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Prevalence and factors associated with hypothermia among neonates born at selected health facilities in Kabale Municipality, south-western Uganda: a cross-sectional study

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Article

Keywords: Neonate hypothermia, neonate, newborn thermal care, warm chain, thermogenesis

Posted Date: October 30th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10985883/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

Global estimates of neonatal hypothermia ranges between 32% to 85%, with disproportionately higher rates reported in Sub-Saharan Africa. Reported prevalence varies widely between 50–83%, however, we never came across any published data that exists on the magnitude and prevalence of hypothermia in Kable Municipality and the wider Kigezi sub-region. We aimed to determine the prevalence and factors associated with hypothermia among neonates admitted at four health facilities in Kabale Municipality, south-western Uganda.

Methods

A cross-sectional study enrolled a total of 384 neonate consecutively between 1st April and 30th June, 2026 from the four facilities in Kabale Municipality, southwestern Uganda. Pproportionate to size sampling was used across study sites based on average monthly deliveries. Core temperature was measured using a digital rectal thermometer, and a structured, pre-tested questionnaire was used which can captured socio-demographic, maternal, newborn, obstetric, and newborn care characteristics. Multivariable logistic regression used to identify predictors of hypothermia in neonates.

Results

The prevalence of neonatal hypothermia was 50.3% (n = 193/384, 95% CI: 45.1–53.4%). After adjustment, factors independently associated with neonatal hypothermia were categorized into maternal and neonatal factors. Maternal factors included maternal level of education (primary; AOR = 1.35, 95% CI: 1.08–2.06), spouse's employment status (unemployed; AOR = 1.52, 95% CI: 1.37–1.69) mother having breastfeeding issues (absence versus presence; AOR = 1.59, 95% CI: 1.25–2.04), leaking liquor/premature rupture of membranes (AOR = 1.72, 95% CI: 1.27–2.32), and Mode of delivery (caesarean delivery: AOR = 1.84, 95% CI: 1.29–2.47). Neonatal factors included not wearing a cap after birth (AOR = 1.38, 95% CI: 1.08–2.21), and low birth weight (AOR = 1.68, 95% CI: 0.79–3.55).

Conclusions

Neonatal hypothermia affects approximately one in every two neonates admitted at these four Kabale Municipality facilities, underscoring it as a major public health concern in this setting. The high burden reflects the combined influence of maternal socio-demographic and obstetric characteristics alongside neonatal care practices, suggesting that no single intervention point is sufficient on its own. Given the substantial proportion of affected neonates, targeted facility-level interventions and continuous health

worker training on thermal care protocols are warranted to reduce the associated morbidity and mortality risks in this population.

Background

Neonatal hypothermia, commonly defined as a core body temperature below 36.5°C (1) within the first hours to days of life, remains a substantial but often overlooked contributor to neonatal morbidity and mortality worldwide. Even in tropical and sub-tropical settings, newborns are physiologically vulnerable to heat loss owing to their large surface-area-to-body-mass ratio, limited subcutaneous fat, and immature thermoregulatory capacity, and hypothermia has been linked to increased risk of neonatal sepsis, hypoglycaemia, respiratory distress, and death (2, 3)

The World Health Organization's Newborn Warm Chain outlines ten practical, low-cost interventions, including immediate drying, skin-to-skin contact, appropriate wrapping and capping, delayed bathing, and early breastfeeding, that together substantially reduce the risk of neonatal hypothermia (4). Despite this evidence base, reported prevalence of neonatal hypothermia across sub-Saharan Africa remains highly variable, ranging from 17.5% in a large Kenyan cohort to over 80% (5) among preterm and NICU-admitted populations in Ethiopia, reflecting differences in study populations, measurement timing, and the consistency of thermal care practice (6).

Globally, neonatal hypothermia prevalence ranges from 32–85%(5) in hospitals and 11–92% (7, 8) in home births, even in tropical climates. Hypothermia increases neonatal mortality risk, with odds rising by 28% for every 1°C decrease in admission temperature among low birth weight and preterm infants (2). Studies in Asia and Africa report 5–10-fold increases in mortality among hypothermic neonates (6, 9, 10).

In Sub-Saharan Africa (SSA), neonatal mortality remains the highest worldwide, with ≈ 27 deaths per 1,000 live births in 2019, accounting for 42% of global neonatal deaths (11). Hypothermia exacerbates risks associated with prematurity, birth asphyxia, infections, and congenital anomalies. Country-specific studies highlight high prevalence: Ghana (44.5% of readings hypothermic among low-birth-weight infants)(12), Nigeria (42.4% admission hypothermia)(13), East Africa pooled prevalence 57.2% (14), Kenya 17.5%(5) among admitted neonates, Tanzania 47% admission hypothermia, radiant warmers reduced mortality

Factors consistently associated with neonatal hypothermia include prematurity, low birth weight (3, 6, 15), delayed breastfeeding(15, 16), delayed skin-to-skin contact (6), inadequate wrapping, cold seasons, night-time deliveries(17), and maternal-related characteristics such as late antenatal booking or disability(13, 18, 19).

In Uganda specifically, a community-based study in the northern region reported a prevalence of 51% (18), and 67.6%(16) closely comparable to global systematic review estimates of 52.5% across 44,532 newborns in 13 countries (1). However, data from south-western Uganda, and from Kabale Municipality

in particular, a relatively cool, high-altitude district, remain scarce. Understanding the local prevalence and determinants of neonatal hypothermia in this setting is essential to inform targeted newborn care interventions. This study therefore aimed to determine the prevalence and factors associated with hypothermia among neonates admitted at Kabale Regional Referral Hospital (KRRH), Rugarama Hospital, Rushoroza Hospital, and Kamukira Health Centre IV in Kabale Municipality.

Methods

Study design

A cross-sectional design was used, conducted at four health facilities in Kabale Municipality, south-western Uganda between 1st April and 30th April. This design was chosen because it allowed simultaneous estimation of the prevalence of neonatal hypothermia and its associated maternal and neonatal factors within a defined time frame

Study setting

This study was conducted concurrently across four selected health facilities within Kabale Municipality, Kabale District, in South-Western Uganda. The four facilities, Kabale Regional Referral Hospital, Rugarama Hospital, Rushoroza Hospital, and Kamukira Health Centre IV were selected because, together, they represent the full spectrum of maternal and newborn care levels operating within Kabale Municipality, thereby capturing a representative cross-section of the municipality's obstetric population regardless of socioeconomic status, referral pathway, or facility ownership.

Kabale Regional Referral Hospital (KRRH) is a public, government-funded tertiary facility located in Kabale Municipality, approximately 426 kilometres from Kampala, and is one of the regional referral hospitals in Uganda. It serves an estimated population of about 2 million people drawn from the districts of Kabale, Kisoro, Rukungiri, Kanungu, and parts of Ntungamo, as well as cross-border populations from Rwanda and the Democratic Republic of Congo, making it the highest-level obstetric and neonatal referral point in the Kigezi sub-region. It functions as a general and teaching hospital for Kabale University, offering specialized emergency obstetric and newborn care, comprehensive theatre services for caesarean deliveries, and a special care newborn unit that receives high-risk and complicated referrals from lower-level facilities. KRRH was purposively included because, as the apex referral institution, it disproportionately manages complicated, pre-term, and low-birth-weight deliveries, a population inherently at higher risk of neonatal hypothermia and therefore anchors the upper end of clinical risk and delivery volume within the study catchment area.

Rugarama Hospital is a private, not-for-profit operating under the Church of Uganda (Anglican) health system within the Diocese of Kigezi. The hospital provides quality health care to poor communities at an affordable cost through curative and preventive medicine, offering services spanning maternity, surgery, dental, ophthalmology, and paediatrics. Hospital was included in this study because it represents the

private-not-for-profit, faith-based tier of maternal and newborn care in Kabale, drawing a distinct clientele, often church-affiliated communities and clients seeking a perceived higher standard of personalized care, thereby broadening the socioeconomic and care-seeking diversity of the sampled population.

Rushoroza Hospital, formally known as Our Lady of Good Health Hospital Rushoroza, is a private not-for-profit health facility operated by the Uganda Catholic Medical Bureau (UCMB. The hospital offers a wide range of services including laboratory services, maternity services, antenatal services, an ART clinic, inpatient and outpatient departments, ultrasound scanning, counselling, and an operating theatre, and it is administratively affiliated with the Catholic Diocese of Kabale. It has an approximate 200-patient bed capacity and is managed by the Catholic Church. Rushoroza Hospital was selected to represent the Catholic faith-based mission-hospital tier of care, which alongside Rugarama forms an important, historically-rooted pillar of maternal and newborn health service delivery in Kabale Municipality, and its inclusion ensured that clients preferentially attending Catholic-affiliated maternity services were proportionately represented in the sample

Kamukira Health Centre IV is a public, government-owned mid-level health facility and is the only Health Centre IV in Kabale Municipality, serving as the first-line public referral point below KRRH for the surrounding parishes. It serves a catchment population of approximately 8,778 people. Kamukira HC IV was included in this study specifically because it represents the lowest-resourced, primary public-care tier accessible to the general population of Kabale Municipality without referral, and its inclusion was essential to capture neonates born under more resource-constrained conditions a context in which thermal care practices, equipment availability, and staffing may differ markedly from the referral and mission hospitals, and where hypothermia risk may consequently be elevated.

Study participants

The study population comprised neonates aged 0–72 hours admitted to the postnatal wards and neonatal units of the four study facilities, neonates are unable to talk or comprehend, in this case the mothers/available caregivers consented on their behalf. Neonates receiving active thermal interventions, such as incubator care or radiant warmers, at the time of assessment were excluded, since their thermal environment was externally regulated and would not reflect an unassisted thermal status.

Data collection procedures

Following ethical approval, trained research assistants introduced the study to mothers and caregivers present on each day of data collection, obtained written informed consent, and thereafter measured neonatal core temperature using a digital rectal thermometer. The lubricated tip of the thermometer was inserted into the anal opening to a depth of approximately 1.5–2 cm and held in place until an automatic audible signal was produced; two consecutive readings in degrees Celsius were taken and averaged for

accuracy. Thermometers were cleaned and disinfected with 70% alcohol-soaked cotton wool between uses. Immediately following temperature measurement, a structured, pre-tested questionnaire, translated into Runyankore-Rukiga for respondents who did not read English, was administered by trained research assistants to capture socio-demographic, obstetric, and newborn thermal care characteristics, taking approximately 20–30 minutes per participant.

For neonates found to be hypothermic (axillary/rectal temperature below 36.5°C) during the temperature assessment, the researchers immediately notified the attending nurse or midwife on duty at the respective ward before proceeding with the questionnaire administration, in order to ensure prompt clinical attention rather than delaying corrective action for research purposes.

Study size

The minimum sample size was calculated using the formula for an infinite population, $n = [Z^2P(1-P)]/d^2$ (20), using a prevalence of 67.6% from a comparable study conducted at Lira Regional Referral Hospital in Northern Uganda (16), a 95% confidence level (Z = 1.96), and a 5% margin of error (d = 0.05), yielding a base sample size of 337. After accounting for a 10% non-response rate, the minimum required sample size was 374 participants. The final sample of 384 participants was distributed proportionately across the four facilities based on average monthly delivery volumes, and eligible neonates were consecutively enrolled at each site until the allocated sample size was achieved.

Of the 384 participants, the largest proportion (200; 52.1%**)** were recruited from Kabale Regional Referral Hospital (RRH). Kamukira Health Centre IV contributed 81 participants (21.1%), Rugarama Hospital contributed 53 (13.8%), and Rushoroza Hospital contributed 50 (13.0%).

Measurement of Variables

Outcome variable: The outcome variable was neonatal hypothermia, operationally defined as a core (rectal) temperature below 36.5°C, in line with WHO thermal care classification. At data collection, this variable was measured objectively rather than by self-report: rectal temperature was obtained using a digital rectal thermometer inserted to a depth of approximately 1.5–2 cm, with two consecutive readings taken per neonate and their average recorded in degrees Celsius on the data collection tool, thereby minimizing measurement error and observer/instrument variability.

At the point of data entry, the continuous temperature value (in °C) was retained in the dataset for descriptive purposes (e.g., mean temperature, range) but was also dichotomized into a binary categorical variable "hypothermic" (< 36.5°C) versus "normothermic" (≥ 36.5°C) to serve as the outcome for prevalence estimation and for bivariate and multivariable logistic regression analysis.

Independent/exposure outcomes

These are predictor/cause/predisposing attributes/behaviours/characteristics/traits in the study population that can be manipulated to measure/observe a change in the dependent variables.

The associated factors were assessed across the following domains.

Neonatal factors

The study examined several characteristics of the newborns that may influenced the outcome, including preterm birth, low birth weight, congenital abnormalities, respiratory distress, asphyxia, sepsis, low APGAR score, neonatal resuscitation, and delayed initiation of breastfeeding.

Obstetrical factor

Maternal and delivery-related factors that could impact the newborn's condition were assessed, such as time of delivery, mode of delivery, and obstetric complications.

Thermoregulatory factors

Key practices affecting neonatal thermal care were considered, including skin-to-skin care, time to first bath, thermal care practices, and not wearing a cap.

Maternal factors

Certain maternal characteristics that may influence neonatal outcomes were evaluated, including maternal age, level of education, premature rupture of membranes (PROM), and low socioeconomic status of the mother.

Across all variable categories, completed questionnaires were reviewed daily for completeness and consistency, after which data were coded, entered into statistical software, and cleaned prior to analysis; each independent variable was first screened against the outcome using bivariate analysis, and only those meeting the pre-specified significance threshold were retained for the multivariable logistic regression model used to generate the final adjusted estimates of association with neonatal hypothermia.

Quality control

Research assistants were trained on the study objectives, ethical procedures and questionnaire administration prior to data collection. The tool was pretested and refined based on feedback. The principal investigator supervised data collection daily, and completed questionnaires were reviewed at the end of each day to identify and resolve missing or inconsistent responses before data entry.

Data analysis and management

Data were entered into Microsoft Excell (www.xlsx.) for validation, coded, and exported to STATA version 17 (StataCorp, College Station, Texas, USA) for analysis. Categorical variables were summarized as frequencies and percentages. The prevalence of neonatal hypothermia was estimated with its 95% confidence interval. Bivariate logistic regression was used to assess the crude association between each independent variable and neonatal hypothermia; variables with $p \leq 0.25$ at this stage were considered candidates for multivariable analysis, consistent with recommended practice for screening variables ahead of multivariable modelling. A multivariable logistic regression model was then fitted to estimate adjusted odds ratios (AOR) with 95% confidence intervals while controlling for potential confounding among the candidate variables. Statistical significance at the level of multivariable level concluded based on confidence interval.

Results

Sociodemographic-related characteristics

A total of 384 mother-neonate pairs were enrolled across the four study facilities: 200 (52.1%) at KRRH, 81 (21.1%) at Kamukira HC IV, 53 (13.8%) at Rugarama Hospital, and 50 (13.0%) at Rushoroza Hospital. The mean age of mothers was 29.4 years (SD 6.5), the majority of mothers were married (98.7%, n = 379/384), of Mukiga tribe (70.6%), and Christian (97.7%). Just over a third (35.4%) had attained only primary-level education, and slightly more than half (52.1%) were either formally or self-employed. Nearly all spouses recorded were alive (100%), while 24.0% of spouses were unemployed. Almost all mothers (99.7%) attended antenatal care, and most pregnancies (79.9%) were intended. Complications during pregnancy were reported in 30.9% of pregnancies with data available, and leaking liquor (premature rupture of membranes) occurred in 28.1% of cases, the mean gravidity was 2 times (IQR 1,3). Slightly more than half of deliveries (53.6%) were spontaneous vaginal deliveries, with the remainder (46.4%) by caesarean section, their mean birth weight was 3.3kg (SD 1.6). Full characteristics of study participants, alongside their bivariate association with neonatal hypothermia, are presented in Table 1.

Prevalence of delayed initiation of breastfeeding

The overall prevalence of neonatal hypothermia among the 384 neonates assessed was 50.3% (n = 193/384, 95% CI: 45.1–53.4%) (Table 1). We had a response rate of 100%. We achieved this by checking all questionnaires for completeness immediately after each interview prior to the participant leaving.

Table 1
Characteristics of mother-neonate pairs and bivariate association with neonatal hypothermia (N = 384)

Variable	Total (N) N = 384	Hypothermic n(%) n = 193(50.3%)	Not hypothermic n(%) n = 191(49.7%)	P-value at Bivariable analysis
Maternal age (years)				
17–25	116	56 (48.3)	60 (51.7)	0.44
26–35	178	90 (50.6)	88 (49.4)	
>35	98	47 (52.2)	43 (47.8)	0.82
Marital status				
Married	379	191 (50.4)	188 (49.6)	
Single	5	2 (40.0)	3 (60.0)	0.38
Ethnic belonging of the mother				
Mukiga	271	140 (51.7)	131 (48.3)	
Others	113	53 (46.9)	60 (53.1)	0.16
Religion				
Christian	375	187 (49.9)	188 (50.1)	
Moslem	9	6 (66.7)	3 (33.3)	0.15
Maternal level of education				
Primary	136	74 (54.4)	62 (45.6)	0.14
Secondary	248	131 (52.8)	117 (47.2)	
Maternal employment				
Employed	200	97 (48.5)	103 (51.5)	
Not employed	184	96 (52.2)	88 (47.8)	0.40
Household wealth index				
Low	142	76 (53.5)	66 (46.5)	
Medium	124	64 (51.6)	60 (48.4)	0.68
High	118	53 (44.9)	65 (55.1)	0.26

Variable	Total (N) N = 384	Hypothermic n(%) n = 193(50.3%)	Not hypothermic n(%) n = 191(49.7%)	P-value at Bivariable analysis
Maternal age (years)				
Spouse status				
Alive	384	193 (50.3)	191 (49.7)	1
Spouse employment status				
Employed	292	140 (48.0)	152 (52.0)	
Not employed	92	53 (57.6)	39 (42.4)	0.00
Wished gender of baby				
Any	148	73 (49.3)	75 (50.7)	
Male	133	66 (49.6)	67 (50.4)	0.98
Female	103	54 (52.4)	49 (47.6)	0.71
Congenital defects				
No	374	188 (50.3)	186 (49.7)	
Yes	10	5 (50.0)	5 (50.0)	0.99
Breastfeeding issues				
Yes	139	59 (42.5)	111 (45.3)	0.00
No	245	134 (54.7)	80 (57.6)	
Pregnancy loss				
No	360	181 (50.3)	179 (49.7)	
Yes	24	12 (50.0)	12 (50.0)	0.97
Intended pregnancy				
Yes	307	151 (49.2)	156 (50.8)	
No	77	42 (54.6)	35 (45.4)	0.31
Mode of delivery				
SVD	206	109 (52.9)	97 (47.1)	
Caesarean section	178	94 (52.8)	84 (47.2)	0.16

Variable	Total (N) N = 384	Hypothermic n(%) n = 193(50.3%)	Not hypothermic n(%) n = 191(49.7%)	P-value at Bivariable analysis
Maternal age (years)				
Gravidity				
<3	309	151 (48.9)	158 (51.1)	
≥3	75	42 (56.0)	33 (44.0)	0.39
Complications during pregnancy				
No	245	132 (48.0)	143 (52.0)	
Yes	109	59 (54.1)	50 (45.9)	0.21
Leaking liquor (PROM)				
No	276	129 (46.7)	147 (53.3)	
Yes	108	64 (59.3)	44 (40.7)	0.00
ANC attendance				
Yes	383	193 (50.4)	190 (49.6)	
No	1	0 (0.0)	1 (100.0)	
Immediate drying				
Yes	310	157 (50.7)	153 (49.4)	
No	74	38 (51.4)	36 (48.7)	0.72
Skin-to-skin care				
Yes	276	138 (50.0)	138 (50.0)	
No	108	55 (50.9)	53 (49.1)	0.34
Wearing a cap after birth				
Yes	270	126 (46.7)	144 (53.3)	
No	114	67 (58.8)	47 (41.2)	0.01
In bed with baby				
Yes	359	180 (50.1)	179 (49.9)	
No	25	13 (52.0)	12 (48.0)	0.74

Variable	Total (N) N = 384	Hypothermic n(%) n = 193(50.3%)	Not hypothermic n(%) n = 191(49.7%)	P-value at Bivariable analysis
Maternal age (years)				
Time of birth				
Night	207	104 (50.2)	103 (49.8)	
Day	177	89 (50.3)	88 (49.7)	0.29
Birth weight				
Normal	259	124 (47.9)	135 (52.1)	
Low	61	38 (62.3)	23 (37.7)	0.10
High	64	31 (48.4)	33 (51.6)	0.94
Birth order				
<3	199	105 (52.8)	94 (47.2)	
≥3	185	88 (47.6)	97 (52.3)	0.26

Factors associated with neonatal hypothermia

Neonates born to mothers with only primary-level education (AOR = 1.35, 95% CI: 1.08–2.06) were more likely to be hypothermic compared to neonates born to mothers with secondary education

Neonates born to fathers who were unemployed (AOR = 1.52, 95% CI: 1.37–1.69) were more likely to be hypothermicc compared to neonates born to fathers who employed spouse.

Neonates born to mothers with breastfeeding issues (AOR = 1.59, 95% CI: 1.25–2.04) were more likely to be hypothermicc compared to neonates born to mothers without breastfeeding issues.

Neonates born to mothers who had premature rupture of membranes (AOR = 1.72, 95% CI: 1.27–2.32) were more likely to be hypothermicc compared to neonates born to mothers who had premature rupture of membranes.

Neonates were not fitted with a cap after birth (AOR = 1.38, 95% CI: 1.08–2.21) were more likely to be hypothermic compared to those those who wore a cap.

Neonates with low birth weight (AOR = 1.68, 95% CI: 0.79–3.55) were more likely to be hypothermic compared to neonates with normal birth weight.

Neonates delivered by caesarean section (AOR = 1.84, 95% CI: 1.29–2.47) were more likely to be hypothermicc compared to those neonates delivered vaginally. (Table 2).

Table 2
Crude and adjusted odds ratios for factors associated with neonatal hypothermia

Variable	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value at multivariate level
Maternal level of education				
Secondary	1		1	
Primary	1.34 (0.91–1.97)	0.14	1.35 (1.08–2.06)	0.17
Ethnic belonging of the mother				
Mukiga	1		1	
Others	0.83 (0.63–1.08)	0.16	0.79 (0.81–1.19)	0.39
Religion				
Christian	1			
Moslem	2.01 (0.78–5.18)	0.15	1.93 (0.69–4.23)	0.41
Spouse employment status				
Employed	1		1	
Not employed	1.48 (1.23–1.78)	0.00	1.52 (1.37–1.69)	0.00
Breastfeeding issues				
Yes	1.61 (1.33–2.00)	0.00	1.59 (1.25–2.04)	0.00
No	1		1	
Complications during pregnancy				
No	1		1	
Yes	1.28 (0.87–1.89)	0.21	1.16 (0.80–1.69)	0.67
Leaking liquor (PROM)				
No	1		1	
Yes	1.66 (1.32–2.09)	0.00	1.72 (1.27–2.32)	0.00

Variable	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value at multivariate level
Maternal level of education				
Wearing a cap after birth				
Yes	1		1	
No	1.63 (1.13–2.35)	0.01	1.38 (1.08–2.21)	0.19
Birth weight				
Normal	1		1	
Low	1.80 (0.90–3.61)	0.10	1.68 (0.79–3.55)	0.17
High	1.02 (0.73–1.90)	0.94	1.23 (0.75–1.98)	0.97
Mode of delivery				
SVD	1		1	
Caesarean section	1.80 (0.28–2.23)	0.16	1.84 (1.29–2.47)	0.19

DISCUSSIONS

This study found that half of the neonates assessed across four health facilities in Kabale Municipality were hypothermic (50.3%, 95% CI: 45.1–53.4%), a prevalence strikingly consistent with the 51% reported in a large community-based study in Northern Uganda(18) and hospital-based study at Lira Regional Referral hospital(16) and closely aligned with the pooled prevalence of 52.5% reported in a 2024 systematic review of 44,532 newborns across 13 countries (3,21).

The similarity in prevalence across these studies likely stems from a shared use of the same WHO temperature threshold (<36.5°C), common structural weaknesses in low-resource newborn care (poor adherence to warm-chain practices like immediate drying, skin-to-skin contact, and delayed bathing), and comparable maternal risk profiles (low ANC attendance, PROM, caesarean delivery) across similar low- and middle-income health system settings. Kabale's cooler highland climate may also contribute additional heat-loss risk consistent with other elevated or cooler settings represented in the pooled review(3).

It is markedly lower than prevalence estimates from preterm-focused or NICU-admitted populations, such as the 83.2% reported in Ethiopia (6), but higher than the 17.5%(5) reported in a large Kenyan

retrospective cohort, a pattern consistent with the well-documented influence of study population, ambient climate, and thermal care practice on reported prevalence.

Maternal level of education was independently associated with neonatal hypothermia, consistent with evidence linking maternal educational attainment in Nigeria and Uganda. Mothers with lower educational attainment may have less access to health information on newborn warming practices(13,18). The plausible explanation is that, mothers with lower educational attainment often have reduced access to, and comprehension of, health information delivered during antenatal and postnatal care sessions including messages on essential newborn thermal care practices such as immediate drying, skin-to-skin contact, delayed bathing, and appropriate wrapping/capping.

Spouse employment status was also independently associated with neonatal hypothermia, reflecting the role of household socioeconomic status in shaping newborn thermal care capacity, consistent with similar findings in Uganda and Nigeria(13,18,22). Households with an unemployed spouse may have fewer financial resources available to purchase warm clothing, blankets, and other essential newborn thermal care items, and may also face broader economic strain that limits the mother's ability to access transport for antenatal/postnatal visits or purchase supplementary newborn care supplies. This resource constraint, distinct from the maternal education pathway, represents an economic rather than an informational barrier to adequate newborn thermal care, underscoring that both knowledge-based and resource-based household factors independently shape a neonate's risk of hypothermia.

Breastfeeding issues were associated with higher odds of neonatal hypothermia, consistent with prior evidence(18)(3). This is biologically plausible because breastfeeding itself is a key thermoregulatory mechanism for the newborn suckling stimulates metabolic heat production, and breastfeeding is typically accompanied by prolonged skin-to-skin contact with the mother, which directly supports thermal stability. When breastfeeding is delayed, ineffective, or disrupted (e.g., due to poor latch, maternal illness, or inadequate lactation support), the neonate loses both this metabolic heat-generating stimulus and the associated close maternal skin contact, increasing vulnerability to heat loss. Additionally, neonates with breastfeeding difficulties may feed less frequently or for shorter durations, reducing caloric intake needed to sustain metabolic heat production, further predisposing them to hypothermia.

Leaking liquor/premature rupture of membranes (PROM) emerged as one of the strongest and most stable predictors of neonatal hypothermia in this study, with an almost identical effect size before and after adjustment indicating that its association with hypothermia was robust and (23) substantially confounded by other maternal or neonatal characteristics. While this specific pathway was not extensively addressed in the literature originally reviewed, it is biologically plausible and finds support in obstetric literature. Obstetric complications such as premature rupture of membranes have been documented as risk factors for admission hypothermia in newborns in a Kenyan cohort study, reinforcing the direct relevance of this finding. This is biologically plausible for several reasons: PROM increases the risk of **preterm birth**, and preterm neonates have immature thermoregulation and less protective fat,

making them prone to rapid heat loss (5,24–26) PROM also raises the risk of **ascending infection/neonatal sepsis**, which can itself disrupt thermoregulatory control (23). Finally, PROM often leads to **prolonged labour and emergency intervention,** which can delay essential warming practices like immediate drying and skin-to-skin contact right after birth. A 2024 Kenyan cohort study similarly identified PROM as a risk factor for admission hypothermia, reinforcing this finding(5,15).

Not wearing a cap after birth was significantly associated with hypothermia, consistent with a 2024 multi-country systematic review identifying this as a significant risk factor. This makes physiological sense: a newborn's head makes up a large share of total body surface area, has thin skin, and features open fontanelles that offer little insulation making the scalp a major site of heat loss right after birth(3), when the baby's own thermoregulation is still immature. A simple cap traps warm air against the scalp and reduces this loss. Because capping is low-cost, requires no special equipment, and is easy to implement, it remains one of the most feasible and impactful elements of the WHO Newborn Warm Chain(4), especially in resource-limited settings like Kabale Municipality and gaps in this simple practice likely represent easily preventable, low-cost missed opportunities.

Caesarean delivery was associated with increased odds of neonatal hypothermia, consistent with the broader literature(27,28). Several mechanisms plausibly explain this association. First, operating theatres are typically kept at cooler ambient temperatures than labour wards, exposing the neonate to a colder immediate environment at birth compared to a vaginal delivery setting. Second, neonates born by caesarean section often experience delayed or reduced skin-to-skin contact with the mother, since the mother may still be under anaesthesia, in recovery, or otherwise unable to hold the baby immediately, missing this critical early window for maternal-to-infant heat transfer and warm-chain initiation.

Low birth weight was associated with increased odds of neonatal hypothermia, consistent with the broader literature(3,27,29). This is biologically well-grounded: low-birth-weight neonates have a disproportionately large surface-area-to-body-mass ratio compared to normal-weight newborns, meaning they lose heat much faster relative to their capacity to generate and retain it. They also have minimal subcutaneous fat, which normally serves as an insulating layer against heat loss, leaving them physiologically less protected against a cold environment. Additionally, low-birth-weight neonates many of whom are preterm or growth-restricted often have immature thermoregulatory centres and limited stores of brown adipose tissue, which is the primary site of non-shivering thermogenesis (heat production) in newborns; reduced brown fat stores mean these infants have a diminished capacity to generate metabolic heat to compensate for losses. Together, these factors greater relative heat loss, poor insulation, and limited heat-generating capacity make low birth weight a well-documented and biologically coherent risk factor for neonatal hypothermia.

Strengths and limitations

This study benefited from standardized temperature measurement using digital rectal thermometry across all four facilities and a sample size that exceeded the calculated minimum requirement. However,

its cross-sectional design precludes causal inference, and the facility-based sampling frame may limit generalizability to neonates delivered outside formal health facilities. Data on maternal knowledge of thermal care practices and health system-level factors, such as staffing and ambient ward temperature, were not captured and may have provided additional explanatory power. The counter-intuitive direction observed for breastfeeding issues warrants cautious interpretation and further qualitative exploration.

Conclusions and recommendations

Neonatal hypothermia affects approximately one in every two neonates admitted at these four Kabale Municipality health facilities. Maternal level of education, spouse employment status, breastfeeding issues, leaking liquor, wearing a cap after birth, low birth weight, and mode of delivery were independently associated with neonatal hypothermia. We recommend consistent facility-level application of the WHO Newborn Warm Chain, with particular emphasis on ensuring every newborn is fitted with a cap immediately after birth; closer thermal monitoring of neonates delivered by caesarean section or born with low birth weight; and integration of maternal and child health programming with household economic empowerment initiatives, given the strong socioeconomic gradient observed.

Abbreviations

AOR
Adjusted odds ratio
ANC
Antenatal care
CI
Confidence interval
KRRH
Kabale Regional Referral Hospital
NICU
Neonatal intensive care unit
OR
Odds ratio
PROM
Premature rupture of membranes
SVD
Spontaneous vaginal delivery
WHO
World Health Organization

Declarations

Ethical considerations

Ethical approval was obtained from the Kabale University Research Ethics Committee (KAB-REC) approval number-**KABREC-2025-988**: Permission to conduct the study was obtained from the hospital directors of KRRH, Rugarama Hospital, Rushoroza Hospital, and Kamukira HC IV. Written informed consent was obtained from all mothers/caregivers prior to enrolment. Identification codes, rather than names, were used to ensure participant confidentiality. Neonates found to be hypothermic during data collection were promptly initiated on thermal care and referred to the attending clinical staff for appropriate management.

Completed questionnaires and all data collection materials were kept in a locked cabinet accessible only to the principal researcher and research team, while electronic data were stored in a password-protected computer/database accessible only to the research team, with data retained strictly for the purposes of this study and safeguarded against unauthorized access throughout and after the research process. The work reported in this manuscript was done in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

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

Competing interests

The authors declare that they have no competing interests.

Clinical trial number

Not applicable

Funding

The authors received no financial support for the research, authorship, and/or publication of this manuscript.

Authors' contributions

DI did conceptualization, data collection, manuscript writing, manuscript review and editing. NR did conceptualization, data collection. ME did conceptualization, data collection, manuscript writing, manuscript review and editing.LK did manuscript writing, manuscript review and editing. JKT did manuscript writing, manuscript review and editing, DJN did manuscript writing, manuscript review and editing, AN did conceptualization, data collection, manuscript writing, manuscript review and editing.

Acknowledgements

The authors would like to thank all study participants for generously sharing their experiences and perspectives, which made this study possible. We also acknowledge the support and cooperation of the staff and management of the study site for facilitating the data collection process. We also appreciate the guidance and support received from our mentors throughout the research process.

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