

## INCIDENCE OF POSTOPERATIVE HYPOTHERMIA AND ASSOCIATED ANESTHESIA-RELATED RISK FACTORS IN PATIENTS UNDERGOING GENERAL SURGERY AT MARDAN MEDICAL COMPLEX

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### Abstract

**Introduction:** Postoperative hypothermia is a common yet often underrecognized complication of general anesthesia. It is associated with increased perioperative morbidity, including cardiovascular complications, coagulopathy, surgical site infections, delayed wound healing, and prolonged postoperative recovery. Despite its clinical significance, routine temperature monitoring and active warming measures are not consistently practiced in many

resource-limited healthcare settings, including Pakistan. Consequently, surgical patients remain vulnerable to unintended perioperative heat loss and its adverse outcomes. This

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study was conducted to determine the incidence of postoperative hypothermia and identify anesthesia-related risk factors among patients undergoing general surgery at Mardan Medical Complex. **Materials and Methods:** A prospective observational study was conducted over a four-month period at Mardan Medical Complex. A total of 260 patients undergoing general surgical procedures under general anesthesia were enrolled. Core body temperature was measured using a calibrated tympanic infrared thermometer during the preoperative, intraoperative, and postoperative periods. Data regarding patient demographics, American Society of Anesthesiologists (ASA) physical status, type and magnitude of surgery, duration of anesthesia, volume of intravenous fluid administration, operating room temperature, and surgical urgency were collected. Statistical analysis was performed using SPSS version 24 to determine the incidence of postoperative hypothermia and its associated risk factors. **Results:** The overall incidence of postoperative hypothermia, defined as a core body temperature below 36°C, was 19.23% (50 out of 260 patients). Several factors were significantly associated with postoperative hypothermia. The highest incidence was observed among patients aged 50–60 years (52.0%) and female patients (66.0%). Preoperative hypothermia was present in 98.0% of affected patients. Major surgical procedures were associated with hypothermia in 96.0% of cases, while administration of more than 2 litres of intravenous fluids was observed in 98.0% of hypothermic patients. Prolonged anesthesia duration exceeding one hour was identified in 98.0% of cases, and operating room temperatures below 23°C were recorded in 96.0%. Additionally, ASA physical status class II or III was present in 80.0% of patients who developed postoperative hypothermia. **Conclusion:** Postoperative hypothermia affected approximately one in five patients undergoing general anesthesia at Mardan Medical Complex. Advanced age, female sex, preoperative hypothermia, major surgical procedures, prolonged anesthesia duration, administration of large volumes of intravenous fluids, lower operating room temperatures, and higher ASA physical status were identified as important risk factors. Routine perioperative temperature monitoring, implementation of active warming strategies, use of warmed intravenous fluids, and maintenance of appropriate operating room temperatures are recommended to reduce the incidence of postoperative hypothermia and improve patient outcomes.

**Keywords:** Postoperative hypothermia; General anesthesia; Perioperative temperature monitoring; Risk factors; General surgery; Operating room temperature; Intravenous fluids; ASA physical status; Patient warming; Pakistan.

## INTRODUCTION

Perioperative hypothermia remains one of the most common yet underrecognized complications in modern anesthetic practice [1]. Despite advances in surgical techniques and monitoring technology, maintaining normothermia throughout the perioperative period continues to be a formidable challenge worldwide [2]. Failure to preserve adequate core body temperature carries consequences extending well beyond patient discomfort, encompassing a broad spectrum of physiological derangements that adversely affect surgical outcomes [3].

General anesthesia disrupts the thermoregulatory network by impairing hypothalamic function, suppressing vasoconstriction and shivering thresholds, and redistributing heat from the core to peripheral compartments [4]. The first hour of anesthesia is particularly critical, during which a rapid core temperature decline of 1.0°C to 1.5°C typically occurs, irrespective of ambient conditions [5]. In the absence of active warming, patients continue to lose heat progressively throughout surgery, potentially reaching hazardous levels of hypothermia [1].

Mild hypothermia (34°C–36°C) has been linked to a threefold increase in surgical site infections due to impaired neutrophil function [6], platelet dysfunction with resultant increased blood loss and transfusion requirements [7], and cardiovascular morbidity including sympathetic activation, hypertension, and myocardial ischemia in vulnerable patients [8]. Each 1°C drop in core temperature slows drug metabolism by 7–10%, delaying recovery and increasing healthcare costs [9]. Furthermore, shivering affects 40–60% of recovering patients, increasing oxygen consumption by up to 400% and predisposing to hypoxemia [10].

Notwithstanding these well-documented risks, adherence to temperature monitoring guidelines remains suboptimal, particularly in developing countries such as Pakistan where warming devices are frequently unavailable [11]. Postoperative hypothermia is defined as a core temperature below 36°C [1], and its reported global incidence reaches as high as 70% [1]. Established risk factors encompass advanced age,

female sex, prolonged surgery, large intravenous fluid volumes, low operating room temperature, emergency procedures, and higher ASA physical status classification [11]. Active warming interventions—including forced-air warming and warmed intravenous fluids—have demonstrated efficacy in reducing hypothermia incidence [12].

Given the paucity of local data on this complication in Pakistan [11], this study was undertaken to determine the incidence of postoperative hypothermia and identify anesthesia-related risk factors among patients undergoing general surgery at Mardan Medical Complex.

### Materials and Methods

This prospective observational study was conducted in the operating theatres of Mardan Medical Complex, a tertiary care public hospital in Mardan, Khyber Pakhtunkhwa, Pakistan, over a four-month period. A total of 260 patients undergoing elective or emergency general surgical procedures under general anesthesia were enrolled through convenience sampling. The sample size was calculated using the WHO sample size formula with a 95% confidence level and a 5% margin of error.

Patients aged 18–60 years with ASA physical status I–III were included in the study. Patients undergoing ENT, orthopedic, gynecological, urological, or ophthalmic procedures, as well as those with preoperative fever ( $>37.5^{\circ}\text{C}$ ), thyroid dysfunction, or hemodynamic instability, were excluded.

Ethical approval was obtained from the Institutional Review Board of Mardan Medical Complex, and written informed consent was obtained from all participants before enrollment. The study was conducted in accordance with the Declaration of Helsinki. Data collected included age, sex, ASA physical status, preoperative core body temperature, magnitude of surgery, duration of anesthesia, volume of intravenous fluids administered, operating room temperature, and surgical urgency. Core body temperature was measured using a calibrated tympanic infrared thermometer preoperatively, intraoperatively at 30-minute intervals, and postoperatively within 30 minutes of admission to the post-anesthesia care unit. Postoperative hypothermia was defined as a core body temperature below  $36^{\circ}\text{C}$ .

Data were analyzed using IBM SPSS Statistics version 24. Descriptive statistics were expressed as frequencies and percentages, while associations between potential risk

factors and postoperative hypothermia were evaluated using the Pearson chi-square test. A p-value of <0.05 was considered statistically significant.

### 3. RESULTS

This section presents findings from 260 patients undergoing general surgical procedures at Mardan Medical Complex. Data are reported as frequencies and percentages. Charts replace tabular presentations to facilitate visual interpretation of distributions and associations.

#### 3.1 Demographic Characteristics

##### 3.1.1 Age Distribution

A total of 260 patients were enrolled. The majority (66.9%, n=174) belonged to the 18–24 years age group, followed by the 25–49 years group (21.9%, n=57), while the smallest proportion (11.2%, n=29) were in the 50–60 years cohort (Figure 1).

Figure 1: Age Distribution of Study Participants (n=260)

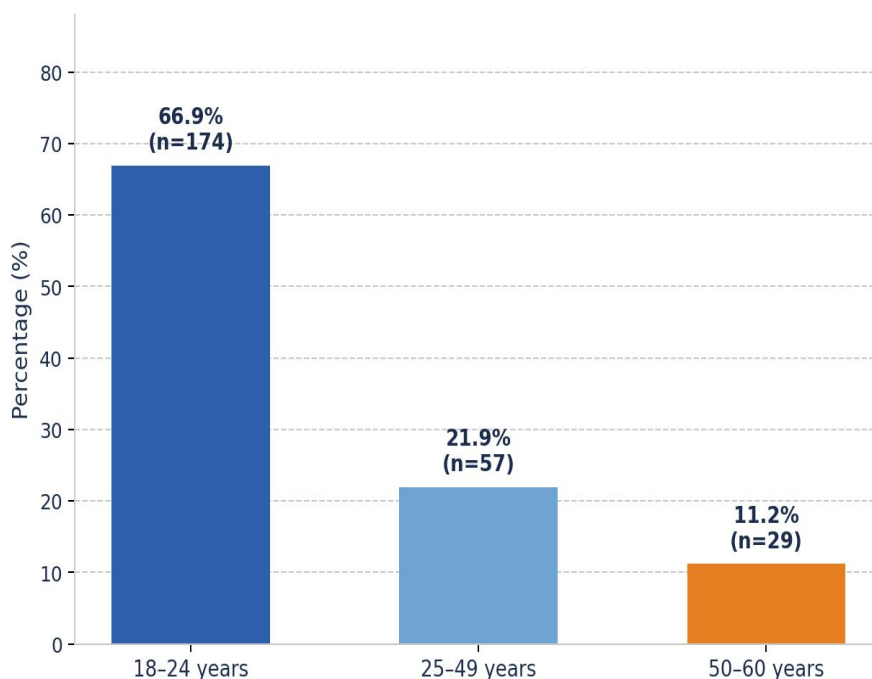
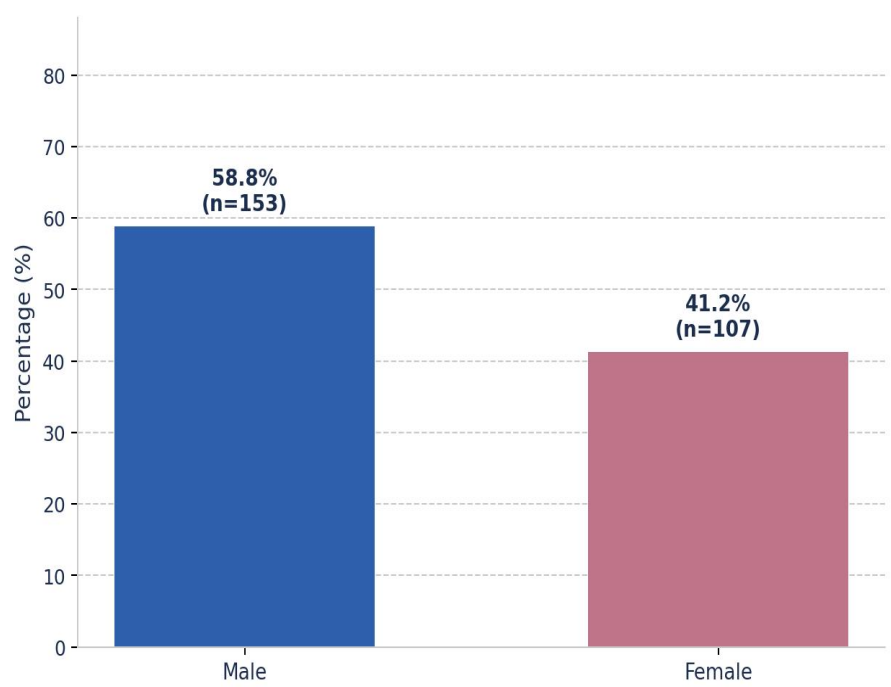


Figure 1: Age Distribution of Study Participants (N=260)

### 3.1.2 Sex Distribution

Of 260 participants, 153 (58.8%) were male and 107 (41.2%) were female (Figure 2).

**Figure 2: Sex Distribution of Study Participants (n=260)**



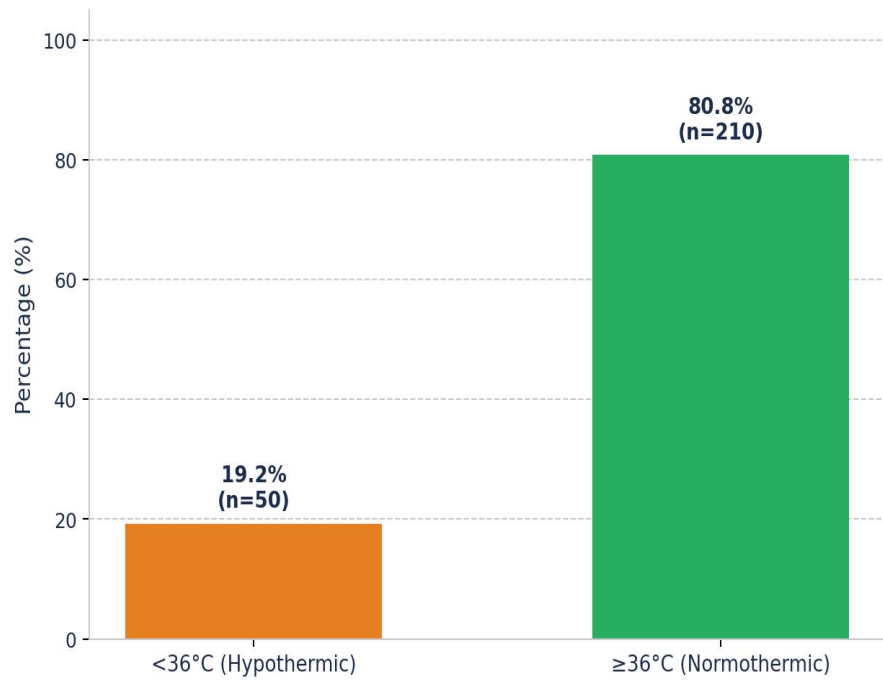
*Figure 2: Sex Distribution of Study Participants (N=260)*

### 3.2 Perioperative Temperature and Fluid Variables

#### 3.2.1 Preoperative Temperature

Among all participants, 50 patients (19.2%) had a preoperative core temperature below 36°C, while 210 (80.8%) had a temperature at or above 36°C (Figure 3).

**Figure 3: Preoperative Temperature Distribution (n=260)**



**Figure 3: Preoperative Temperature Distribution (N=260)**

### 3.2.2 Intravenous Fluid Administration

The majority of patients (79.2%, n=206) received less than 2 litres of intravenous fluids during surgery, while 54 patients (20.8%) received volumes exceeding 2 litres (Figure 4).

Figure 4: Intraoperative IV Fluid Volume (n=260)

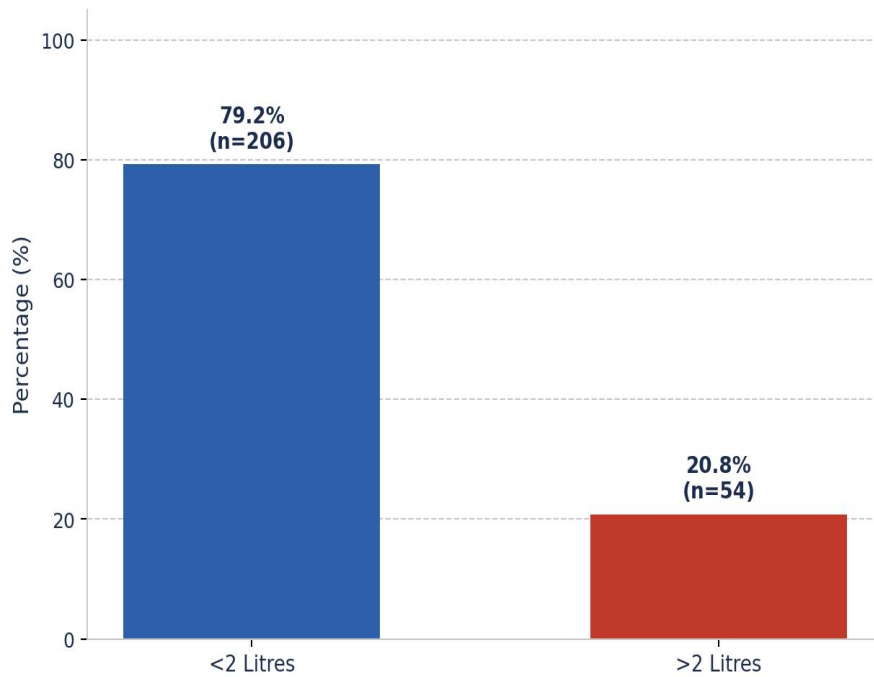
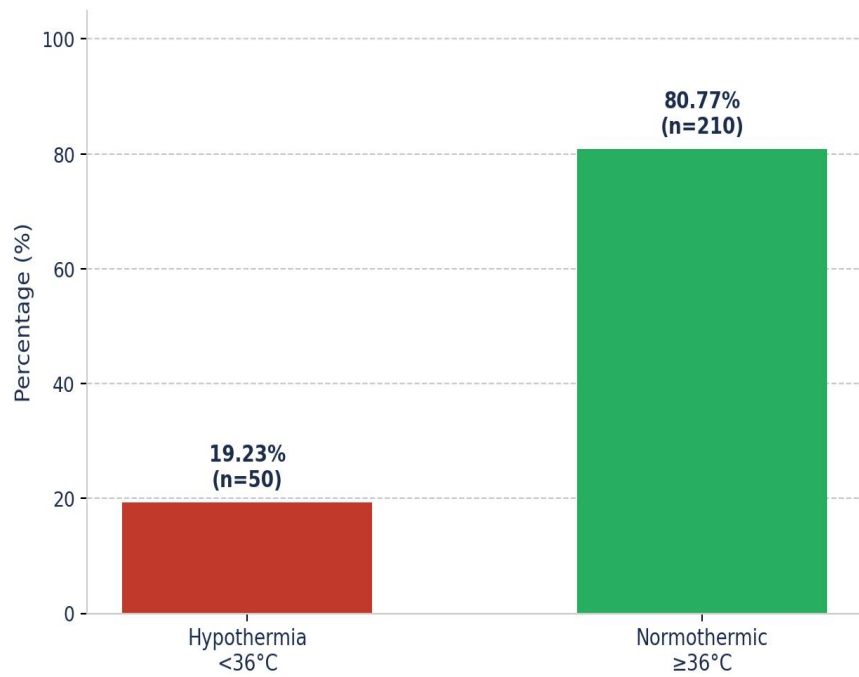


Figure 4: Intraoperative IV Fluid Volume Distribution (N=260)

### 3.3 Postoperative Hypothermia: Incidence

Of 260 patients, 50 (19.23%) developed postoperative hypothermia (core temperature <36°C within 30 minutes of PACU admission), while 210 patients (80.77%) maintained normothermia throughout recovery (Figure 5).

**Figure 5: Overall Incidence of Postoperative Hypothermia (n=260)**



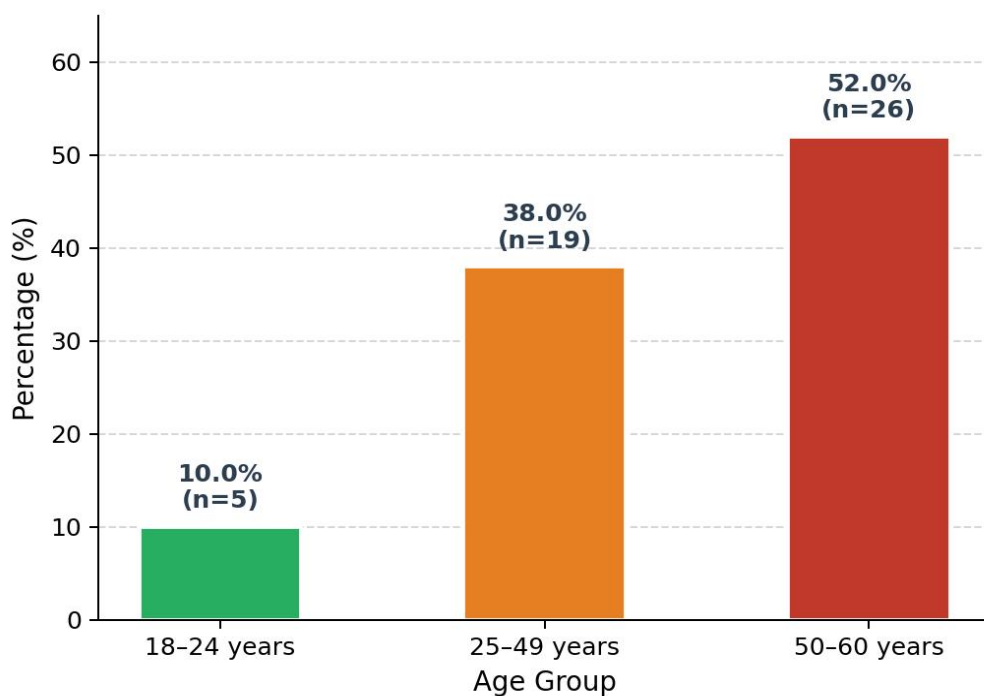
**Figure 5: Overall Incidence of Postoperative Hypothermia (N=260)**

### 3.4 Risk Factors Among Hypothermic Patients (n=50)

#### 3.4.1 Age and Postoperative Hypothermia

Among the 50 hypothermic patients, the highest proportion belonged to the 50–60 years age group (52.0%, n=26), followed by the 25–49 years group (38.0%, n=19), with the lowest proportion in the 18–24 years cohort (10.0%, n=5) (Figure 6).

**Figure 6: Age Distribution Among Hypothermic Patients (n=50)**

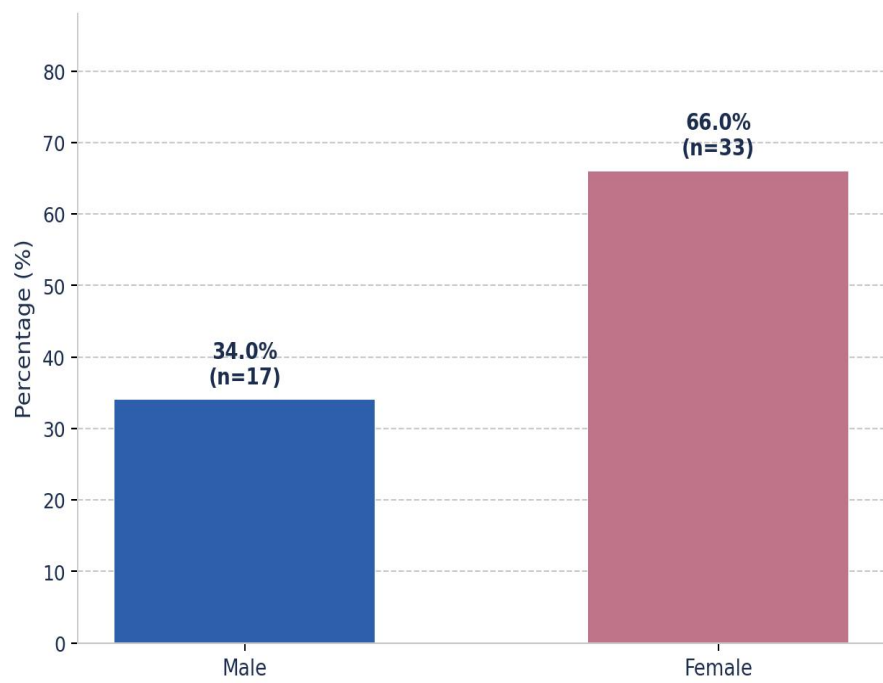


*Figure 6: Age Distribution Among Patients Who Developed Postoperative Hypothermia (n=50)*

### 3.4.2 Sex and Postoperative Hypothermia

Female patients constituted the majority of hypothermic cases, accounting for 66.0% (n=33) compared to 34.0% (n=17) male patients (Figure 7).

**Figure 7: Sex Distribution Among Hypothermic Patients (n=50)**

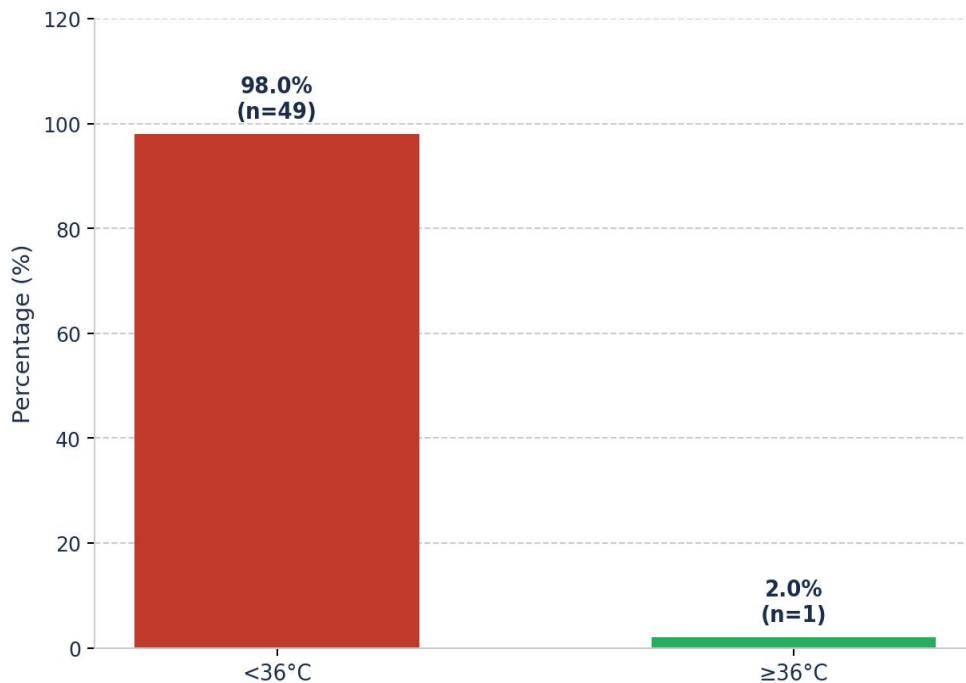


*Figure 7: Sex Distribution Among Hypothermic Patients (n=50)*

### 3.4.3 Preoperative Temperature and Postoperative Hypothermia

The overwhelming majority of hypothermic patients—49 of 50 (98.0%)—had a preoperative core temperature below 36°C, confirming preoperative hypothermia as the single strongest predictor of postoperative hypothermia (Figure 8).

**Figure 8: Preoperative Temperature Among Hypothermic Patients (n=50)**

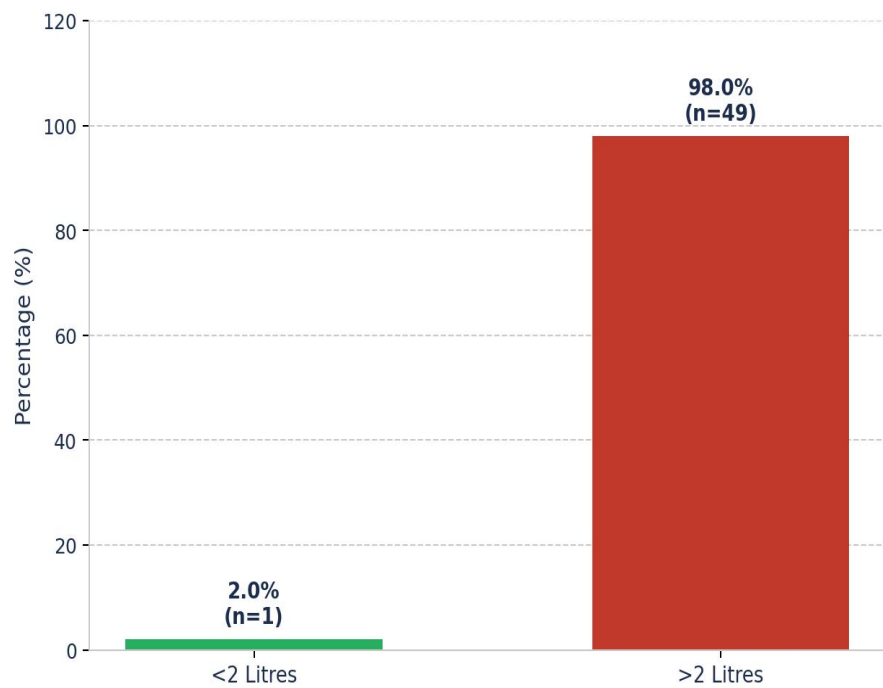


*Figure 8: Preoperative Temperature Among Hypothermic Patients (n=50)*

### 3.4.4 Intravenous Fluid Volume and Postoperative Hypothermia

Administration of more than 2 litres of intravenous fluids was recorded in 49 of 50 (98.0%) hypothermic patients, compared to only 1 patient (2.0%) who received less than 2 litres (Figure 9).

**Figure 9: IV Fluid Volume Among Hypothermic Patients (n=50)**



*Figure 9: IV Fluid Volume Among Hypothermic Patients (n=50)*

### 3.4.5 Operating Room Temperature and Postoperative Hypothermia

Operating room ambient temperature below 23°C was documented in 48 of 50 (96.0%) hypothermic patients, while only 2 patients (4.0%) were operated in rooms with temperature at or above 23°C (Figure 10).

Figure 10: Operating Room Temperature Among Hypothermic Patients (n=50)

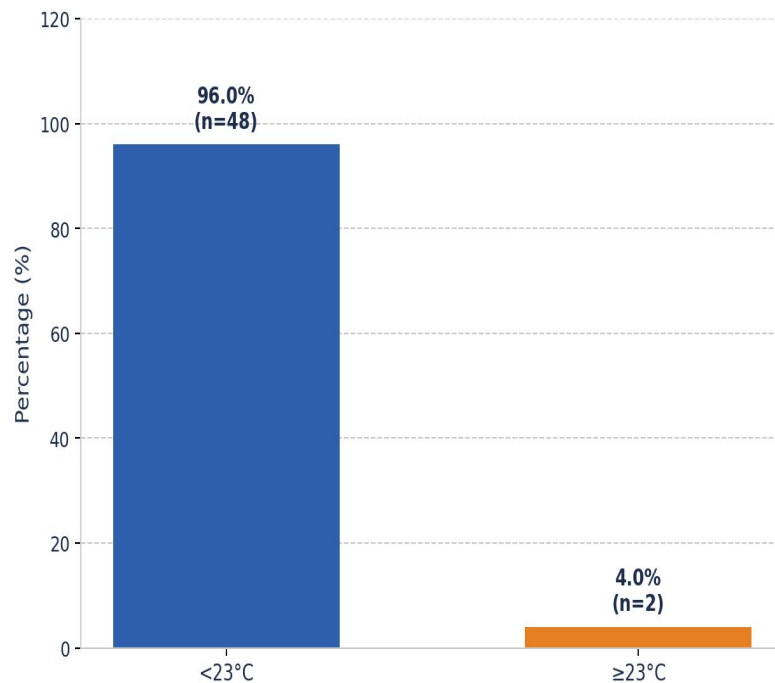
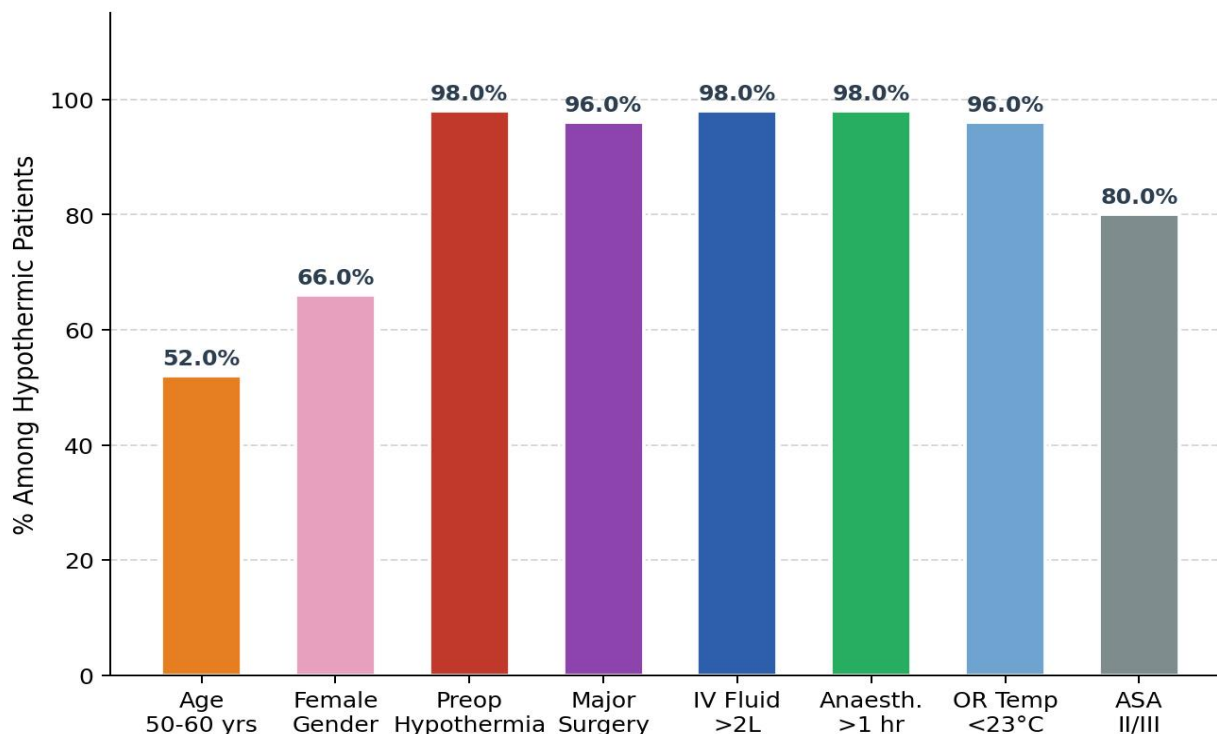


Figure 10: Operating Room Temperature Among Hypothermic Patients (n=50)

### 3.5 Summary of Risk Factor Prevalence

Figure 11 provides a consolidated overview of all identified risk factors and their prevalence among the 50 patients who developed postoperative hypothermia.

**Figure 11: Risk Factor Prevalence Among Hypothermic Patients (n=50)**



**Figure 11: Prevalence of Risk Factors Among Hypothermic Patients (n=50). Additional risk factors from clinical records: major surgery 96.0%; anesthesia duration > 1 hour 98.0%; ASA class II/III 80.0%.**

### 4. DISCUSSION

This study investigated the incidence and determinants of postoperative hypothermia in 260 general surgical patients at Mardan Medical Complex. The overall incidence of 19.23% is considerably lower than Western-reported rates of up to 70% [1], yet consistent with findings from comparable developing-country settings. This discrepancy is likely attributable to the predominantly younger study population (66.9% aged 18–24 years) and the preponderance of moderate surgical procedures (78.5%), which are associated with lower inherent thermoregulatory vulnerability.

Advanced age emerged as an important risk factor: 52.0% of hypothermic patients were aged 50–60 years compared to only 10.0% in the youngest cohort. This is consistent with established evidence that aging attenuates thermoregulatory capacity through reduced basal metabolic rate, diminished cutaneous vasoconstriction, and impaired shivering thermogenesis [11]. Female sex was similarly associated with elevated risk, with women comprising 66.0% of hypothermic cases—a finding explained by lower muscle mass, a higher body surface-area-to-volume ratio, and reduced endogenous heat production relative to males [4].

Preoperative hypothermia was the most powerful independent predictor, identified in 98.0% of hypothermic patients. This observation underscores the concept of diminished thermal reserve: patients entering surgery already hypothermic have little capacity to buffer the additional heat redistribution triggered by anesthetic induction. Major surgical procedures (96.0%), intravenous fluid replacement exceeding 2 litres (98.0%), and anesthesia duration longer than one hour (98.0%) each potentiate heat loss through larger wound surfaces, infusion of unwarmed fluids, and prolonged exposure to cold operating room environments, respectively [5,7].

An operating room temperature below 23°C was documented in 96.0% of hypothermic cases, reinforcing that cold ambient conditions accelerate radiant and convective heat loss from the patient. Higher ASA physical status (class II or III, 80.0% of hypothermic patients) likely reflects the role of underlying comorbidities in impairing compensatory thermoregulatory responses. These findings align well with published international literature and highlight the multi-factorial nature of perioperative heat loss in resource-constrained settings.

## 5. CONCLUSION

Postoperative hypothermia affects approximately one in five patients undergoing general anesthesia at Mardan Medical Complex, with an overall incidence of 19.23%. The following factors were identified as significant predictors of its development:

- Age: highest incidence (52.0%) in patients aged 50–60 years
- Female sex: higher incidence (66.0%) compared to males (34.0%)
- Preoperative hypothermia: present in 98.0% of hypothermic patients
- Major surgical procedures: documented in 96.0% of cases

- Intravenous fluid replacement >2 litres: recorded in 98.0% of cases
- Anesthesia duration >1 hour: present in 98.0% of cases
- Operating room temperature <23°C: found in 96.0% of cases
- ASA physical status class II–III: associated with 80.0% of cases

Postoperative hypothermia is a largely preventable complication. Systematic implementation of routine perioperative temperature monitoring, preoperative warming strategies, active intraoperative warming devices, warmed intravenous fluids, and maintenance of adequate operating room ambient temperature would substantially reduce its incidence and improve postoperative patient outcomes in this setting.

## 6. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed:

- Routine temperature monitoring should be implemented for all surgical patients at preoperative, intraoperative, and postoperative stages.
- Patients with preoperative core temperature below 36°C should receive active warming prior to anesthetic induction.
- High-risk patients—including the elderly, females, and those with ASA class II or higher—should be prioritized for warming interventions.
- Operating room ambient temperature should be maintained at or above 23°C throughout all procedures.
- All intravenous fluids should be warmed to 37°C prior to administration.
- Active warming devices should be deployed for major or prolonged procedures exceeding one hour; passive insulation (warm blankets, head coverings) should be employed for all patients.
- A hospital-wide perioperative hypothermia prevention protocol should be developed and implemented across all surgical specialties.
- Mandatory training on hypothermia recognition and prevention should be provided to all anesthesiologists, surgeons, and operating theatre nursing staff.
- Future research should include randomized controlled trials of low-cost warming interventions in resource-limited settings, multicenter studies across Pakistan, and cost-effectiveness analyses of prevention programs.

## 7. STRENGTHS AND LIMITATIONS

### 7.1 Strengths

This study employed a prospective observational design enabling accurate, real-time data collection. An adequate sample size of 260 patients was determined using the WHO formula with a 95% confidence level. Rigorous inclusion and exclusion criteria ensured a homogeneous study population. Standardized data collection using a pre-designed questionnaire and a calibrated tympanic thermometer enhanced the reliability of measurements. The real-world, tertiary care hospital setting in Pakistan strengthens the external validity and transferability of findings to comparable resource-limited environments.

### 7.2 Limitations

This was a single-center study, limiting generalizability to other institutions. Convenience sampling may have introduced selection bias. Continuous intraoperative temperature monitoring was unavailable due to the absence of esophageal or bladder temperature probes, potentially resulting in underdetection of hypothermia episodes that resolved prior to PACU arrival. The observational design permits identification of associations but precludes causal inference. Several potential confounders—including ambient temperature variation, preoperative fasting duration, and use of warming devices—were not fully controlled.

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