Scientific Research Publishing

Open Journal of Pediatrics, 2026, 16(3), 493-502
https://www.scirp.org/journal/ojped
ISSN Online: 2160-8776
ISSN Print: 2160-8741

Factors Associated with Hypothermia in the Neonatology Unit of the Ouémé-Plateau Departmental University Hospital Center

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How to cite this paper: Bognon, G., Tchiakpe, N., Ladjouan, M., Dyne, B., Padonou, C. and Dai Tometin, O. (2026) Factors Associated with Hypothermia in the Neonatology Unit of the Ouémé-Plateau Departmental University Hospital Center. *Open Journal of Pediatrics*, **16**, 493-502.
https://doi.org/10.4236/ojped.2026.163049

Received: January 15, 2026
Accepted: May 24, 2026
Published: May 27, 2026

Abstract

Introduction: Neonatal hypothermia is common, and thermoregulation remains a major physiological challenge for the newborn. The objective of this study was to investigate the factors associated with hypothermia in the neonatology unit of the pediatric department at CHUD-OP. **Methods**: This was a cross-sectional, descriptive, and analytical study conducted from March 1 to May 31, 2024. It involved newborns admitted to the neonatology unit of CHUD-OP who experienced hypothermia. Data analysis was performed using the R software, version 4.3.2. The significance level was set at 5%. **Results**: The prevalence of hypothermia was 62.1% (n = 663). The majority of newborns (n = 467; 70.4%) had hypothermia upon admission. The median age was 19 hours, with extremes ranging from 3 minutes to 631 hours. The sex ratio was 1.2. Nearly half of the newborns (n = 278; 41.9%) were premature. Less than one-third (29.6%, n = 196) were transported in a warm manner. The main causes of hypothermia were neonatal infections, low birth weight, and perinatal asphyxia. Almost all newborns were warmed (n = 639; 96.4%). The mortality rate was 15.2%. The main factors associated with hypothermia upon admission were age ($p < 0.001$), low birth weight ($p = 0.02$), and the absence of warm clothing ($p < 0.001$). **Conclusion**: The prevalence of hypothermia is high in the neonatology unit at CHUD-OP, increasing neonatal mortality. It is therefore essential to adhere to the elements of the warm chain to achieve sustainable development goal 3.

Keywords

Neonatal Hypothermia, Low Birth Weight, Warm Chain

1. Introduction

Neonatal hypothermia is defined as a core temperature lower than 36.5˚C in a newborn, whether full-term or not [1] [2]. It is a very common problem worldwide, with a prevalence ranging from 11% to 95% [3]-[5]. The prevalence of hypothermia is 57.2% in East Africa, compared with 82% in Asia (India), 31.6% in America and 48.4% in Europe (Italy) [6]-[9].

Neonatal hypothermia is one of the most significant risk factors for morbidity and mortality in newborns of all birth weights and gestational ages. Premature and low birth weight newborns are particularly more susceptible to hypothermia, and the consequences can be severe, leading to apnea, hypoglycemia, and poor weight gain [6]. Thermoregulation remains a major physiological challenge faced by a newborn after birth [10]. At CHUD-OP, despite a focus on prevention, hypothermia is still common and has been associated with high morbidity. The purpose of this study is therefore to assess the prevalence of neonatal hypothermia and to determine the associated factors in the neonatology unit of the pediatric department at CHUD-OP, in order to improve its management.

2. Methods

This was a prospective, cross-sectional study with descriptive and analytical aims, conducted over five months from March 1 to May 31, 2023. Sampling was exhaustive and included all newborns, regardless of gestational age, who presented with hypothermia and were treated in the neonatology unit of CHUD-OP during the study period. Temperature was taken for all newborns upon admission and during hospitalization, initially every 4 hours and then every 30 minutes until normalization if the newborn presented with hypothermia. It was measured with an electronic thermometer and considered hypothermia if below 36.5˚C. All newborns with hypothermia were included and systematically received treatment appropriate to the etiology. The variables studied were socio-demographic (identity, age, gender, origin of the newborn, date and time of admission), related to childbirth (gestational age, time and place of birth, birth weight, condition at birth, resuscitation at birth, skin-to-skin contact, early breastfeeding), related to the transport of the newborn (means of transport, cold protection measures: appropriate wrapping, warm clothing, wearing a hat and booties, warm clothing, transport incubator), clinical (temperature at admission, weight at admission, clinical condition at admission), therapeutic (cleaning of the newborn, warming table, early feeding, authorized feeding on the day of hypothermia, continuous infusion of 10% glucose solution, delay in weighing), and progressive (hypothermia during hospitalization, complications related to hypothermia, mode of discharge: recovery, death, discharge against medical advice, date and time of discharge, length of hospitalization).

Data were collected using a questionnaire. Analysis was conducted using R software, version 4.3.2. Absolute and relative frequencies were calculated for qualitative variables. Quantitative variables were expressed as mean and standard devia-

tion because they all followed a normal distribution. The normality of the distribution was verified using the Shapiro-Wilk test. To identify associated factors, bivariate analyses were performed between the dependent variable and each independent variable. Proportions were compared using Fisher's exact test and Pearson's chi-squared test. Fisher's exact test was used when the smallest expected count was less than 5. A difference was considered statistically significant for a p-value less than 0.05. The strength of the association was assessed using the odds ratio (OR) and its confidence interval.

3. Results

At the end of this study, 663 newborns were included out of a total of 1,067 admitted, resulting in a hospital prevalence of 62.1%. The newborns experienced hypothermia at admission (70.4%; n = 467) and during hospitalization (29.6%; n = 467). More than three-quarters (87.9%; n = 583) of the newborns were less than 24 hours old at admission. Premature newborns represented nearly half of the children (41.9%; n = 278). The median age was 19 hours, with extremes ranging from 3 minutes to 631 hours. There was a male predominance (54.6%; n = 362) with a sex ratio of 1.2. The majority of the newborns (73.8%; n = 489) came from the CHUD-OP maternity ward (in-born) and were delivered vaginally (56.0%; n = 371). More than half had a low birth weight (53.7%; n = 356). At birth, the Apgar score was good (greater than 7) in the majority of children (67.1%; n = 445), intermediate (between 4 and 7) in more than a quarter (27.8%; n = 184), and poor (less than 4) in a minority (5.1%; n = 34).

Few newborns (0.8%; n = 5) benefited from early breastfeeding, and less than half (40.9%; n = 271) had skin-to-skin contact with their mother at birth. All in-born newborns were transported on foot. The out-born newborns were transported by motorcycle (56.9%; n = 99), by medical vehicle (35.1%; n = 61), or non-medical vehicle (8%; n = 14).

Less than a third of the included newborns (29.6%; n = 196) were transported in a warm manner. No newborns had an intra-hospital transport with skin-to-skin contact with their mother. The newborns from the maternity ward were wrapped in a cloth. No ambulance was equipped with a transport incubator.

The main pathologies found in the newborns are presented in Table 1.

In the neonatology unit, almost all newborns were warmed on a warming table (96.4%, n = 639) and nearly all received a continuous infusion of 10% glucose solution (91.4%, n = 606). The room temperature was appropriately adjusted in almost all cases (98.6%, n = 654). Few children had the delay in weighing (1.4%; n = 9) and early feeding (5.9%; n = 39). Recurrence of hypothermia after 24 hours of hospitalization was noted in most of the newborns who had it at admission (48.4%; n = 321). The outcome was marked by recovery in the majority of the children (84.7%; n = 502). The observed mortality rate was 15.2% (n = 101).

The main factors associated with hypothermia at admission were age less than 24 hours, prematurity, low birth weight, and lack of warm clothing. The relation-

ship between hypothermia and these associated factors is detailed in Table 2.

Table 1. Distribution of newborns according to the diagnosis chosen.

	Numbers	Percentage
IMF/INN	319	48.1
Prematurity	217	32.7
Hypotrophy	161	24.3
APN	157	23.7
Jaundice	110	16.6
Hypoglycemia	19	2.9
Congenital malformation	13	2.0
Exposed to HIV	12	1.8
Congenital heart disease	7	1.1
Hypocalcemia	7	1.1
Neonatal trauma	5	0.8
Macrosomia	5	0.8
Neonatal anemia	3	0.5
Congenital malaria	2	0.3
MHNN	1	0.2
Post term	1	0.2

Table 2. Relationship between hypothermia at admission and sociodemographic data.

	Hypothermia on admission			
	n (%)	OR	95% IC	p-value
Age groups				**0.001**
≥1 day	44 (55.0)	1.00	-	
<1 day	423 (72.6)	2.16	1.34 - 3.48	
Term				**0.023**
≥37 weeks	258 (67.0)	1.00	-	
<37 weeks	209 (75.2)	1.49	1.06 - 2.11	
Birth weight				**0.012**
≥2500 g	198 (65.6)	1.00	-	
<2500 g	269 (74.5)	1.54	1.10 - 2.15	

Continued

Warm clothing				**0.001**
Yes	109 (60.9)	1.00	-	
No	358 (74.0)	1.82	1.27 - 2.62	

Neonatal infections ($p < 0.001$) and growth restriction ($p = 0.002$) were the main pathologies associated with the occurrence of hypothermia. The mortality rate was 2.5 times higher (OR = 2.54; 95% CI [1.45; 4.47]) in newborns who had hypothermia at admission compared to those who developed it during hospitalization.

4. Discussion

The hospital prevalence of hypothermia in our study was 62.1%, and nearly three-quarters of the newborns presented with this condition at admission. This high prevalence could be explained by non-compliance with measures contributing to the hot chain, in particular individual protection measures for newborns and the conditions under which newborns are transported to the neonatology unit. These various shortcomings were observed both in maternity hospitals referring children to the neonatology unit and in the CHUDOP maternity hospital. It is lower in a study conducted in 2023 in the USA, where it was 21.7%, and in Bangladesh in 2013, where it was 34% [11] [12]. Much higher prevalences were observed in Ethiopia and Iran in 2015, where the prevalences were 69.8% and 84%, respectively [13] [14]. This variation is not related to the level of advanced technology in the countries, given the prevalence in Iran and Bangladesh. In all these studies, the majority of newborns presented with hypothermia at admission.

The male predominance found in our study is reported in most African and Western studies [15]-[17]. The median age was 19.0 hours, and newborns less than 24 hours old were the most represented (87.9%). In most studies, more than three-quarters of admitted children were less than 24 hours old [12] [18] [19]. This could be explained by the difficulties in thermoregulation during the first 24 hours after birth, highlighting the importance of adhering to the measures of the warm chain. The majority of the newborns in our study came from the CHUD-OP maternity ward (73.8%). This poses a real problem in maintaining the warm chain in our hospitals. It is therefore urgent to revisit the principles of the warm chain to prevent neonatal hypothermia in the hospital setting. In most emerging countries, premature infants are heavily affected by hypothermia. They represent nearly half of the newborns (41.9%) in our study, 47.6% in Kenya in 2021, and 63.5% in India in 2021 [6] [20]. In contrast, a study conducted in the USA in 2023 on neonatal hypothermia reported a low rate (5.6%) [12]. This relatively high frequency of premature births results from poverty in third-world countries and poor pregnancy monitoring in our region. Additionally, the CHUD-OP is a referral hospital where pathological pregnancies and cases of threatened premature delivery are referred. More than half (53.7%) of the newborns had a low birth weight. This finding is reported

in studies conducted in Ethiopia in 2018 and Rwanda in 2019, where the rates were 55.7% and 83.6%, respectively [10] [19]. In contrast, in Iran and the USA, it is low, at 33.1% and 4.3%, respectively [12] [21] [22]. Growth restriction is a risk factor for hypothermia, which explains the high prevalence among low birth weight newborns. More than a quarter of the newborns (28.2%) were resuscitated at birth, similar to a study conducted in Ethiopia in 2018, which reported that 33.33% of newborns were resuscitated at birth [19]. Obstetric complications and poor monitoring of labor in third-world countries lead to perinatal asphyxia, which accounts for the high proportion of resuscitated newborns. Less than half of the newborns (40.9%, n = 271) benefited from skin-to-skin contact. The poor clinical condition of newborns or their mothers would be a hindrance to skin-to-skin contact in referral hospitals that handle pathological pregnancies. This obstacle also explains why very few newborns (0.8%) received early breastfeeding in our study. However, in Ethiopia in 2019, Minuye reported a higher rate of 67.04% in a hospital-based study [15]. All newborns from the CHUD-OP maternity ward were transported on foot. They were wrapped in a cloth without a hat and carried in the arms of a caregiver. In the absence of a transport incubator, during pedestrian transport, one should ensure the newborn is kept warm by wrapping them in a dry, warm cloth with a hat on their head. The use of plastic bags could be an alternative for very low birth weight newborns. Of the 174 newborns from outside CHUD-OP, more than half were transported on a motorcycle (56.9%). They were thus exposed to the elements. It is therefore necessary to provide ambulances equipped with transport incubators for the medical transfer of newborns. Protective measures are an integral part of the warm chain to be maintained throughout the transport of the newborn as well as during hospitalization by healthcare staff. Nearly all newborns with hypothermia had a health problem, as reported by several authors [14] [15] [23]. The main pathologies diagnosed in newborns with hypothermia were neonatal infections, prematurity, growth restriction, perinatal asphyxia, jaundice, and hypoglycemia, as reported by several authors in the literature [7] [24]. Protective measures against cold, such as delaying weighing (1.4%), dressing the newborn in warm clothing (0.8%), early and regular feeding (5.9%), and kangaroo mother care (3.9%), were applied to only a minority of the newborns. This could be explained by the fact that most newborns treated in the unit were ill, and these measures could be contraindicated depending on the newborn's condition. This highlights the importance of continuous temperature monitoring and the availability of equipment to keep them warm. Kangaroo mother care has been shown to reduce neonatal mortality by increasing the survival of premature and growth-restricted infants. It is a simple, practical method that protects the newborn from hypothermia and infections, allows for rapid growth due to regular breastfeeding, and strengthens the bond between the mother and her newborn. The mortality rate was 15.2%, similar to that reported in a 2009 hospital study in Nigeria (16.7%) and lower than that reported in Rwanda in 2019 (26%) [18] [22]. Nevertheless, it is difficult to determine the extent to which hypothermia contributes to death in these newborns. This

study revealed that newborns less than 24 hours old were twice as likely to have hypothermia at admission compared to those older than 24 hours (OR = 2.16; 95% CI [1.34; 3.48]). In Bangladesh in 2013, a risk of 2.23 was reported (OR = 2.23; 95% CI [1.22; 4.00]) [11]. This could be due to the fact that newborns lack adequate brown adipose tissue and do not have shivering thermogenesis, making them incapable of thermoregulation. The first 24 hours of life are a high-risk period for hypothermia, especially if caloric needs are elevated due to other conditions. Premature newborns had a 1.5 times higher risk of developing hypothermia compared to full-term newborns (OR = 1.49; 95% CI [1.06; 2.11]). In Pakistan in 2012, premature newborns were 4.0 times more likely to develop hypothermia compared to full-term newborns [25]. This is explained by immature and thin skin that increases heat loss through radiation, poorly developed hypothalamic control, reduced glycogen stores, decreased fat for insulation, and a lack of brown adipose tissue. They therefore have a reduced ability to regulate their body temperature through non-shivering thermogenesis [26] [27]. Low birth weight newborns were 1.5 times more likely to have hypothermia compared to eutrophic ones (OR = 1.54; 95% CI [1.10; 2.15]). This risk is 8.51; 95% CI [2.7; 26.73] in a 2018 study on the determinants of hypothermia at admission in the neonatology unit of public hospitals in central Ethiopia [28]. Low birth weight newborns have ineffective thermoregulation. Neonatal infections increased the risk of hypothermia both at admission and during hospitalization (OR = 1.78; 95% CI [1.27; 2.50]). This risk was 3.10; 95% CI [1.06; 9.46] in a study conducted in 2015 in north-western Ethiopia [13]. This could be due to health problems increasing the energy needs of the newborn, consuming available energy, which leads to hypoglycemia and hypothermia. The mortality rate in our study (15.2%) represents 60.8% of neonatal deaths. The risk of neonatal death is multiplied by 2.5 if there is hypothermia at admission (OR = 2.54; 95% CI [1.45; 4.47]). Although it is difficult to determine the extent to which hypothermia contributes to deaths in these newborns, it is well known that hypothermia can impair the overall metabolism of the newborn, predispose them to hypoglycemia, increase oxygen consumption at the initial stage, depress respiration, and have adverse effects on central nervous system functions [29] [30].

5. Conclusion

Particular attention must therefore be paid to the thermal care of newborns, especially premature and low-birth-weight babies. The warm chain must be maintained in accordance with WHO recommendations. All newborns suffering from hypothermia must be properly cared for to avoid associated complications, in order to reduce neonatal mortality and achieve the MDG3 "Health and well-being for all".

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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