

Prevalence and Associated Factors of Perioperative Hypothermia among Surgical Patients at a Regional Referral Hospital in Eastern Uganda

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Abstract

Background

Perioperative hypothermia is a preventable complication associated with adverse surgical outcomes; however, routine temperature monitoring and warming interventions remain inconsistently implemented in many resource-constrained surgical settings. This study determined the prevalence and factors associated with perioperative hypothermia among surgical patients at Mbale Regional Referral Hospital in eastern Uganda.

Methods

We conducted a hospital-based observational study among patients undergoing elective or emergency surgery. Participants were recruited consecutively. Tympanic temperature was measured using a calibrated infrared thermometer before induction of anesthesia, intraoperatively, and during the immediate postoperative period in the post-anesthesia care unit. Perioperative hypothermia was defined as any measured temperature below 36.0°C. Modified Poisson regression was used to estimate prevalence ratios and identify factors associated with perioperative hypothermia.

Results

Of 358 participants, most were female, aged 18–39 years, underwent emergency surgery, and received regional anesthesia. Overall, 121 participants developed perioperative hypothermia, giving a prevalence of 33.8% (95% CI: 28.9–39.0). Hypothermia was present before induction in 12.0% of participants, peaked one hour after induction of anesthesia at 21.6%, and declined to 11.2% by 30 minutes postoperatively. In adjusted analysis, older age was associated with a higher prevalence of perioperative hypothermia (aPR = 1.01; 95% CI: 1.01–1.02), as was longer surgical duration (aPR = 1.01; $p = 0.003$). Regional anesthesia was associated with lower prevalence compared with general anesthesia (aPR = 0.62; 95% CI: 0.46–0.84), while operating-room temperature $> 30^{\circ}\text{C}$ was also associated with lower prevalence (aPR = 0.67; 95% CI: 0.60–0.75).

Conclusion

Perioperative hypothermia affected approximately one-third of surgical patients at this regional referral hospital. Routine temperature monitoring and targeted warming strategies, particularly for older patients and those undergoing prolonged procedures, should be prioritized in similar low-resource surgical settings.

BACKGROUND

Perioperative hypothermia, commonly defined as a core body temperature below 36.0°C, is a frequent but preventable complication among surgical patients ^{1,2}. It may occur before, during, or after surgery as a result of anesthetic-induced impairment of thermoregulation, redistribution of heat from the core to peripheral tissues, exposure to cool operating-room environments, administration of unwarmed fluids, and evaporative heat loss from surgical incision sites ³⁻⁵. General anesthesia suppresses hypothalamic thermoregulation, reduces metabolic heat production, and promotes peripheral vasodilation, while surgical exposure further increases heat loss through radiation, convection, conduction, and evaporation ^{3,6}. If not prevented or corrected, perioperative hypothermia can contribute to coagulopathy, increased blood loss, delayed drug metabolism, prolonged recovery from anesthesia, surgical site infections, cardiac complications, longer hospital stay, and increased healthcare costs ⁷⁻⁹.

The reported prevalence of perioperative hypothermia varies widely across settings, ranging from approximately 20% to 90%, depending on patient characteristics, type and duration of surgery, anesthetic technique, ambient operating-room temperature, temperature-monitoring practices, and availability of warming interventions ^{8,10-12}. Higher estimates have been reported in low-resource settings, including studies from Ethiopia, Rwanda, and Uganda, where routine perioperative temperature monitoring and active warming systems are often inconsistently available ¹³⁻¹⁶. This variation suggests that perioperative hypothermia is not only a physiological consequence of anesthesia and surgery, but also a marker of perioperative system readiness, including access to monitoring devices, warmed intravenous fluids, patient-warming equipment, and standardized thermal-management protocols ¹⁷.

In resource-constrained surgical settings, including regional referral hospitals such as Mbale Regional Referral Hospital, perioperative hypothermia is shaped not only by patient-level susceptibility and anesthetic technique, but also by health-system factors such as inconsistent temperature monitoring, limited access to warming devices, lack of fluid-warming capacity, and constrained postoperative recovery infrastructure. Although these constraints are likely shared by many district and regional referral hospitals in sub-Saharan Africa, facility-level data to guide feasible prevention strategies, such as context-appropriate temperature monitoring and warming practices, remain limited. This study, therefore, aimed to determine the prevalence and associated factors of perioperative hypothermia among patients undergoing surgery at Mbale Regional Referral Hospital.

METHODS

Study design and setting

We conducted a hospital-based observational study among patients undergoing elective and emergency surgery at Mbale Regional Referral Hospital in eastern Uganda between 5th January 2026 to 16th March 2026. The hospital is a 450-bed regional referral and teaching hospital serving approximately 4.6 million people across Eastern Uganda. The surgical department comprises general surgery, orthopedics, otolaryngology, ophthalmology, urology, obstetrics and gynecology, anesthesia, dentistry, and

physiotherapy services, supported by four operating rooms and a high dependency unit. Approximately 5,000 surgical procedures are performed annually, including cesarean sections, laparotomies, orthopedic procedures, hernia repairs, and hysterectomies.

At the time of the study, perioperative temperature monitoring was not routinely practiced because most patient monitors lacked temperature probes. Active warming resources were limited to a single forced-air warming device primarily reserved for pediatric patients, while intravenous fluid warming facilities were inconsistently available. Operating rooms were not air-conditioned, and postoperative warming largely depended on patient-provided blankets.

Study population and eligibility

The study population included patients scheduled for elective or emergency surgery during the study period. Eligible participants were patients undergoing surgery in the main operating theatres who provided written informed consent or, where appropriate, had consent provided by a legally authorized representative. Patients were excluded if they had an ear infection, previous ear surgery, or an ear abnormality that could interfere with tympanic temperature measurement. Patients who died intraoperatively or were transferred to the High-Dependency Unit while still intubated were also excluded because complete perioperative temperature follow-up could not be obtained.

Sample size determination and sampling

The sample size was calculated using the Kish–Leslie formula for cross-sectional studies ¹⁸:

$$n = Z^2 P(1 - P) / E^2$$

Using a prevalence (P) of 70% from a previous study, a 95% confidence level (Z = 1.96), and a margin of error of 5%, the minimum sample size obtained was 322 participants. After adjustment for a 10% non-response rate, the final sample size was 358 participants.

Consecutive sampling was used to recruit eligible participants until the required sample size was achieved.

Data collection procedures

The research team developed a structured, interviewer-administered questionnaire for this study, based on the study objectives, relevant literature, and previously identified risk factors for perioperative hypothermia. The questionnaire collected information on participants' socio-demographic and clinical characteristics, type and duration of surgery, type of anesthesia, perioperative temperature measurements, operating room environmental conditions, and use of warming interventions (supplementary file 1).

Tympanic temperature was measured using a calibrated OMRON Gentle Temp 520 (MC-520-E) infrared tympanic thermometer (OMRON Healthcare Co., Ltd., Japan), with a measurement accuracy of $\pm 0.2^{\circ}\text{C}$. A new probe cover was used for each participant, and the thermometer was allowed to acclimatize to room temperature for at least 30 minutes before use each day. Temperature was measured preoperatively before induction of anesthesia, immediately after induction, hourly during surgery, and postoperatively at arrival to the post-anesthesia care unit, 15 minutes after arrival, and 30 minutes after arrival. Three readings were taken at each time point, and the arithmetic mean was recorded.

Data collection was performed by the principal investigator and two trained research assistants. Participants were followed from the preoperative period until discharge from the post-anesthesia care unit. Because of limited recovery-room capacity, most patients were observed for approximately 30 minutes postoperatively.

Study variables

The primary outcome was perioperative hypothermia, defined as at least one measured tympanic temperature below 36.0°C at any perioperative time point from the preoperative period through 30 minutes after arrival in the post-anesthesia care unit.

Independent variables included patient-related factors, anesthesia-related factors, surgical factors, perioperative management factors, and environmental factors. Patient-related factors included age, sex, body mass index, and comorbidities. Anesthesia-related factors included ASA physical status, type of anesthesia, and duration of anesthesia. Surgical factors included elective or emergency surgery, surgical specialty, magnitude of surgery, and duration of surgery. Perioperative management factors included use of warmed intravenous fluids, blood transfusion, and patient warming. Environmental factors included operating-room temperature.

Statistical analysis

Data were entered using KoboToolbox and exported to R version 4.5.3 (RStudio-2026.01.2-418) for analysis. Continuous variables, including age, body mass index, duration of surgery, duration of anesthesia, operating-room temperature, and perioperative temperature measurements, were summarized using means and standard deviations or medians and interquartile ranges, depending on distribution. Categorical variables were summarized using frequencies and percentages.

The prevalence of perioperative hypothermia was estimated as the proportion of participants with at least one tympanic temperature measurement $< 36.0^{\circ}\text{C}$ during the perioperative observation period. Point prevalence was also estimated separately at each perioperative time point, with 95% confidence intervals.

Bivariable analyses were conducted to examine associations between participant, anesthetic, surgical, perioperative management, environmental factors, and perioperative hypothermia. Pearson's chi-square

test or Fisher's exact test was used for categorical variables, as appropriate. Continuous variables were compared using Student's t-test or Wilcoxon rank-sum test, depending on distribution.

Modified Poisson regression with robust standard errors was used to estimate crude and adjusted prevalence ratios with 95% confidence intervals. Variables were considered for multivariable analysis based on clinical relevance and evidence of association in bivariable analysis. Because anesthesia type, surgical specialty, sex, and emergency status may be closely related, the final model was assessed for collinearity and clinical plausibility. Statistical significance was set at $p < 0.05$.

Ethical considerations

Ethical approval was obtained from the Mbarara University of Science and Technology Research Ethics Committee under approval number MUST-2025-482. Administrative clearance was obtained from Mbale Regional Referral Hospital. Written informed consent was obtained from all participants or their legally authorized representatives before enrollment. Participation was voluntary, and confidentiality was maintained throughout the study. The study was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

Study flow

During the study period, 366 patients were assessed for eligibility. Eight patients were excluded: one underwent ear surgery, five were transferred to the high dependency unit while intubated, and two died intraoperatively. A total of 358 participants were enrolled and included in the final analysis. Of these, 121 (33.8%) developed perioperative hypothermia, while 237 (66.2%) remained normothermic (Fig. 1)

Participant demographic and perioperative characteristics

The study population was predominantly female (61.5%), with a mean age of 30.2 ± 18.7 years. Most participants underwent emergency surgery (55.3%), major procedures (73.5%), and regional anesthesia (64.0%). The mean duration of surgery was 69.1 ± 27.9 minutes. General surgery and obstetric procedures accounted for the largest proportion of cases.

Perioperative thermal management practices were limited. Warmed intravenous fluids and active patient warming devices were used in only 2.0% and 2.5% of patients, respectively. The mean operating room temperature was $29.6 \pm 1.1^\circ\text{C}$, with most procedures conducted in rooms maintained between 26°C and 30°C (Table 1).

Compared with participants who remained normothermic, those who developed perioperative hypothermia were more commonly male (47.9% vs 33.8%; $p = 0.013$) and were older, with a higher mean age (34.4 vs 28.1 years; $p = 0.009$). The distribution of age groups also differed significantly: participants

with hypothermia had a higher proportion of adults aged ≥ 60 years than those without hypothermia (17.4% vs 6.3%; $p < 0.001$). Chronic illness was more frequent among participants with hypothermia than among those without hypothermia (14.9% vs 7.2%; $p = 0.033$).

Several perioperative characteristics also differed by hypothermia status. General anesthesia was more common among participants who developed hypothermia, whereas regional anesthesia was more common among those who remained normothermic ($p = 0.048$). Participants with hypothermia had longer mean anesthesia duration (91.2 vs 78.7 minutes; $p < 0.001$) and longer mean surgical duration (76.2 vs 65.4 minutes; $p = 0.006$). Elective surgery was more frequent among those with hypothermia, while emergency surgery was more frequent among those who remained normothermic ($p = 0.019$). Surgical specialty also differed significantly, with general surgery accounting for a larger proportion of hypothermia participants than normothermic participants (47.9% vs 31.2%; $p = 0.009$).

Participants who developed hypothermia had a lower mean operating-room temperature than those who remained normothermic (29.1°C vs 29.8°C; $p < 0.001$). Procedures conducted in rooms $> 30^\circ\text{C}$ were less frequent among participants with hypothermia than among those without hypothermia (14.0% vs 30.4%; $p = 0.001$) (Table 1).

Table 1
Baseline demographic, surgical, anesthetic, and thermal-management characteristics of participants, N = 358

Perioperative Hypothermia				
Characteristic	Overall N = 358 ¹	No N = 237 ¹	Yes N = 121 ¹	p-value ²
Sex				0.013
Male	138 (38.5%)	80 (33.8%)	58 (47.9%)	
Female	220 (61.5%)	157 (66.2%)	63 (52.1%)	
Age (years)	30.2 (18.7)	28.1 (16.2)	34.4 (22.3)	0.009
Age group				< 0.001
< 18	73 (20.4%)	48 (20.3%)	25 (20.7%)	
18–39	200 (55.9%)	148 (62.4%)	52 (43.0%)	
40–59	49 (13.7%)	26 (11.0%)	23 (19.0%)	
>=60	36 (10.1%)	15 (6.3%)	21 (17.4%)	
BMI category				0.4
Underweight	74 (20.7%)	46 (19.4%)	28 (23.1%)	
Normal	147 (41.1%)	93 (39.2%)	54 (44.6%)	
Overweight	80 (22.3%)	56 (23.6%)	24 (19.8%)	
Obese	57 (15.9%)	42 (17.7%)	15 (12.4%)	
Chronic illness	35 (9.8%)	17 (7.2%)	18 (14.9%)	0.033
ASA classification				0.288
ASA I	123 (34.4)	21 (48.8)	102 (32.4)	
ASA II	202 (56.4)	19 (44.2)	183 (58.1)	
ASA III	26 (7.3)	2 (4.7)	24 (7.6)	
ASA IV	6 (1.7)	1 (2.3)	5 (1.6)	
Type of anaesthesia				0.048
General	117 (32.7%)	68 (28.7%)	49 (40.5%)	
Regional	229 (64.0%)	159 (67.1%)	70 (57.9%)	
¹ n (%); Mean (SD), ² Pearson's Chi-squared test; Wilcoxon rank sum test				

Perioperative Hypothermia				
Characteristic	Overall N = 358 ¹	No N = 237 ¹	Yes N = 121 ¹	p-value ²
Local/MAC	12 (3.4%)	10 (4.2%)	2 (1.7%)	
Duration of anaesthesia (min)	82.9 (29.7)	78.7 (25.3)	91.2 (35.7)	< 0.001
Anaesthesia duration category				0.035
Short (< 60 min)	1 (0.3%)	1 (0.4%)	0 (0.0%)	
Intermediate (60–180 min)	349 (97.5%)	234 (98.7%)	115 (95.0%)	
Long (> 180 min)	8 (2.2%)	2 (0.8%)	6 (5.0%)	
Type of surgery				0.019
Elective	160 (44.7%)	95 (40.1%)	65 (53.7%)	
Emergency	198 (55.3%)	142 (59.9%)	56 (46.3%)	
Duration of surgery (min)	69.1 (27.9)	65.4 (23.2)	76.2 (34.4)	0.006
Surgery duration category				0.094
Short (< 60 min)	149 (41.6%)	105 (44.3%)	44 (36.4%)	
Intermediate (60–120 min)	179 (50.0%)	99 (55.3%)	80 (61.2%)	
Long (> 120 min)	30 (5.4%)	12 (0.4%)	18 (2.5%)	
Surgical specialty				0.009
General Surgery	132 (36.9%)	74 (31.2%)	58 (47.9%)	
Orthopaedic	50 (14.0%)	32 (13.5%)	18 (14.9%)	
Obstetrics	138 (38.5%)	99 (41.8%)	39 (32.2%)	
Gynaecology	21 (5.9%)	18 (7.6%)	3 (2.5%)	
Other	17 (4.7%)	14 (5.9%)	3 (2.5%)	
Surgery magnitude				0.5
Minor	10 (2.8%)	5 (2.1%)	5 (4.1%)	
Moderate	85 (23.7%)	59 (24.9%)	26 (21.5%)	
Major	263 (73.5%)	173 (73.0%)	90 (74.4%)	
¹ n (%); Mean (SD), ² Pearson's Chi-squared test; Wilcoxon rank sum test				

Characteristic	Perioperative Hypothermia			
	Overall	No	Yes	p-value ²
	N = 358 ¹	N = 237 ¹	N = 121 ¹	
Warm IV fluids used	7 (2.0%)	5 (2.1%)	2 (1.7%)	0.94
IV fluid volume (mL)	1,235.4 (618.3)	1,211.6 (547.2)	1,281.9 (738.3)	0.6
Blood transfusion	49 (13.7%)	31 (13.1%)	18 (14.9%)	0.8
OR temperature (°C)	29.6 (1.1)	29.8 (1.0)	29.1 (1.1)	< 0.001
OR temperature category				0.001
Warm (26–30 C)	269 (75.1%)	165 (69.6%)	104 (86.0%)	
Hot (> 30 C)	89 (24.9%)	72 (30.4%)	17 (14.0%)	
Patient warmer used	9 (2.5%)	6 (2.5%)	3 (2.5%)	> 0.9
¹ n (%); Mean (SD), ² Pearson's Chi-squared test; Wilcoxon rank sum test				

Prevalence of perioperative hypothermia

The overall prevalence of perioperative hypothermia was 33.8% (95% CI: 28.9–39.0). Preoperative hypothermia was present in 12.0% of patients. The prevalence was 11.2% immediately after induction, increased to 21.6% one hour after induction, remained elevated at PACU arrival (20.1%), and declined to 11.2% by 30 minutes postoperatively (Fig. 2).

Factors associated with perioperative hypothermia

In bivariable analysis, perioperative hypothermia was less prevalent among female participants than male participants (cPR = 0.68; 95% CI: 0.51–0.91; p = 0.009) and among participants undergoing regional rather than general anesthesia (cPR = 0.73; 95% CI: 0.55–0.98; p = 0.034). Conversely, hypothermia prevalence was higher among participants aged ≥ 60 years compared with those aged < 18 years (cPR = 1.70; 95% CI: 1.12–2.60; p = 0.014) and among participants with chronic illness compared with those without chronic illness (cPR = 1.61; 95% CI: 1.12–2.31; p = 0.009). Emergency surgery (cPR = 0.70; 95% CI: 0.52–0.93; p = 0.015), obstetric surgery (cPR = 0.64; 95% CI: 0.46–0.90; p = 0.009), and gynecological surgery (cPR = 0.33; 95% CI: 0.11–0.95; p = 0.040) were associated with lower crude prevalence, while surgery lasting > 120 minutes showed a borderline association with higher prevalence (cPR = 1.58; 95% CI: 1.00–2.50; p = 0.050) (Table 2).

After adjustment, older age, longer surgical duration, and type of anesthesia remained independently associated with perioperative hypothermia. Participants aged ≥ 60 years had a higher adjusted prevalence of hypothermia (aPR = 1.01; 95% CI: 1.01–1.02; p < 0.001), as did those undergoing longer surgical procedures (aPR = 1.01; 95% CI: 1.00–1.01; p = 0.004). Participants who received regional

anesthesia had a 35% lower prevalence of perioperative hypothermia than those who received general anesthesia (aPR = 0.65; 95% CI: 0.46–0.93; p = 0.017) (Table 2).

Table 2

Factors associated with perioperative hypothermia among surgical patients at Mbale Regional Referral Hospital, eastern Uganda, January – March

Variable	Crude Prevalence Ratio (95% CI)	p-value	Adjusted Prevalence Ratio (95% CI)*	p-value
Sex				
Male	Ref	—	Ref	—
Female	0.68 (0.51–0.91)	0.009	0.74 (0.54–1.01)	0.056
Age category (years)				
<18	Ref	—	Ref	—
18–39	0.76 (0.51–1.13)	0.174	1.00 (1.00–1.01)	0.819
40–59	1.37 (0.88–2.12)	0.158	1.01 (1.00–1.01)	0.047
≥60	1.70 (1.12–2.60)	0.014	1.01 (1.01–1.02)	< 0.001
BMI category				
Underweight	Ref	—	—	—
Normal	0.97 (0.68–1.40)	0.873	—	—
Overweight	0.79 (0.51–1.24)	0.308	—	—
Obese	0.70 (0.41–1.18)	0.176	—	—
Chronic illness				
No	Ref	—	Ref	—
Yes	1.61 (1.12–2.31)	0.009	1.35 (0.90–2.02)	0.147
Type of anesthesia				
General	Ref	—	Ref	—
Regional	0.73 (0.55–0.98)	0.034	0.65 (0.46–0.93)	0.017
Local/MAC	0.40 (0.11–1.44)	0.161	0.41 (0.11–1.52)	0.181
Type of surgery				
Elective	Ref	—	Ref	—
Emergency	0.70 (0.52–0.93)	0.015	0.89 (0.61–1.29)	0.522
Surgery duration category				
Short (< 60 min)	Ref	—	Ref	—

Variable	Crude Prevalence Ratio (95% CI)	p-value	Adjusted Prevalence Ratio (95% CI)*	p-value
Intermediate (60–120 min)	1.19 (0.87–1.64)	0.281	1.00 (1.00–1.01)	0.155
Long (> 120 min)	1.58 (1.00–2.50)	0.050	1.01 (1.00–1.01)	0.004
Surgical specialty				
General Surgery	Ref	—	Ref	—
Orthopaedic	0.82 (0.54–1.25)	0.352	0.93 (0.59–1.46)	0.744
Obstetrics	0.64 (0.46–0.90)	0.009	0.81 (0.52–1.25)	0.331
Gynaecology	0.33 (0.11–0.95)	0.040	0.48 (0.15–1.49)	0.201
Other	0.40 (0.14–1.15)	0.089	0.54 (0.18–1.59)	0.264
Surgery magnitude				
Minor	Ref	—	—	—
Moderate	0.61 (0.30–1.23)	0.169	—	—
Major	0.68 (0.36–1.30)	0.249	—	—
Warm IV fluids used				
No	Ref	—	—	—
Yes	0.84 (0.26–2.75)	0.777	—	—
Blood transfusion				
No	Ref	—	—	—
Yes	1.10 (0.74–1.65)	0.635	—	—
OR temperature category				
Warm (26–30°C)	Ref	—	Ref	—
Hot (> 30°C)	1.04 (0.55–1.96)	0.908	1.05 (0.52–2.09)	0.892
Patient warmer used				
No	Ref	—	—	—
Yes	0.99 (0.39–2.52)	0.976	—	—

PR, prevalence ratio; CI, confidence interval; MAC, monitored anesthesia care.

DISCUSSION

In this hospital-based observational study, perioperative hypothermia was common in this regional referral hospital, affecting one in three surgical patients. The highest point prevalence of hypothermia was one hour after induction. Older age, longer surgical duration, and general anesthesia were independently associated with perioperative hypothermia. Taken together, these findings suggest that perioperative hypothermia in this setting is not merely a physiological effect of anesthesia and surgery, but a preventable perioperative safety event shaped by patient risk, duration of exposure, anesthetic technique, and gaps in routine temperature monitoring and warming systems. This study found an overall perioperative hypothermia prevalence of 33.8%. Although this estimate falls within the wide global range reported in previous studies ^{3, 5}, it was lower than findings from several African settings, including Ethiopia, Rwanda, and previous Ugandan referral-hospital studies, where prevalence estimates have ranged from approximately 55% to more than 70% ^{6, 9, 12, 15, 16, 19}. Nevertheless, the burden remains substantial when compared with better-resourced settings where standardized temperature monitoring and active warming protocols are more consistently implemented ²⁰. The lower prevalence observed in this study may partly reflect the relatively high ambient operating-room temperatures and the predominance of regional anesthesia, which remained independently associated with lower hypothermia prevalence. These findings suggest that perioperative hypothermia remains a relevant patient-safety concern even in warm tropical operating environments.

Hypothermia prevalence was highest one hour after induction of anesthesia, consistent with the well-described effects of anesthetic agents on thermoregulation, peripheral vasodilation, and redistribution of core heat to peripheral tissues ¹³. The presence of preoperative hypothermia is also important. It suggests that prevention should begin before induction of anesthesia, especially in emergency surgical pathways where patients may wait in cool environments, receive unwarmed fluids, or arrive with physiological stressors that increase vulnerability. Routine preoperative temperature assessment would allow early identification and warming before theatre transfer.

Regional anesthesia was independently associated with a lower prevalence of perioperative hypothermia than general anesthesia. This is clinically plausible because general anesthesia more profoundly impairs hypothalamic thermoregulation, reduces vasoconstrictive responses, and promotes redistribution of core heat to peripheral tissues ^{5, 13}. Based on this finding, patients receiving general anesthesia could be prioritized for routine temperature monitoring and warming interventions, especially in resource-constrained theatres with limited warming equipment.

Older age and longer surgical duration were independently associated with perioperative hypothermia. Older patients may be more susceptible because of reduced thermoregulatory reserve, lower metabolic heat production, and impaired vasoconstrictive responses ^{14, 21}. Similarly, prolonged surgical duration independently increased hypothermia risk, likely due to cumulative intraoperative heat loss associated with prolonged anesthesia and surgical exposure ^{9, 20, 22}. These findings support targeted temperature monitoring and warming for older patients and those expected to undergo longer operations.

LIMITATIONS

This study had limitations. First, the study was conducted at a single regional referral hospital, which may limit generalizability to facilities with different patient populations, theatre environments, staffing patterns, and perioperative warming resources. Second, tympanic infrared thermometry was used because it was feasible in this setting, but it may be less accurate than invasive core-temperature monitoring methods. Third, postoperative follow-up was limited to the immediate recovery period; therefore, delayed postoperative hypothermia and related complications were not assessed. Fourth, residual confounding is possible because some perioperative factors, including anesthetic depth, skin preparation practices, duration of surgical exposure, intraoperative workflow, and the volume and temperature of administered fluids, may not have been fully captured. Finally, the primary outcome combined any hypothermia episode from preoperative assessment through early PACU follow-up. Although this provided an overall estimate of hypothermia burden, preoperative, intraoperative, and postoperative hypothermia may have different predisposing factors.

Despite these limitations, the study prospectively measured temperature at multiple perioperative time points, included both elective and emergency surgeries, and provides practical facility-level evidence from a resource-constrained surgical setting. Future studies in this setting could distinguish preoperative hypothermia, incident intraoperative hypothermia, and postoperative hypothermia as separate outcomes, and could evaluate feasible prevention interventions such as routine temperature monitoring, prewarming, warmed fluids, passive insulation, and targeted active warming for high-risk patients.

CONCLUSION

Perioperative hypothermia was common in this regional referral hospital, affecting one in three surgical patients, and occurred across the perioperative pathway, including before induction, during surgery, and in the immediate postoperative period. Older age and longer surgical duration were associated with higher hypothermia prevalence, while regional anesthesia was associated with lower prevalence compared with general anesthesia. These findings support routine temperature assessment before induction, intraoperatively, and during early recovery, with closer monitoring and warming prioritized for older patients, patients undergoing prolonged procedures, and those receiving general anesthesia. Future studies could assess the prognostic and clinical implications of perioperative hypothermia, and evaluate feasible thermal-management bundles for similar resource-constrained surgical settings

Declarations

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Research and Ethics Committee of Mbarara University of Science and Technology (Approval number: MUST-2025-482). Administrative clearance was obtained from Mbale Regional Referral Hospital. Written informed consent was obtained from all participants or

their legally authorized representatives before enrollment. The study was conducted in accordance with the principles of the Declaration of Helsinki. Clinical trial registration was not applicable.

Consent for Publication

Not applicable.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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Authors' Contributions

FS, DCA, RM, and ROO conceptualized and designed the study. FS and DCA conducted the data analysis. FS, DCA, RM, and ROO contributed to manuscript drafting, critical revision, and interpretation of the findings. DCA, RM, and ROO provided scientific supervision and overall guidance throughout the study. All authors read and approved the final manuscript.

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Figures

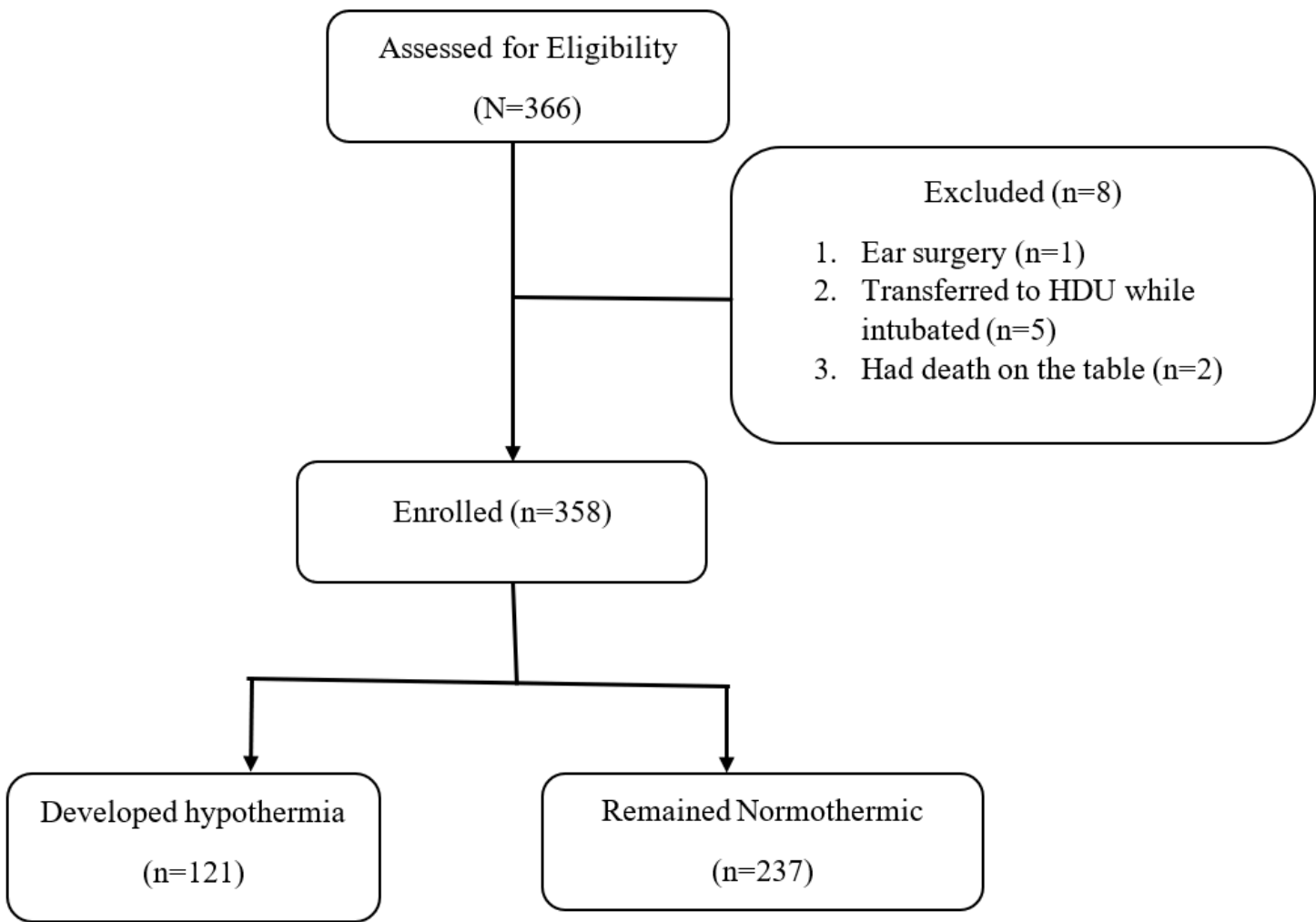


Figure 1

Flow diagram showing participant recruitment, exclusions, and final analytic sample.

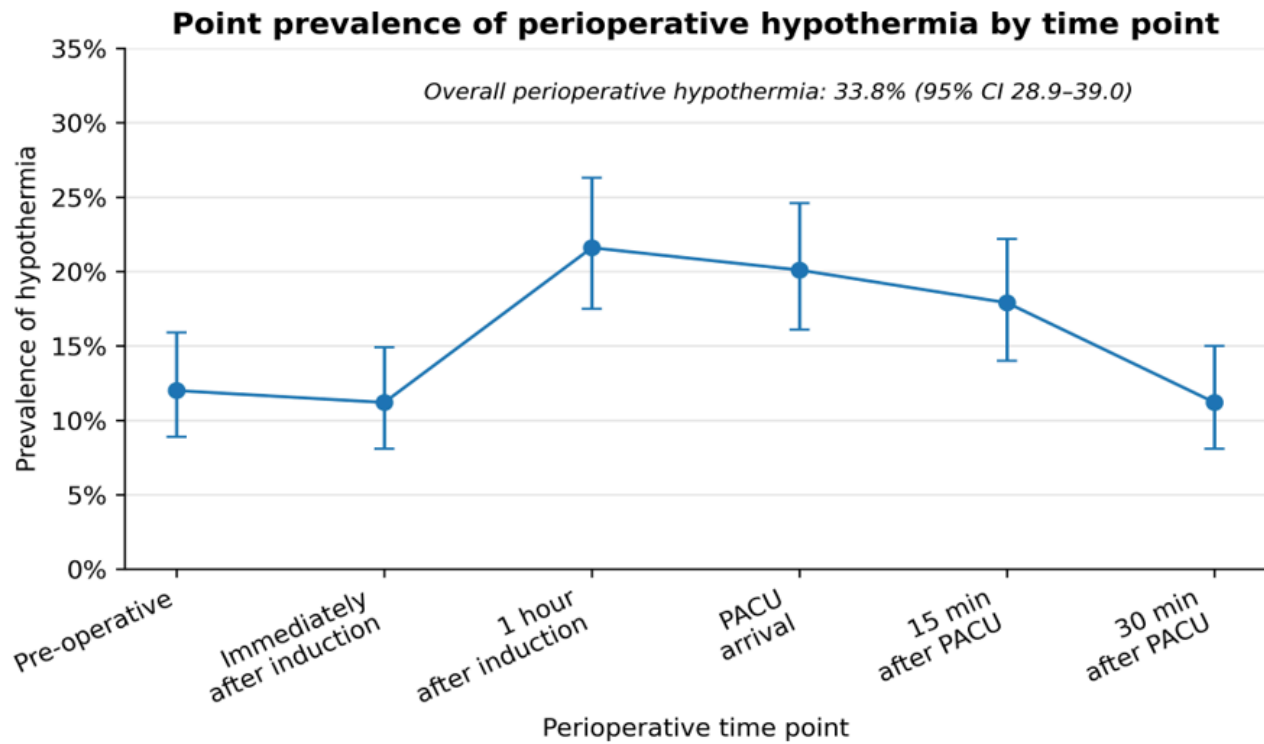


Figure 2

Point prevalence of perioperative hypothermia across perioperative time points. Error bars represent exact binomial 95% confidence intervals

Supplementary Files

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