:30 pm), evening (2:30 pm- 8:30 pm), and night (8:30 pm- 7:30 am) shifts was recorded and compared. The prevalence of hypothermia and severity per month of admission were recorded.

Data analysis
This was performed using IBM SPSS version 25. Categorical variables were summarised using frequencies and percentages, while continuous variables were expressed as means and standard deviations. The associations between variables were assessed using the Chi-Square test or Fisher's Exact test, as appropriate. Odds ratios with 95% confidence intervals were calculated to determine the strength of associations, and statistical significance was set at a p-value of less than 0.05.

Results

Study population demographics (Tables I and II)
During the six-month study period, a total of 258 neonates were admitted to the SCBU. Of these, admission temperature was recorded in 230 (89.1%) infants, and this formed the basis of this analysis.
The sex distribution showed a male predominance, with 149 males (64.8%) and 81 females (35.2%), giving a male-to-female ratio of 1.8:1.

Prevalence of hypothermia at admission
The mean admission temperature for the entire cohort was 37.0 ± 1.2°C, with a range of 33.0°C to 42.0°C. The prevalence of point-of-admission hypothermia was 29.6% (n = 68). The severity distribution was as follows: 44 (64.7%) had mild hypothermia, 24 (35.3%) had moderate hypothermia, but no neonate had severe hypothermia.

Table I: Distribution of neonates according to clinical characteristics

Variable		Frequency (%)
Sex	Male	149 (64.8)
	Female	81 (35.2)
Age at presentation	<72 Hours	49 (21.3)
	>72 Hours	174 (75.7)
	Missing data	7 (3.0)
Gestational Age	Term	174 (75.7)
	Preterm	56 (24.3)
Place of birth	Inborn	154 (67.0)
	Outborn	75 (32.6)
	Missing data	1 (0.4)
Antenatal Care Booking	Booked	203 (88.3)
	Unbooked	17 (7.4)
	Missing data	10 (4.3)
Birthweight Group	Normal	138 (60.0)
	Macrosomia	7 (3.0)
	LBW	74 (32.2)
	Missing data	11 (4.8)
Mode of delivery	SVD	165 (71.7)
	C/S	54 (23.5)
	Assisted Delivery	11 (4.8)
Body temperature group	Normothermia	99 (43.0)
	Hypothermia	68 (29.6)
	Hyperthermia	63 (27.4)

LBW - Low birth weight; SVD - Spontaneous vaginal delivery; C/S - Caesarean section.
Inborn – Babies who are born within the study hospital, Outborn – Babies born in other hospitals and referred.

The mean gestational age, birthweight and age at presentation were 37.8 weeks, 2.6kg and 56.8 hours, respectively.

Table II: Mean values of clinical parameters of the subjects

Parameters	Mean	Range
Temperature (°C)	37.0±1.2	33.0-42.1
Age at Admission (Hours)	56.8±96	1-672
Birth weight (Kg)	2.64±0.8	0.95-4.60
Gestational Age (Weeks)	37.86±3.248	28-41
OFC (cm)	33.72±3.194	26-41
Length (cm)	46.85±4.350	32-58

Correlates of Hypothermia

Common clinical diagnoses among hypothermic neonates included perinatal asphyxia (34; 43.0%), prematurity (19; 50.0%), sepsis 6 (9.5%). There was a significant association between LBW and hypothermia (p=0.03) as depicted in Table V.

Prevalence of hypothermia by months of admission (Table III)

Most cases of neonatal hypothermia were recorded in May (26.5%; 59/223), followed by January (21.5%; 48/223), while the least was recorded in February (6.3%). Overall, mild hypothermia was more frequent than moderate hypothermia across most months.

Prevalence of hypothermia by shifts

Most cases of neonatal hypothermia were recorded during the evening shifts (61.0%; 136/223), with the moderate type being the most frequent in the same shift.

Table III: Prevalence of hypothermia and severity on a monthly basis

Month	Frequency (%)	Mild Hypothermia n (%)	Moderate Hypothermia n (%)	Normothermia n (%)
January	48 (21.5)	18 (37.5)	9 (18.8)	21 (43.8)
February	14 (6.3)	3 (21.4)	4 (28.6)	7 (50.0)
March	37 (16.6)	5 (13.5)	4 (10.8)	28 (75.7)
April	40 (18.0)	2 (5.0)	3 (7.5)	35 (87.5)
May	59 (26.5)	11 (18.6)	2 (3.4)	46 (78.0)
June	25 (11.2)	2 (8.0)	2 (8.0)	21 (84)

Table IV: Hypothermia cases and severity recorded per duty shift

Shift	Frequency (%)	Mild Hypothermia n (%)	Moderate Hypothermia n (%)	Normothermia n (%)
Morning	47 (21.1)	5 (10.6)	2 (4.3)	40 (85.1)
Evening	136 (61.0)	25 (18.4)	18 (13.2)	93 (68.4)
Night	40 (18.0)	11 (27.5)	4 (10.0)	25 (62.5)

Table V: Factors Associated with hypothermia among neonates

Variable	Hypothermia n (%)	No Hypothermia n (%)	Chi-Square (χ^2)	p-value	Odd Ratio
Birth weight					
Normal	38 (26.2)	107 (73.8)	$\chi^2 = 4.702$	0.03	1.920(1.060-3.476)
LBW	30 (40.5)	44 (59.5)			
Gestational age					
Preterm	21 (37.5)	35 (62.5)	$\chi^2 = 2.238$	0.135	1.621(0.858-3.063)
Term	47 (27.0)	127 (73.0)			
Place of birth					
Inborn	48 (31.2)	106 (68.8)	$\chi^2 = 0.913$	0.634	1.245
Outborn	20 (26.7)	55 (73.3)			
Diagnosis					
PNA	34 (43.0)	45 (57.0)	$\chi^2 = 37.723$	<0.001	
Prematurity	19 (50.0)	19 (50.0)			
Sepsis	6 (9.5)	57 (90.5)			
Outcome					
Alive	63 (28.4)	159 (71.6)	$\chi^2 = 13.321$	0.001	
Dead	5 (100.0)	0 (0.0)			

LBW – low Birth Weight; PNA – Perinatal asphyxia

Mortality and outcome analysis

The overall mortality rate in the study cohort was 2.2% (5 deaths). Most deaths occurred in those with moderate hypothermia 4 (80%), while 1

(20%) had mild hypothermia. Prematurity was diagnosed in 3 (60%) of the deceased neonates and perinatal asphyxia in 2 (40%). All deaths occurred within 72 hours of admission. There was a significant association between hypothermia and mortality (p = 0.002).

Discussion

The study assessed the prevalence of hypothermia at the point of admission and its correlates among neonates seen at the Special Care Baby Unit (SCBU) of UDUTH, Sokoto. This study found a point-of-admission hypothermia prevalence of 29.6% among hospitalised neonates; this cohort comprised 48 (70.6%) males and 20 (29.4%) females. Although lower than figures reported in several sub-Saharan African settings, this prevalence remains clinically significant and represents nearly one in three admitted neonates. Compared with reports from Ethiopia (60.96%)5 and other rural African settings where prevalence often exceeds 50%, our finding suggests relatively better thermal care practices within the referral chain to UDUTH.

Contextual and health system differences may explain the discrepancy. UDUTH is an urban tertiary centre, and a substantial proportion of neonates are either inborn or referred from facilities within relatively short transport distances. In contrast, studies reporting higher prevalence often include neonates transported over long rural distances without adequate thermal protection, frequently using open vehicles or motorcycles. Delays in referral, lack of transport incubators, and limited caregiver awareness of the “warm chain” likely contribute to more severe hypothermia in such settings. This study did not include mode and means of transportation and distance from referring to peripheral hospitals or homes.

It is good to note that the recorded monthly cases of hypothermia showed that point-of-admission hypothermia cases were higher in January. This observation may be because January falls in the harmattan period in Sokoto. However, the study period did not extend throughout the year. Most of these hypothermia cases were also found to have been presented in the evening shifts, which is the period when the cold might have set in.

The observed male predominance (70.6%) among hypothermic neonates aligns with global neonatal epidemiology, where male neonates consistently demonstrate increased vulnerability to perinatal morbidity and mortality.[14] Biological explanations include relatively delayed pulmonary maturation, hormonal influences affecting stress response, and possible differences in brown adipose tissue metabolism.[15,16] While gender itself may not directly cause hypothermia, it likely interacts with other perinatal stressors such as asphyxia and prematurity to amplify vulnerability.

The mean admission temperature of 37.0°C falls within the normothermic range; however, the wide temperature range observed in this study underscores variability in pre-admission thermal practices. The presence of both mild and moderate hypothermia, without cases of severe hypothermia, may suggest relatively early presentation or partial thermal protection during transport. This pattern is encouraging because it indicates opportunities for intervention before progression to severe hypothermia, which is strongly associated with metabolic acidosis, coagulopathy, hypoglycemia, and death. According to the WHO classification (1997), even mild hypothermia (36.0 - 36.4°C) is clinically significant and should not be regarded as benign, particularly in low-resource settings where comorbidities are common.

The major comorbidities associated with hypothermia in this study were prematurity (50.0%), perinatal asphyxia (43.0%), and neonatal sepsis (9.5%). Prematurity predisposes

neonates to hypothermia due to several mechanisms: high surface area-to-body-mass ratio, thin skin with increased transepidermal water loss, reduced subcutaneous fat, and immature hypothalamic thermoregulation. Additionally, preterm neonates have limited glycogen stores, making them more susceptible to hypoglycemia when exposed to cold stress.[17] Perinatal asphyxia impairs thermoregulation through reduced metabolic heat production, impaired oxygen delivery to brown adipose tissue, and central nervous system depression. Hypoxic-ischemic injury also diminishes the neonate's ability to initiate non-shivering thermogenesis.[16,18] In such infants, hypothermia may not merely be environmental but a consequence of systemic metabolic failure. Prolonged exposure during resuscitation may also be a cause of hypothermia in these neonates. Sepsis further compounds thermal instability. Infection disrupts hypothalamic temperature regulation and increases metabolic demand. [19,20] While fever may occur in older children, neonates, especially preterm infants, often present with hypothermia as a manifestation of overwhelming infection. Therefore, hypothermia in our cohort may represent both a cause and a consequence of systemic illness.

A statistically significant association between low birth weight (LBW) and hypothermia, in this study reinforces the established evidence that LBW infants are particularly vulnerable to thermal instability. [17] The increased odds reported in similar African studies (e.g., OR 5.32 in Ethiopia) highlight the magnitude of risk. In Sokoto, where rates of maternal malnutrition, teenage pregnancy, and limited antenatal care persist in some communities, LBW remains prevalent and likely contributes substantially to neonatal thermal morbidity. [21-23] A recent review of neonates admitted into the special care baby unit of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto, by Adamu and her colleagues, [24] reported that among 818 admissions in 2022, the main reasons for admission were perinatal asphyxia (30.0%) and prematurity (22.3%).

The overall mortality in this study was 18.2%, with most deaths attributed to complications of prematurity (40.9%) or birth asphyxia (39.6%). Although this study did not report detailed temperature-tracking data, its findings underscore the dominance of prematurity and asphyxia as contributors to neonatal mortality in their SCBU, consistent with the notion that thermal instability (hypothermia), particularly in preterms, is a significant, yet under-recognised, risk factor for adverse outcomes. Perhaps the most clinically compelling finding is the significant association between hypothermia and mortality, which supports the evidence that hypothermia significantly increases neonatal mortality risk, [25] with all recorded deaths occurring among hypothermic neonates. This finding supports the concept of hypothermia as a "mortality amplifier''. [26] Cold stress increases oxygen consumption, exacerbates metabolic acidosis, induces hypoglycemia, impairs surfactant production, and worsens pulmonary hypertension.[18,27,28] In neonates already compromised by asphyxia or prematurity, hypothermia may tip the balance towards multi-organ failure. Hypothermia is not benign. A study in Ethiopia showed that it is associated with prolonged hospital stay and complications like sepsis. [5]

Not all the neonates in this study had their temperature documented on admission, as only 230 out of 258 had such a record. This is an improvement when compared to the situation reported three years ago, in the same unit where a study by Adamu *et al.* [10] revealed suboptimal documentation practices and only 43.6% had documented temperature at admission. This probably reflects improved practices in the unit following the previous work and it may be an

indication that there is a chance for improvement in thermal care practices following this study. In Sokoto and similar northern Nigerian settings, cultural practices surrounding childbirth and neonatal care may influence thermal outcomes. Early bathing, delayed initiation of breastfeeding, and inadequate wrapping during harmattan (cold season) may increase the risk of cold stress. In a nine-year retrospective study of abandoned neonates admitted to the SCBU of UDUTH, 53.8% of these infants presented with hypothermia at the time of admission (alongside hypoglycemia and sepsis), illustrating that thermal instability is a common acute problem among vulnerable neonates in this unit, including preterm neonates. [29,30]

Strengths and limitations

This study benefits from a relatively large sample size and detailed extraction of clinical variables, enhancing internal validity. The focus on point-of-admission temperature provides practical insight into gaps within the referral and stabilisation chain. However, the retrospective design introduces potential information bias due to incomplete or inaccurately recorded temperatures. Temporal relationships between hypothermia and comorbidities cannot be definitively established. As a single-centre study, the findings may also not be generalizable to rural or primary care settings. Additionally, environmental variables (e.g., seasonality, transport conditions) were not systematically analysed and may have influenced results.

Conclusion

Point-of-admission hypothermia affects nearly one-third of hospitalised neonates at UDUTH, Sokoto. It is significantly associated with perinatal asphyxia, prematurity, low birth weight, and increased mortality. Although all the cases were mild to moderate, the strong association with death underscores its clinical significance. Hypothermia remains largely preventable through simple, evidence-based, and low-cost interventions. Strengthening adherence to the WHO warm chain, expanding Kangaroo Mother Care, improving referral transport systems, and embedding culturally sensitive community education strategies are urgent priorities.

Based on the findings in this study, there is a need to strengthen routine temperature monitoring and documentation practices for hospitalised neonates to ensure early identification and prompt management of hypothermia. Greater emphasis should be placed on adherence to the WHO warm chain practices, and particular attention should be given to high-risk neonates such as those who are preterm, of low birth weight, or affected by perinatal asphyxia. Regular training of healthcare workers and caregiver education on neonatal thermal care, especially during the harmattan season, should be encouraged. Furthermore, improving referral and transport systems to maintain thermal stability during transfer of neonates may help reduce the burden of hypothermia and improve neonatal survival outcomes in the study setting. Integrating newborn thermal care messages into community structures, including religious and traditional institutions, could enhance acceptance and uptake.

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