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THE RELATIONSHIP BETWEEN BODY MASS INDEX AND DURATION OF SURGERY WITH THE INCIDENCE OF HYPOTHERMIA IN PATIENTS FOLLOWING SPINAL ANESTHESIA: A LITERATURE REVIEW

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ABSTRACT

Hypothermia is a common perioperative complication in patients undergoing surgery with spinal anesthesia, resulting from disrupted thermoregulatory mechanisms caused by sympathetic blockade and heat redistribution from the body core to peripheral tissues. Body mass index (BMI) and duration of surgery are two factors frequently reported to be associated with the incidence of hypothermia following spinal anesthesia. This study aimed to synthesize national and international evidence on the association of body mass index and duration of surgery with the incidence of hypothermia in patients following spinal anesthesia through a PRISMA-based literature review. Google Scholar, PubMed, and Scopus were searched for articles published in 2021–2026, yielding 1,350 articles, of which 10 articles (5 national and 5 international) were selected based on the eligibility criteria and quality appraisal using the Critical Appraisal Skills Programme (CASP). Most included studies were observational. The synthesis showed that lower body mass index and longer duration of surgery were associated with an increased incidence of hypothermia and shivering following spinal anesthesia in most studies ($p<0.05$), although the observational designs do not allow causal inference. Integrating Indonesian and international evidence indicates that these associations are similar across health systems, while national evidence is still dominated by small single-site studies. In conclusion, body mass index and duration of surgery are associated factors that warrant attention from anesthesia providers and nurses for early risk identification, rigorous body temperature monitoring, and adequate perioperative thermal management.

Keywords: *Body mass index, duration of surgery, hypothermia, spinal anesthesia, postoperative.*

INTRODUCTION

Spinal anesthesia is one of the most widely used regional anesthesia techniques in surgical practice due to its ease of administration, rapid onset of action, relatively affordable cost, and favorable safety profile for patients compared with general anesthesia. Nevertheless, spinal anesthesia has significant physiological consequences for the body's thermoregulatory system. The sympathetic blockade induced by spinal anesthesia causes vasodilation of peripheral blood vessels below the block level, resulting in redistribution of heat from the body's core compartment to peripheral tissues, so that core body temperature decreases rapidly within the first hour after subarachnoid block (Rauch et al., 2021). Perioperative hypothermia, defined as a decrease in core body temperature below 36°C, is a complication that is often overlooked but has the potential to cause serious clinical consequences.

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The effects of perioperative hypothermia include impaired blood coagulation, increased blood loss and transfusion requirements, increased risk of surgical site infection, impaired wound healing, cardiac dysrhythmia, shivering, decreased patient comfort, and prolonged recovery and length of hospital stay (Rauch et al., 2021). Rauch et al. (2021) through a comprehensive narrative review affirmed that perioperative hypothermia remains a significant clinical problem despite the wide availability of advances in temperature monitoring technology and active warming devices, so that active temperature management recommendations remain necessary for all surgeries under general or spinal anesthesia lasting more than 30 minutes.

Body mass index (BMI) is one individual factor consistently reported to be associated with patients' susceptibility to perioperative hypothermia. Subcutaneous fat tissue acts as a natural thermogenic insulator that helps maintain core body temperature; therefore, patients with low BMI have smaller fat reserves and are consequently more susceptible to heat loss and decreased body temperature during and after surgery (Ashoobi et al., 2023). Conversely, a recent study in cesarean section patients under spinal anesthesia showed that higher BMI is associated with a higher vasoconstriction threshold, thereby delaying the vasoconstriction response and helping to better maintain core body temperature (Mashak et al., 2026).

In addition to body mass index, duration of surgery is also an important factor associated with hypothermia following spinal anesthesia. The longer the duration of surgery, the greater the patient's exposure to the relatively cold operating room temperature, room-temperature infusion and irrigation fluids, evaporation of body fluids from the open surgical area, and the duration of sympathetic blockade that inhibits the body's compensatory vasoconstriction mechanism (Ferede et al., 2021). An institution-based study in Ethiopia involving cesarean section patients under spinal anesthesia reported that duration of surgery was one of the factors significantly associated with the incidence of intraoperative shivering, with an incidence reaching more than half of the study population (Ferede et al., 2021). Shivering is also common after spinal anesthesia in other settings, with an incidence of 42.8% in one observational study (Kanchan et al., 2022), and its drug treatment continues to be evaluated in systematic reviews (Wan et al., 2023).

Recent syntheses and cohort studies support these associations beyond spinal anesthesia. A meta-analysis of 17 studies including 21,004 patients undergoing non-cardiac surgery found higher odds of postoperative hypothermia in patients with a BMI below 18.5 kg/m² (OR 1.83) and in surgeries lasting more than 60 minutes (OR 2.34), although the certainty of evidence was mostly low to very low because the primary studies were observational (Tan et al., 2025). A meta-analysis of pregnant women undergoing cesarean section also identified low BMI and spinal anesthesia among the risk factors for perioperative hypothermia (Wang et al., 2024), and a retrospective analysis of 833 robotic-surgery patients showed that lower BMI and each additional hour of surgery were associated with intraoperative hypothermia (Hu et al., 2023). At the same time, warming measures may remain insufficient in prolonged procedures (Zhou et al., 2025), and only

about 59.1% of surveyed nurses had good knowledge and 50.4% good practice of hypothermia prevention in referral hospitals in Ethiopia (Woretaw et al., 2023).

In Indonesia, several studies have reported associations between body mass index and duration of surgery and the incidence of hypothermia following spinal anesthesia in regional and referral hospitals. Muntaha et al. (2022) at RSU Metro Medical Center Lhokseumawe and Tubalawony and Siahaya (2023) reported significant associations between these two factors and hypothermia following spinal anesthesia, and a recent Indonesian study also reported an association between BMI and hypothermia after general anesthesia (Thaher et al., 2024). Nevertheless, existing syntheses mostly pool heterogeneous surgical populations or focus on specific groups such as cesarean section patients, and comprehensive reviews that examine BMI and duration of surgery together in spinal anesthesia, while integrating national and international evidence, remain limited. The novelty of this review is therefore the side-by-side synthesis of five Indonesian and five international studies, which is expected to show whether the associations observed in Indonesian settings, mostly from small single-site studies, are consistent with international evidence, and to support context-appropriate perioperative hypothermia prevention. Based on this background, this study aims to examine the association of body mass index and duration of surgery with the incidence of hypothermia in patients following spinal anesthesia through a PRISMA-based literature review approach using recent empirical studies from 2021–2026, comprising 5 national articles and 5 international articles.

RESEARCH METHOD

This study used a literature review design based on the topic "The Relationship between Body Mass Index and Duration of Surgery with the Incidence of Hypothermia in Patients Following Spinal Anesthesia" through the PICO framework as follows: P (Population): postoperative patients under spinal anesthesia; I/E (Exposure): body mass index and duration of surgery; C (Comparison): different categories of BMI and duration of surgery; O (Outcome): incidence of hypothermia or shivering following spinal anesthesia. The databases used were Google Scholar, PubMed, and Scopus. The database searches were conducted between 5 and 12 September 2026 (date of last search: 12 September 2026). The keywords used were "indeks massa tubuh", "body mass index", "lama operasi", "duration of surgery", "hipotermia", "hypothermia", "shivering", "anestesi spinal", "spinal anesthesia" with Boolean operators (AND, OR). Full search string: ("body mass index" OR "indeks massa tubuh" OR "IMT") AND ("duration of surgery" OR "lama operasi" OR "durasi operasi") AND ("hypothermia" OR "hipotermia" OR "shivering" OR "menggigil") AND ("spinal anesthesia" OR "anestesi spinal" OR "neuraxial anesthesia").

Eligibility Criteria. The inclusion criteria used were: (1) articles published between 2021–2026; (2) available in full text with open access; (3) written in Indonesian or English; (4) quantitative research design (cross-sectional, cohort, case-control, retrospective); (5) research variables consistent with body mass index and/or duration of

surgery as the exposure variable, and incidence of hypothermia or shivering following spinal anesthesia as the outcome variable; (6) consisting of a combination of national and international articles to provide a comprehensive perspective. Exclusion criteria included: articles in the form of opinions, editorials, case reports, or reviews without primary data; articles examining hypothermia under general anesthesia without a spinal anesthesia component; articles that did not report quantitative relationship analysis results; and articles not relevant to the research topic after full-text reading.

Data Extraction. The article search stage was conducted systematically through three main databases. Articles that did not meet the inclusion criteria were excluded in stages. After obtaining articles that met the inclusion criteria, methodological quality was appraised using the Critical Appraisal Skills Programme (CASP), as described below, to ensure that only studies with adequate methodological quality were included in the synthesis. The search was conducted in two stages: the first stage focused on general criteria (publication year 2021–2026, full-text open access, Indonesian or English language); the second stage focused on conformity with the PICO framework and the balance of national and international article proportions. Data were extracted in a standardized manner, including: researcher name, year of publication, country/origin of journal (national/international), research design, sample size, method of measuring BMI and duration of surgery, instrument for measuring hypothermia/shivering, whether adjusted multivariable analysis was reported, and main results (p-value, strength of relationship).

Quality Assessment. The methodological quality of the 22 full-text articles that met the eligibility criteria was appraised using the CASP checklists (cohort and case-control checklists, adapted for cross-sectional designs). The appraisal covered: (1) a clearly focused research question; (2) appropriateness of the study design and of the recruitment or sampling method; (3) valid measurement of the exposure (BMI and duration of surgery); (4) valid measurement of the outcome (body temperature or shivering scale); (5) identification and handling of confounding factors; (6) appropriateness of the statistical analysis and precision of the results; and (7) applicability of the results to the review question. Each item was rated “yes”, “cannot tell”, or “no”. Articles were retained when at least 5 of the 7 items were rated “yes” (≥70%). Twelve articles were excluded at this stage because of low methodological quality (Figure 1), mainly due to unclear sampling methods and inadequate control of confounding factors, leaving 10 articles for synthesis.

RESULTS AND DISCUSSION

The article search through the Google Scholar, PubMed, and Scopus databases yielded 1,350 articles. After the process of removing duplicates and staged selection based on title, abstract, and full-text eligibility, 10 articles that met all inclusion criteria were obtained and analyzed in this study, consisting of 5 national articles and 5 international articles. Of the 22 articles appraised with CASP, 12 were excluded because

of low methodological quality (Figure 1). The characteristics and main findings of the 10 included articles are summarized in Table 1.

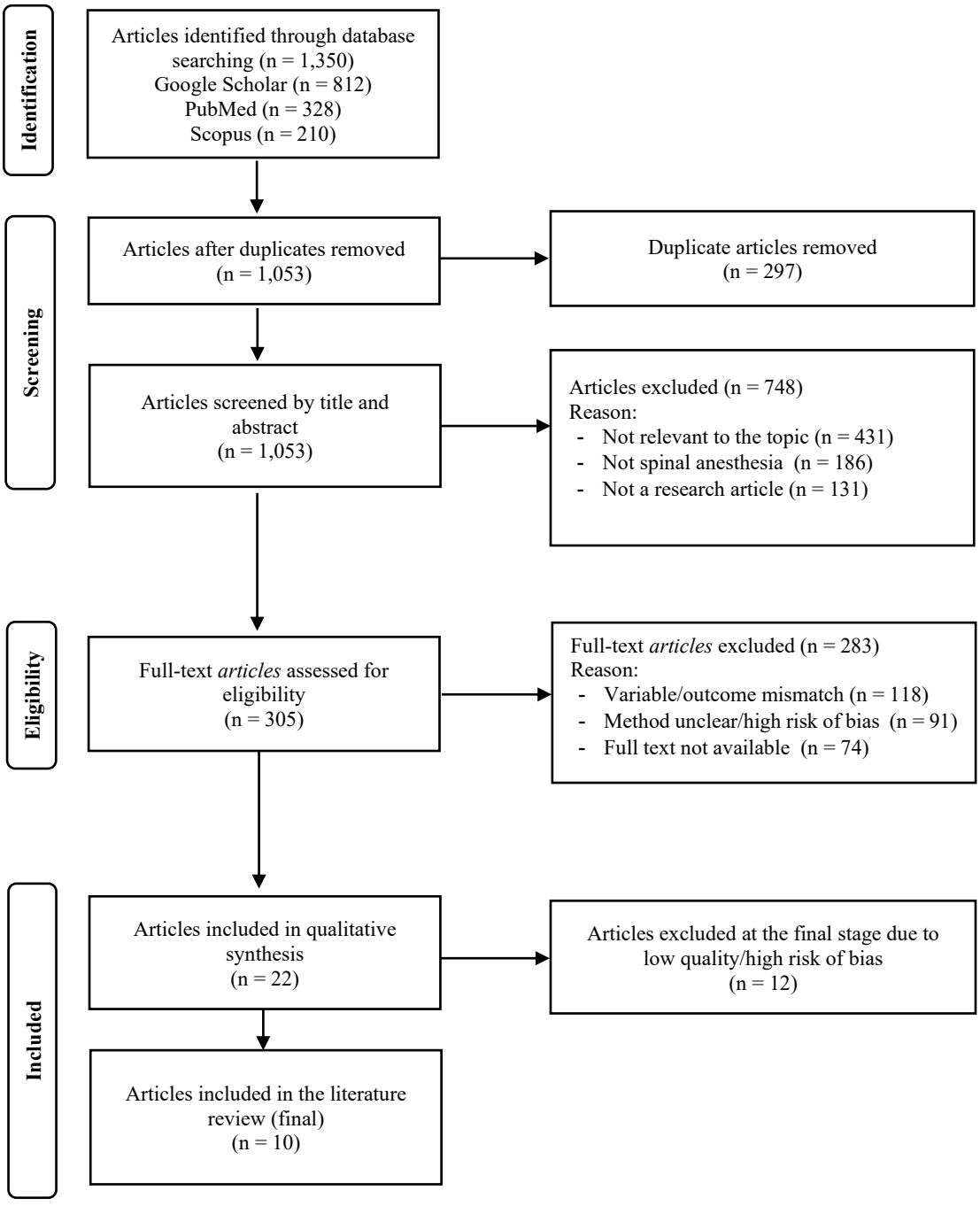


Figure 1. PRISMA flow diagram of the article selection process

Table 1. Article Analysis

No	Topic	Researcher(s)	Design	Population & Sample	Results
1	The Relationship between Body Mass Index and Duration of Surgery with the Incidence of Hypothermia in Postoperative Patients with Spinal Anesthesia at RSU Metro Medical Center Lhokseumawe	(Muntaha et al., 2022)	Descriptive Correlational, Cross-sectional	Postoperative patients with spinal anesthesia at RSU Metro Medical Center Lhokseumawe	There is a significant relationship between body mass index and duration of surgery with the incidence of hypothermia in postoperative patients with spinal anesthesia ($p<0.05$). Patients with low BMI and longer duration of surgery showed a higher risk of hypothermia.
2	The Effect of Spinal Anesthesia on the Incidence of Hypothermia in Postoperative Patients	(Tubalawony & Siahaya, 2023)	Descriptive Correlational, Cross-sectional, Probability Sampling	76 postoperative patients with spinal anesthesia	The chi-square test results showed a significant relationship between duration of surgery ($p=0.015$) and body mass index ($p=0.027$) with the incidence of hypothermia following spinal anesthesia, indicating that both variables are associated factors (bivariate analysis).
3	The Relationship between Body Mass Index (BMI) and Hypothermia in Postoperative Patients in the Recovery Room	(Chaidir et al., 2023)	Descriptive Analytic, Cross-sectional	37 postoperative patients in the Operating Room of Sawahlunto Community Health Center, West Sumatra	There is a significant relationship between body mass index and the incidence of hypothermia in postoperative patients ($p=0.044$). Patients with low BMI (<17) showed a greater tendency to experience decreased body temperature following surgery.

4	The Effect of Body Mass Index on the Incidence of Hypothermia in Spinal Anesthesia Patients	(Rakasiwi et al., 2021)	Cross-sectional	Patients undergoing spinal anesthesia	Low body mass index is significantly associated with an increased incidence of hypothermia in spinal anesthesia patients, reinforcing the role of adipose tissue as a thermogenic insulator in preventing body heat loss during and after surgery.
5	The Relationship between Operation Duration and Shivering in Post-Spinal Anaesthesia Patients	(Renaningtyastutik et al., 2022)	Quantitative, Cross-sectional, Systematic Sampling	Patients undergoing surgery with spinal anesthesia	There is a significant relationship between duration of surgery and the incidence of shivering following spinal anesthesia as measured using the Crossley and Mahajan scale, with longer duration of surgery correlating with a more severe degree of shivering as a manifestation of hypothermia.
6	The Magnitude and Associated Factors of Intraoperative Shivering after Cesarean Section Delivery under Spinal Anesthesia: A Cross-Sectional Study	(Ferede et al., 2021)	Institution-based Cross-sectional	Parturients undergoing cesarean section with spinal anesthesia in Ethiopia	Duration of surgery, hypothermia, and hypotension were identified as factors significantly associated with the incidence of intraoperative shivering, with the incidence of shivering following spinal anesthesia reaching 51.8% in the study population.
7	Prevalence of Postoperative Hypothermia in the Post-	(Ashoobi et al., 2023)	Cross-sectional	400 patients undergoing elective surgery at Poursina Public	Postoperative hypothermia was more frequently found in patients with low body mass

	Anesthesia Care Unit			University Hospital, Iran	index and longer duration of surgery and anesthesia, alongside factors such as female sex, general anesthesia, and ASA score II.
8	Incidence and Associated Factors of Perioperative Hypothermia in Adult Patients at a University-Based, Tertiary Care Hospital in Thailand	(Wongyingsinn & Pookprayoon, 2023)	Retrospective Cohort	742 adult patients undergoing surgery at a tertiary care hospital, Thailand	The incidence of postoperative hypothermia was recorded at 11.9%, with ASA physical status III–IV and preoperative hypothermia identified as factors significantly associated with the incidence of postoperative hypothermia.
9	Incidence of Postoperative Hypothermia and Shivering and Risk Factors in Patients Undergoing Malignant Tumor Surgery: A Retrospective Study	(Xu et al., 2023)	Retrospective Study	Patients undergoing malignant tumor surgery at Fudan University Shanghai Cancer Center, China	Long duration of surgery and low body mass index were identified as significantly associated factors for the incidence of hypothermia and postoperative shivering, with risk increasing as surgical time increased.
10	Association between Body Mass Index and Perioperative Shivering after Elective Cesarean Delivery under Spinal Anesthesia: A Prospective Observational Study	(Mashak et al., 2026)	Prospective Cohort	180 third-trimester pregnant women undergoing elective cesarean section with spinal anesthesia, Iran	Higher body mass index was significantly associated with a decrease in the incidence and severity of perioperative shivering ($p<0.001$), indicating that low BMI is associated with a greater risk of thermoregulatory disturbance following spinal anesthesia.

The synthesis of the 10 analyzed articles, both national and international studies, consistently showed that low body mass index (BMI) and longer duration of surgery are significantly associated with an increased incidence of hypothermia and shivering following spinal anesthesia ($p<0.05$ in the studies reporting these tests). The consistency of these findings across various geographic contexts and healthcare systems strengthens the plausibility of an association between these two factors and thermoregulatory disturbance following spinal anesthesia. However, because most included studies were observational (cross-sectional, retrospective, or cohort designs), the findings should be interpreted as associations and do not establish a causal relationship.

At the national level, Muntaha et al. (2022) at RSU Metro Medical Center Lhokseumawe reported a significant association of BMI and duration of surgery with the incidence of hypothermia following spinal anesthesia. Tubalawony and Siahaya (2023) reported similar findings through a chi-square test showing a significant association for both duration of surgery ($p=0.015$) and BMI ($p=0.027$), indicating that both variables are associated with hypothermia incidence in bivariate analysis. Chaidir et al. (2023) at Sawahlunto Community Health Center, West Sumatra, reinforced these findings at the primary care level by reporting a significant association between BMI and the incidence of hypothermia in postoperative patients ($p=0.044$), with patients having a BMI below 17 showing a greater tendency toward decreased body temperature, suggesting the relevance of preoperative BMI screening even at primary healthcare facilities.

Rakasiwi et al. (2021) reinforced the specific role of BMI by demonstrating that low BMI is significantly associated with an increased incidence of hypothermia in spinal anesthesia patients, underscoring the physiological mechanism of adipose tissue as a thermogenic insulator. Renaningtyastutik et al. (2022) complemented the national evidence by focusing on the duration-of-surgery dimension, reporting a significant association between duration of surgery and degree of shivering as measured using the Crossley and Mahajan scale, with longer duration of surgery correlating with a more severe degree of shivering. These five national studies collectively indicate that the association of BMI and duration of surgery with hypothermia following spinal anesthesia is similar across various healthcare facilities in Indonesia, including hospitals in Aceh and a primary healthcare facility in West Sumatra.

At the international level, Ferede et al. (2021) through an institution-based study in Ethiopia in cesarean section patients under spinal anesthesia reported that duration of surgery, together with hypothermia and hypotension, was significantly associated with intraoperative shivering, with an incidence reaching 51.8%. Ashoobi et al. (2023) in Iran expanded on this evidence through a larger-scale study (400 patients), reporting that postoperative hypothermia occurred more frequently in patients with low BMI and longer duration of surgery and anesthesia, consistent with the heat-loss mechanism mediated by reduced subcutaneous fat reserves and prolonged exposure to the operating room environment.

Wongyingsinn and Pookprayoon (2023) in Thailand, through a retrospective medical record review of 742 patients, found a postoperative hypothermia incidence of

11.9%, with ASA physical status III–IV and preoperative hypothermia as factors significantly associated, enriching the understanding of the interaction between patients' physical condition and procedure duration on hypothermia risk. Xu et al. (2023) in China, in a population of malignant tumor surgery patients, reported that long duration of surgery and low BMI remain significantly associated with postoperative hypothermia and shivering even across different types of surgery, suggesting that the associations are not limited to a single surgical procedure type.

Mashak et al. (2026) in Iran, through a recent prospective cohort study of 180 third-trimester pregnant women undergoing elective cesarean section with spinal anesthesia, provided important insight into the direction of the relationship between BMI and shivering: higher BMI was in fact associated with a decrease in the incidence and severity of perioperative shivering ($p<0.001$), consistent with the mechanism of a higher vasoconstriction threshold in individuals with greater fat reserves. This finding complements the understanding that the relationship between BMI and thermoregulatory disturbance following spinal anesthesia is inverse across the populations studied. Overall, the convergence of evidence from the five national and five international studies illustrates that low BMI and long duration of surgery are two consistently associated factors for hypothermia incidence following spinal anesthesia, which can support identifying higher-risk patients from the preoperative stage onward to enable more targeted hypothermia prevention strategies.

These findings are in line with recent evidence beyond the ten included studies. A meta-analysis of 17 observational studies in non-cardiac surgery reported higher odds of postoperative hypothermia in patients with a BMI below 18.5 kg/m² and in surgeries lasting more than 60 minutes, but rated the certainty of the evidence as mostly low to very low (Tan et al., 2025). Low BMI was likewise identified as a risk factor in a meta-analysis of cesarean section patients (Wang et al., 2024), and lower BMI and longer surgery were associated with intraoperative hypothermia in a retrospective analysis of robotic surgery (Hu et al., 2023). Several considerations call for cautious interpretation. First, most included studies were observational, so residual confounding by age, ASA status, operating room temperature, fluid volume, and warming measures cannot be excluded. Second, adjusted multivariable analyses were not reported consistently; several studies relied on bivariate tests such as the chi-square test (e.g., Tubalawony & Siahaya, 2023), so the associations should not be regarded as independent effects. Third, outcome definitions (measured temperature versus shivering scales), BMI categories, and sites of temperature measurement differed across studies, which favored a narrative rather than a quantitative synthesis. Finally, not all studies examined both factors: Wongyingsinn and Pookprayoon (2023) highlighted ASA physical status and preoperative hypothermia, and some studies used shivering as the outcome (Renaningtyastutik et al., 2022; Mashak et al., 2026).

The specific novelty of this review lies in integrating five national and five international studies within one PRISMA-based synthesis that focuses on spinal anesthesia and examines BMI and duration of surgery together. This integration provides

three new insights. First, lower BMI and longer duration of surgery were associated with hypothermia or shivering in Indonesian hospitals, including a primary healthcare facility, and in international university and tertiary hospitals, which suggests that these associations are not limited to a single health system. Second, the evidence base differs in character: the national studies reporting sample sizes were small single-site studies (37 and 76 patients) analyzed mostly with bivariate tests, whereas the international studies reporting sample sizes included 180 to 742 patients (Mashak et al., 2026; Ashoobi et al., 2023; Wongyingsinn & Pookprayoon, 2023) and considered a wider range of co-factors such as ASA status, sex, anesthesia type, and preoperative temperature. This points to a clear need for adequately powered studies with adjusted analyses in Indonesia. Third, the international evidence adds a physiological explanation that most national studies did not address: a higher BMI was associated with less shivering, consistent with a higher vasoconstriction threshold in individuals with greater fat reserves (Mashak et al., 2026).

The practical implications of this review concern the prevention of perioperative hypothermia and its application in wider healthcare services. Anesthesia nurses and operating room personnel are expected to perform preoperative BMI screening and consider the estimated duration of surgery to identify patients at higher risk of hypothermia following spinal anesthesia. Because both factors are available before surgery at no additional cost, they can be built into a standardized preoperative risk checklist used from primary healthcare facilities to referral hospitals, linked to a tiered bundle of measures: routine temperature monitoring, passive insulation and warmed fluids for all patients, and active warming for higher-risk patients, consistent with recommendations for active temperature management in surgeries lasting more than 30 minutes (Rauch et al., 2021). Patients with a low BMI who are expected to undergo longer procedures merit particularly close monitoring (Tan et al., 2025), since warming measures may remain insufficient in prolonged surgery (Zhou et al., 2025). Given reported gaps in nurses' knowledge and practice and in institutional procedures (Woretaw et al., 2023; Sahin Akboga & Dikmen Aydin, 2024), standardized protocols should be accompanied by team-wide training and institutional support. Further prospective studies with larger samples are needed to determine clinically meaningful BMI and duration-of-surgery thresholds in the Indonesian context.

CONCLUSION

Based on the synthesis of ten articles (5 national and 5 international), lower body mass index and longer duration of surgery were associated with a higher incidence of hypothermia in patients following spinal anesthesia ($p<0.05$ in the studies reporting these tests). Low body mass index is associated with an increased risk of hypothermia, plausibly because of reduced fat reserves as a thermogenic insulator and a lower vasoconstriction threshold, while longer duration of surgery is associated with increased risk, plausibly through prolonged exposure to the cold operating room environment and longer duration of sympathetic blockade. National studies showed similar associations across several hospitals and a primary healthcare facility in Indonesia, while international studies

indicate that the associations also appear across various populations, types of surgery, and study designs. Because most included studies were observational, these findings represent associations rather than causal effects. They support early identification of patients at higher risk based on BMI and estimated duration of surgery as part of perioperative nursing care to prevent hypothermia following spinal anesthesia.

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