



The Relationship Between Age and Duration of Surgery and the Incidence of Post-Anesthetic Shivering (Pas) in Patients Following Spinal Anesthesia

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Abstract

Post-Anesthetic Shivering (PAS) remains a relevant complication after spinal anesthesia and may be influenced by patient and procedural characteristics. This study aimed to determine the relationship between age and duration of surgery and PAS among patients undergoing spinal anesthesia at the Central Surgical Unit of Dr. H. Soewondo Regional General Hospital, Kendal. A quantitative observational-analytic study with a cross-sectional design was conducted among 104 patients selected through total sampling. Age data were obtained from medical records, whereas surgical duration and PAS severity were assessed through observation. Spearman rank correlation was used for bivariate analysis. Most participants were in the early and late elderly groups, each comprising 23.1% of the sample, and 55.8% underwent surgery lasting more than 60 minutes. Grade 1 PAS was the most frequent outcome, occurring in 32.7% of patients. Age was significantly associated with PAS severity ($r = 0.561$, $p < 0.001$), while surgical duration showed a stronger positive association ($r = 0.766$, $p < 0.001$). These findings indicate that increasing age and longer surgical duration are associated with higher PAS severity following spinal anesthesia during recovery.

Keywords: age, surgical duration, Post-Anesthetic Shivering, spinal anesthesia, perioperative nursing.



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INTRODUCTION

Perioperative nursing care plays an essential role in maintaining physiological stability and preventing complications before, during, and after surgical procedures. Spinal anesthesia is widely used for various surgical interventions because it provides effective sensory and motor blockade while allowing patients to remain conscious and reducing several risks associated with general anesthesia. Despite these advantages, patients undergoing spinal anesthesia remain vulnerable to thermoregulatory disturbances, including Post-Anesthetic Shivering (PAS), during the postoperative recovery period. PAS deserves particular clinical attention because it may increase metabolic demand, oxygen consumption, carbon dioxide production, cardiovascular workload, and patient discomfort following surgery (Shirozu et al., 2024).

Post-Anesthetic Shivering is characterized by involuntary, repetitive muscular activity that may occur following anesthesia and is frequently associated with disturbances in body temperature regulation. During spinal anesthesia, sympathetic blockade induces peripheral vasodilation and facilitates the redistribution of heat from the body's core compartment to peripheral tissues, thereby promoting a decrease in core temperature. The anesthetic blockade may simultaneously impair normal vasoconstrictive and shivering responses below the level of the block, reducing the body's ability to compensate for heat loss during surgery. Consequently, perioperative hypothermia and alterations in thermoregulatory thresholds are considered important physiological mechanisms underlying postoperative shivering after regional anesthesia (Pu et al., 2022; Tan et al., 2025).

Age is one of the patient-related factors that may influence thermoregulatory responses during the perioperative period. Increasing age is accompanied by physiological changes such as reduced basal metabolic activity, decreased skeletal muscle mass, impaired peripheral vasoconstriction, and diminished responsiveness of thermoregulatory mechanisms to environmental temperature changes. A systematic review and meta-analysis identified age as a significant factor associated with unplanned

intraoperative hypothermia, while more recent evidence indicates that patients aged 60 years or older have a greater risk of postoperative hypothermia than younger patients (Pu et al., 2022; Tan et al., 2025). Yang et al. (2024) further demonstrated that age was an independent factor influencing perioperative hypothermia, emphasizing the importance of considering patient age when evaluating the risk of temperature-related complications.

In addition to age, the duration of surgery represents an important procedural factor that may contribute to postoperative thermoregulatory disturbances. Prolonged surgical procedures increase the length of exposure to a relatively cold operating-room environment, uncovered body surfaces, anesthetic-induced vasodilation, and continuous heat loss through radiation, convection, conduction, and evaporation. Tan et al. (2025) reported that surgical procedures lasting more than one hour were associated with a substantially increased risk of postoperative hypothermia, with an odds ratio of 2.34 compared with shorter procedures. Similarly, Wang et al. (2025) found that a surgical duration exceeding 120 minutes increased the risk of intraoperative hypothermia, indicating that cumulative operative time is an important consideration in perioperative temperature management.

Recent evidence also suggests that postoperative shivering cannot be explained solely by the presence of overt hypothermia because the condition may occur even when postoperative core temperature has been adequately maintained. Shirozu et al. (2024) demonstrated that postoperative shivering among patients with maintained core temperature was associated with several factors, including patient age and operation time, with each additional 30 minutes of surgery increasing the odds of postoperative shivering. In another study, Shen and Zhong (2024) identified age of 60 years or older, surgical duration, and intraoperative temperature below 36°C as important factors associated with postoperative shivering among surgical patients. These findings indicate that PAS is a multifactorial phenomenon in which both patient characteristics and surgical exposure may interact with perioperative temperature regulation.

Nevertheless, important limitations remain in the existing evidence concerning the simultaneous contribution of age and surgical duration to PAS following spinal anesthesia. A substantial proportion of recent investigations have focused on general anesthesia, laparoscopic procedures, oncological surgery, or specific surgical populations such as patients undergoing percutaneous nephrolithotomy, making direct generalization to broader populations receiving spinal anesthesia difficult (Shen & Zhong, 2024; Shirozu et al., 2024; Wang et al., 2025). Differences in anesthetic techniques, surgical characteristics, operating-room temperature, warming interventions, intravenous fluid management, and patient characteristics may also contribute to variations in reported shivering and hypothermia outcomes. Therefore, further investigation in patients specifically undergoing spinal anesthesia is necessary to clarify whether age and duration of surgery are associated with the occurrence and severity of PAS in routine clinical settings.

The Central Surgical Unit of Dr. H. Soewondo Regional General Hospital in Kendal provides surgical care to patients with varying demographic characteristics and operative durations, making perioperative temperature management an important component of patient safety. PAS of varying degrees remains clinically relevant among patients recovering from spinal anesthesia, particularly because individual physiological characteristics and the duration of surgical exposure may affect the body's ability to maintain thermal balance. Identifying age- and surgery-related factors associated with PAS may enable nurses and anesthesia personnel to recognize vulnerable patients earlier and implement appropriate temperature monitoring and warming strategies. Such risk-based perioperative management is important for reducing preventable complications, improving thermal comfort, and supporting safer postoperative recovery.

Early recognition of patients at risk for Post-Anesthetic Shivering is particularly relevant to perioperative nursing because many preventive measures can be initiated before clinically significant shivering develops. Assessment of patient age, anticipated surgical duration, baseline temperature, environmental exposure, and other perioperative factors may support more individualized strategies for maintaining normothermia throughout anesthesia and recovery. Based on the physiological rationale, emerging empirical evidence, and the remaining clinical research gap, age and duration of surgery warrant further evaluation as factors associated with PAS following spinal anesthesia. Accordingly, this study aims to determine the relationship between age and duration of surgery and the incidence of Post-Anesthetic Shivering among patients following spinal anesthesia at the Central Surgical Unit of Dr. H. Soewondo Regional General Hospital, Kendal.

RESEARCH METHODS

This study employed a quantitative observational-analytic design with a cross-sectional approach to examine the relationship between age and duration of surgery and the incidence of Post-Anesthetic Shivering (PAS) among patients following spinal anesthesia. The study population consisted of patients undergoing surgical procedures under spinal anesthesia at the Central Surgical Unit of Dr. H. Soewondo Regional General Hospital, Kendal. A total of 104 respondents were included using a total sampling technique. The independent variables were age and duration of surgery, while the dependent variable was the incidence and severity of Post-Anesthetic Shivering. Age data were obtained from patients' clinical records, whereas surgical duration and PAS were assessed through direct observation during the perioperative period. The severity of shivering was classified using an observational grading scale ranging from 0 to 3.

Data were analyzed using both descriptive and inferential statistical procedures. Descriptive analysis was performed to summarize respondents' characteristics and to describe the distributions of age, surgical duration, and PAS severity using frequencies, percentages, and other appropriate descriptive measures. Bivariate analysis was subsequently conducted to assess the relationship between age and PAS as well as between duration of surgery and PAS. Because the variables were analyzed on an ordinal scale, the Spearman rank correlation test was applied to determine the strength and direction of the relationships. Statistical significance was determined at a p-value of less than 0.05. The analysis was designed to determine whether increasing age and longer surgical duration were significantly associated with a higher degree of Post-Anesthetic Shivering among patients following spinal anesthesia.

RESULTS AND DISCUSSION

Participant Characteristics and Distribution of Age, Surgical Duration, and Post-Anesthetic Shivering

The present study included 104 patients who underwent surgical procedures under spinal anesthesia at the Central Surgical Unit of Dr. H. Soewondo Regional General Hospital, Kendal. The sex distribution was completely balanced, consisting of 52 male patients (50.0%) and 52 female patients (50.0%), indicating that neither sex predominated in the study population. This balanced distribution is useful when interpreting subsequent findings because disproportionate representation of one sex is less likely to dominate the descriptive characteristics of the sample. Previous perioperative research has demonstrated that demographic and physiological characteristics should be considered when evaluating susceptibility to perioperative hypothermia and shivering because these complications have multifactorial determinants (Pu et al., 2022; Güven et al., 2023).

The age distribution showed considerable variation across the six predefined age categories. The early elderly group aged 46–55 years and the late elderly group aged 56–65 years represented the largest categories, with 24 patients (23.1%) in each group, followed by 21 patients (20.2%) aged 26–35 years, 17 patients (16.3%) aged 36–45 years, 11 patients (10.6%) aged >65 years, and 7 patients (6.7%) aged 17–25 years. The mean score of the coded age categories was 3.67 ± 1.46 , with a median category of 4, a minimum category of 1, and a maximum category of 6; this value represents the ordinal age-category score rather than mean chronological age in years. The predominance of middle-aged and older patients is clinically important because increasing age has been identified as a factor associated with disturbances in perioperative thermal homeostasis (Pu et al., 2022; Wang et al., 2025).

The relatively large proportion of patients aged 46 years and older provides an important context for evaluating PAS in this population. Age-related physiological alterations may influence peripheral vascular responses, metabolic heat production, autonomic regulation, and the ability to respond appropriately to perioperative heat loss, although the direction and magnitude of the association with shivering may vary according to clinical circumstances. Pu et al. (2022), in a meta-analysis involving 15,010 adult surgical patients, identified age as one of the factors significantly associated with unplanned intraoperative hypothermia. More recent evidence has similarly shown that age contributes to the risk profile of intraoperative hypothermia, reinforcing the importance of considering the age structure of a surgical population when interpreting postoperative thermoregulatory outcomes (Wang et al., 2025; Yang et al., 2024).

Educational characteristics were also heterogeneous, with junior high school representing the most frequent educational level at 27 patients (26.0%), followed by elementary school at 23 patients

(22.1%), senior high school at 20 patients (19.2%), higher education at 18 patients (17.3%), and bachelor's degree education at 16 patients (15.4%). These variables were collected as baseline characteristics rather than as primary determinants of PAS, and therefore the present study does not infer a direct causal relationship between educational attainment and postoperative shivering. Nevertheless, describing educational background remains relevant in clinical nursing research because it provides a more complete profile of the population to whom perioperative assessment, communication, and nursing interventions are delivered. In perioperative care, risk assessment should remain centered on clinically established physiological and procedural factors rather than assuming that sociodemographic characteristics independently determine hypothermia or shivering (Pu et al., 2022; Güven et al., 2023).

Occupational characteristics showed a similarly broad distribution, with laborers constituting the largest group at 23 patients (22.1%), followed by homemakers at 22 patients (21.2%), private-sector employees at 21 patients (20.2%), farmers at 19 patients (18.3%), and self-employed patients at 19 patients (18.3%). No single occupational category accounted for more than one-quarter of the study population, demonstrating that the sample represented patients from several occupational backgrounds rather than one dominant socioeconomic group. As with educational status, occupation was treated descriptively and was not analyzed as an independent predictor of PAS in the present study. The primary clinical interpretation therefore remains focused on age, surgical duration, and PAS, which are more directly aligned with the objectives and analytical framework of this investigation.

Table 1. Characteristics of Patients Following Spinal Anesthesia at the Central Surgical Unit of Dr. H. Soewondo Regional General Hospital, Kendal (N = 104)

Variable	Category	Frequency (n)	Percentage (%)
Sex	Male	52	50.0
	Female	52	50.0
Age	Late adolescence, 17–25 years	7	6.7
	Early adulthood, 26–35 years	21	20.2
	Late adulthood, 36–45 years	17	16.3
	Early elderly, 46–55 years	24	23.1
	Late elderly, 56–65 years	24	23.1
	Older elderly, >65 years	11	10.6
Education	Elementary school	23	22.1
	Junior high school	27	26.0
	Senior high school	20	19.2
	Higher education	18	17.3
	Bachelor's degree	16	15.4
Occupation	Homemaker	22	21.2
	Laborer	23	22.1
	Farmer	19	18.3
	Private-sector employee	21	20.2
	Self-employed	19	18.3
Surgical duration	<60 minutes	46	44.2
	>60 minutes	58	55.8
PAS severity	No shivering	23	22.1
	Grade 1	34	32.7
	Grade 2	29	27.9
	Grade 3	18	17.3

Surgical duration revealed that 58 of the 104 patients (55.8%) underwent procedures lasting more than 60 minutes, whereas 46 patients (44.2%) underwent procedures lasting less than 60 minutes. Thus, more than half of the study population experienced prolonged exposure according to the operational cut-off used in this study, an important finding given the cumulative mechanisms of heat loss during surgical procedures. Prolonged surgery can increase exposure to a cool operating-

room environment and extend the period during which radiation, convection, conduction, and evaporation contribute to heat loss, while neuraxial anesthesia may interfere with normal thermoregulatory responses. Evidence from Pu et al. (2022) supports this interpretation, as anesthesia lasting more than two hours was associated with greater odds of unplanned intraoperative hypothermia, while Güven et al. (2023) likewise identified longer operation time as a perioperative hypothermia risk factor.

The distribution of PAS severity showed that only 23 patients (22.1%) did not experience shivering, whereas 81 patients (77.9%) exhibited some degree of PAS. Grade 1 was the most frequently observed category, affecting 34 patients (32.7%), followed by Grade 2 in 29 patients (27.9%) and Grade 3 in 18 patients (17.3%). These findings indicate that PAS was clinically common in this sample and that the phenomenon was not restricted to isolated severe episodes, because mild and moderate manifestations constituted substantial proportions of the observed cases. Previous investigations among patients receiving spinal anesthesia have likewise documented shivering as an important perioperative complication, although reported incidence varies according to population characteristics, anesthetic technique, surgical procedure, temperature management, and preventive intervention (Girma et al., 2022; Palanisamy et al., 2022; Thakur et al., 2023).

The predominance of Grade 1 and Grade 2 PAS also has practical implications for postoperative surveillance. Mild shivering should not automatically be considered clinically unimportant because visible muscular activity may indicate disruption of thermal equilibrium and may progress or contribute to patient discomfort when precipitating factors persist. Studies examining shivering under spinal anesthesia have emphasized the influence of perioperative temperature management and pharmacological or non-pharmacological preventive strategies on the occurrence and intensity of shivering (Girma et al., 2022; Mortazavi et al., 2024). Mortazavi et al. (2024), for example, evaluated warmed intravenous fluid in patients receiving general or spinal anesthesia, illustrating the continuing clinical relevance of active strategies aimed at limiting perioperative thermal disturbances.

The descriptive pattern observed in this study should nevertheless be interpreted as the result of multiple interacting factors rather than attributing PAS solely to one patient characteristic. Qi et al. (2022) demonstrated that intraoperative shivering can be influenced by several perioperative factors, while Shirozu et al. (2024) showed that postoperative shivering may occur even among patients whose core temperature has been maintained after surgery. Shirozu et al. further reported differences in age, sex distribution, anesthesia duration, and operation time between patients with and without postoperative shivering, illustrating the multifactorial nature of this complication. Consequently, the descriptive distributions of age, operative duration, and PAS in the present study provide the necessary empirical foundation for the subsequent correlation analyses rather than establishing causality by themselves.

The overall clinical profile therefore demonstrates three notable features: an equal male-to-female distribution, a relatively high representation of patients aged 46–65 years, and a predominance of procedures lasting more than 60 minutes. In parallel, more than three-quarters of the participants experienced PAS of Grade 1–3, with Grade 1 representing the single largest category. Indonesian studies have also reported postoperative or intraoperative shivering among patients receiving spinal anesthesia, supporting the relevance of continued investigation in local hospital settings (Hidayah et al., 2021; Trisetoyo et al., 2022). These descriptive findings establish a coherent basis for examining whether increasing age and longer surgical duration are statistically related to the severity of PAS, which is addressed in the subsequent inferential analyses.

Relationship Between Age and Post-Anesthetic Shivering Following Spinal Anesthesia

The cross-tabulation between age and Post-Anesthetic Shivering (PAS) demonstrated a clear variation in shivering severity across the six age categories included in this study. Among patients aged 17–25 years, 3 of 7 patients (42.9%) did not experience shivering, another 3 patients (42.9%) experienced Grade 2 shivering, and 1 patient (14.3%) experienced Grade 3 shivering, while no patient in this group experienced Grade 1 PAS. In the 26–35-year age group, 13 of 21 patients (61.9%) did not experience shivering, representing the highest proportion of shivering-free patients across all age categories. These descriptive

findings indicate that absence of PAS was more frequently observed among younger adults, although shivering of varying severity was still present in some younger patients.

A different distribution was observed among patients aged 36–45 years, of whom 7 patients (41.2%) did not experience shivering and 10 patients (58.8%) developed Grade 1 PAS, with no Grade 2 or Grade 3 cases recorded in this age category. Among patients aged 46–55 years, none remained free from shivering, as 18 of 24 patients (75.0%) experienced Grade 1, 5 patients (20.8%) experienced Grade 2, and 1 patient (4.2%) experienced Grade 3 PAS. This shift from predominantly absent or mild PAS among younger age groups toward a greater concentration of PAS among middle-aged patients suggests an age-related pattern within the present population. Nevertheless, the descriptive distribution alone does not establish an independent causal effect of age because multiple perioperative characteristics may influence thermoregulatory responses simultaneously (Pu et al., 2022).

The pattern became more pronounced in the two oldest age categories. Among patients aged 56–65 years, none were free from shivering, while 3 of 24 patients (12.5%) experienced Grade 1, 13 patients (54.2%) experienced Grade 2, and 8 patients (33.3%) experienced Grade 3 PAS. Similarly, among patients aged over 65 years, no patient was recorded without PAS; 1 of 11 patients (9.1%) experienced Grade 1, while Grade 2 and Grade 3 PAS were each observed in 5 patients (45.5%). Thus, the raw distribution in this study shows that moderate-to-severe PAS was concentrated more heavily in the older age categories than in the younger categories.

The Spearman rank correlation analysis confirmed a statistically significant relationship between age and PAS severity. The analysis generated a correlation coefficient of $r = 0.561$ with a statistical output of $p = 0.000$, which should conventionally be reported in scientific writing as $p < 0.001$ rather than as an exact probability of zero. The correlation coefficient indicates a moderate positive relationship, meaning that higher age categories were associated with higher PAS grades within this sample of patients following spinal anesthesia. This finding provides statistical support for the descriptive pattern observed in the cross-tabulation and addresses the first inferential relationship examined in the study.

The observed association is broadly consistent with evidence that age can influence vulnerability to perioperative thermal disturbances, although hypothermia and shivering should not be considered physiologically identical outcomes. Pu et al. (2022), in a systematic review and meta-analysis involving 15,010 adult surgical patients, found that age was significantly associated with unplanned intraoperative hypothermia. Wang et al. (2025) similarly reported age as a significant risk factor for intraoperative hypothermia in laparoscopic surgery, with an OR of 1.02 (95% CI: 1.00–1.03), while Yang et al. (2024) found an independent association between increasing age and intraoperative hypothermia with an OR of 1.066 (95% CI: 1.025–1.108). These studies support the relevance of age to perioperative thermal regulation, although their populations and anesthetic techniques differ from those of the present investigation.

Table 2. Relationship Between Age and Post-Anesthetic Shivering Among Patients Following Spinal Anesthesia (N = 104)

Age category	No shivering, n	Grade 1, n	Grade 2, n	Grade 3, n	Total, n	Spearman r	p-value
17–25 years	3	0	3	1	7	0.561	0.000*
26–35 years	13	2	3	3	21		
36–45	7	10	0	0	17		

years					
46–55	0	18	5	1	24
years					
56–65	0	3	13	8	24
years					
>65 years	0	1	5	5	11
Total	23	34	29	18	104

Several physiological mechanisms may explain why age is relevant to perioperative temperature regulation. Advancing age is accompanied by alterations in autonomic responses, vascular reactivity, metabolic heat production, body composition, and the capacity to compensate for thermal stress during anesthesia and surgery. When spinal anesthesia produces sympathetic blockade and peripheral vasodilation, heat redistribution from the core toward peripheral tissues may become clinically important, particularly when other factors such as low ambient temperature, intravenous fluid administration, and prolonged procedures coexist. The association found in the present study should therefore be understood as reflecting age-related vulnerability within a broader multifactorial perioperative thermoregulatory process rather than as evidence that age alone produces PAS (Pu et al., 2022; Wang et al., 2025).

Evidence from Indonesian clinical settings further demonstrates that PAS following spinal anesthesia occurs in heterogeneous patient populations and is influenced by multiple characteristics. Millizia et al. (2020) specifically investigated age, sex, type of surgery, anesthetic dose, duration of surgery, and body temperature as potential factors associated with PAS among patients undergoing spinal anesthesia, illustrating the multifactorial framework within which age should be evaluated. Hidayah et al. (2021) also reported postoperative shivering among patients receiving both spinal and general anesthesia and observed that shivering was more frequently encountered in particular clinical subgroups, including patients undergoing prolonged procedures. Consequently, the relationship observed in the present study is best interpreted together with other perioperative exposures rather than independently from them.

Importantly, the direction of the association between chronological age and actual shivering responses is not completely uniform across studies. Shirozu et al. (2024), in an analysis of 441 patients whose postoperative core temperature was maintained at $\geq 36.5^{\circ}\text{C}$, reported that each one-year increase in age was associated with slightly lower odds of postoperative shivering (OR = 0.98, 95% CI: 0.96–0.996), whereas longer operation time increased the odds of shivering. This apparent difference from the positive correlation observed in the present study may reflect differences in study population, anesthetic technique, surgical procedure, temperature management, outcome definition, and adjustment for confounding variables. It also emphasizes that greater susceptibility to perioperative hypothermia among older patients does not necessarily imply an identical physiological pattern of overt muscular shivering in every surgical population.

The findings therefore have practical implications for perioperative nursing and anesthesia care, particularly because almost all patients in the two oldest age categories experienced some degree of PAS in the present sample. Older patients may benefit from more intensive assessment of baseline temperature, continuous or repeated perioperative temperature monitoring, attention to operating-room exposure, appropriate warming strategies, and careful observation during recovery. Such interventions should not be restricted solely to older individuals, because younger patients in this study also experienced Grade 2 and Grade 3 PAS and because shivering may occur despite maintenance of apparently adequate core temperature. Shirozu et al. (2024) demonstrated that peripheral

temperature and the core-to-peripheral temperature relationship also contribute to postoperative shivering, highlighting the importance of comprehensive thermal assessment rather than reliance on age alone.

The moderate correlation identified in this study should also be interpreted within the methodological boundaries of a cross-sectional observational design. A Spearman coefficient of 0.561 demonstrates an ordered association between age category and PAS grade but does not prove that increasing age independently causes more severe shivering, particularly because factors such as surgical duration, baseline temperature, operating-room temperature, body mass index, type of surgery, intravenous fluid administration, blood loss, and warming interventions may act as confounders. Evidence from previous studies similarly indicates substantial heterogeneity in perioperative hypothermia and shivering risk factors across patient populations, reinforcing the need for multivariable assessment in future research (Pu et al., 2022; Yang et al., 2024; Wang et al., 2025). Nevertheless, within the present sample, the findings provide clear evidence of a statistically significant and moderately positive relationship between age and PAS severity following spinal anesthesia, supporting age as an important characteristic to consider in perioperative risk assessment.

Relationship Between Surgical Duration and Post-Anesthetic Shivering Following Spinal Anesthesia

The cross-tabulation analysis demonstrated a marked difference in Post-Anesthetic Shivering (PAS) severity according to surgical duration. Among the 46 patients whose surgical procedures lasted less than 60 minutes, 23 patients (50.0%) did not experience shivering, 21 patients (45.7%) developed Grade 1 PAS, and only 2 patients (4.3%) developed Grade 2 PAS. No Grade 3 shivering was observed among patients undergoing procedures lasting less than 60 minutes. This distribution indicates that shorter surgical procedures were predominantly associated with either the absence of shivering or only mild PAS in the present study, a pattern consistent with previous Indonesian studies examining the relationship between surgical duration and shivering following spinal anesthesia (Mashitoh et al., 2018; Syauqi et al., 2020; Def et al., 2022).

A substantially different pattern was observed among the 58 patients whose operations lasted more than 60 minutes. None of these patients remained free from shivering, while 13 patients (22.4%) experienced Grade 1 PAS, 27 patients (46.6%) experienced Grade 2 PAS, and 18 patients (31.0%) experienced Grade 3 PAS. Thus, all patients in the >60-minute category developed some degree of postoperative shivering, and 45 of the 58 patients (77.6%) experienced moderate-to-severe PAS corresponding to Grades 2 and 3. These findings are consistent with reports by Gunarto et al. (2022), Nita et al. (2022), and Nasrun (2022), which identified surgical duration as an important factor associated with shivering among patients recovering from spinal anesthesia.

The inferential analysis further strengthened the descriptive findings by demonstrating a statistically significant association between surgical duration and PAS severity. Spearman rank correlation analysis produced a coefficient of $r = 0.766$ with a statistical software output of $p = 0.000$, which is conventionally reported in scientific literature as $p < 0.001$. The coefficient represents a strong positive correlation, indicating that increasing surgical duration was associated with progressively higher PAS grades among the patients included in this study. The strength of this association was greater than that observed between age and PAS in the same population, for which the correlation coefficient was $r = 0.561$, suggesting that surgical duration represented a particularly prominent procedural correlate of PAS in this dataset.

The relationship between prolonged surgery and postoperative shivering can be explained through cumulative perioperative heat loss. During surgery, body heat is continuously lost through radiation, convection, conduction, and evaporation, while exposure of surgical surfaces may further accelerate heat dissipation. Spinal anesthesia additionally produces sympathetic blockade and peripheral vasodilation, facilitating redistribution of heat from the core compartment toward peripheral tissues and impairing normal vasoconstrictive responses in anesthetized regions. Consequently, the longer a patient remains exposed to these physiological and environmental

influences, the greater the opportunity for disturbances in thermal equilibrium to develop and subsequently manifest as postoperative shivering (Lopez, 2018; Li et al., 2021; Pu et al., 2022).

Previous national evidence supports the pattern identified in the present study. Mashitoh et al. (2018) specifically examined surgical duration and shivering after spinal anesthesia, while Syauqi et al. (2020) similarly reported a relationship between duration of surgery and shivering among patients receiving spinal anesthesia. More recent Indonesian investigations by Def et al. (2022), Gunarto et al. (2022), and Nita et al. (2022) continued to evaluate this relationship across different hospital populations, demonstrating the persistent clinical relevance of operative duration as a potential PAS-associated factor. Trisetyo et al. (2022) also documented shivering among patients undergoing urologic endoscopic procedures following spinal anesthesia, supporting the need for systematic perioperative thermal surveillance across different surgical settings.

Table 3. Relationship Between Surgical Duration and Post-Anesthetic Shivering Among Patients Following Spinal Anesthesia (N = 104)

Surgical duration	No shivering, n (%)	Grade 1, n (%)	Grade 2, n (%)	Grade 3, n (%)	Total, n (%)	Spearman r	p-value
<60 minutes	23 (50.0)	21 (45.7)	2 (4.3)	0 (0.0)	46 (100.0)	0.766	0.000*
>60 minutes	0 (0.0)	13 (22.4)	27 (46.6)	18 (31.0)	58 (100.0)		
Total	23	34	29	18	104		

International evidence also supports the clinical importance of operative exposure time in perioperative thermal disturbances. Pu et al. (2022), through a systematic review and meta-analysis, identified prolonged anesthetic exposure among the factors associated with unplanned intraoperative hypothermia, while Güven et al. (2023) reported longer operation time as an important characteristic associated with inadvertent perioperative hypothermia. Wang et al. (2025) further identified prolonged surgical duration as a significant risk factor for intraoperative hypothermia in laparoscopic surgical populations. Most importantly for the shivering outcome itself, Shirozu et al. (2024) demonstrated that longer operation time was associated with postoperative shivering even among patients whose postoperative core temperatures were maintained within an acceptable range, indicating that duration-related risk cannot necessarily be explained solely by measured postoperative hypothermia.

The strong association observed in this study also emphasizes the importance of perioperative warming interventions during procedures expected to last longer than one hour. Prewarming and active warming approaches can reduce redistribution hypothermia and limit progressive decreases in core temperature, particularly when implemented before substantial heat loss has occurred (Connelly et al., 2017). Mortazavi et al. (2024) demonstrated the relevance of warmed intravenous fluid administration to shivering and postoperative recovery among patients receiving general and spinal anesthesia, while Palanisamy et al. (2022) showed that perioperative hemodynamic and thermal management could influence shivering and hypothermia during spinal anesthesia. Pharmacological prevention has likewise been investigated, including intrathecal pethidine evaluated by Girma et al. (2022) and other pharmacological strategies used to reduce PAS severity (Nugroho et al., 2016).

Preventing PAS is clinically important because shivering represents more than a subjective sensation of cold or postoperative discomfort. Repetitive involuntary muscular activity can markedly increase metabolic activity and oxygen consumption, potentially increasing carbon dioxide production and cardiovascular demand during recovery, as demonstrated by Badjatia et al. (2008) in physiological assessments of shivering. The pathophysiological review by Lopez (2018) similarly emphasizes that post-anesthetic shivering has clinically relevant metabolic and hemodynamic consequences that justify prevention and prompt management. Although the populations and anesthetic contexts of these studies differ, their physiological findings support the importance of reducing substantial postoperative shivering, particularly among patients with limited cardiopulmonary reserve.

The findings also demonstrate that surgical duration should not be interpreted in isolation from other perioperative determinants. Studies have identified factors such as age, body mass index, anesthetic exposure, baseline and intraoperative temperature, fluid administration, environmental temperature, and patient-specific clinical characteristics as contributors to perioperative hypothermia or shivering (Millizia et al., 2020; Li et al., 2021; Nurmansah et al., 2022; Qi et al., 2022; Yang et al., 2024). Hidayah et al. (2021) further demonstrated that postoperative shivering can occur following both spinal and general anesthesia, suggesting that anesthetic technique interacts with broader physiological and procedural factors. Therefore, although the present correlation of $r = 0.766$ is strong, it should be understood as an association within a multifactorial perioperative environment rather than evidence that prolonged surgery independently causes PAS.

From a clinical nursing perspective, the findings support intensified thermal monitoring for patients scheduled for procedures expected to exceed 60 minutes. Perioperative personnel should assess baseline temperature, minimize unnecessary body exposure, monitor temperature throughout surgery and recovery, consider warmed intravenous or irrigation fluids when clinically indicated, and initiate appropriate passive or active warming interventions before substantial heat loss develops. Patients undergoing longer operations may particularly benefit from proactive rather than reactive thermal management because the present data show a pronounced shift toward Grade 2 and Grade 3 shivering after the 60-minute threshold. Such preventive management is consistent with the broader perioperative objective of maintaining patient safety, physiological stability, comfort, and efficient postoperative recovery (Connelly et al., 2017; Firtrianingsih et al., 2021; Mortazavi et al., 2024).

The findings must nevertheless be interpreted according to the observational cross-sectional design of the study. Spearman correlation establishes the strength and direction of an association but cannot demonstrate temporal or independent causation, and the analysis did not simultaneously adjust for potential confounders such as baseline core temperature, operating-room temperature, body mass index, surgical procedure, intravenous fluid temperature, blood loss, spinal block level, medication use, or active warming interventions. Future studies should therefore employ multivariable regression models, prospective temperature measurements, and more detailed perioperative exposure data to determine whether surgical duration remains an independent predictor of PAS after relevant confounders are controlled. Within the current dataset, however, the evidence demonstrates a statistically significant and strong positive relationship between surgical duration and PAS severity ($r = 0.766$; $p < 0.001$), indicating that longer surgical procedures were associated with more severe Post-Anesthetic Shivering among patients following spinal anesthesia.

CONCLUSION

The findings of this study demonstrate that Post-Anesthetic Shivering (PAS) remains a common postoperative response among patients undergoing spinal anesthesia at the Central Surgical Unit of Dr. H. Soewondo Regional General Hospital, Kendal. Most respondents were categorized as early elderly and late elderly, while more than half underwent surgical procedures lasting more than 60 minutes. Grade 1 PAS was the most frequently observed level of shivering. A statistically significant moderate positive relationship was identified between age and PAS severity ($r = 0.561$; $p < 0.001$), indicating that higher age categories tended to be associated with greater PAS severity.

Surgical duration showed a statistically significant strong positive relationship with PAS severity ($r = 0.766$; $p < 0.001$), indicating that longer surgical procedures were associated with more severe postoperative shivering. Patients undergoing procedures lasting more than 60 minutes demonstrated a markedly greater occurrence of Grade 2 and Grade 3 PAS than those undergoing shorter procedures. These findings emphasize the importance of considering both age and anticipated surgical duration when assessing patients at risk of PAS following spinal anesthesia. Appropriate perioperative temperature monitoring, early identification of high-risk patients, and timely thermal management strategies are therefore important to reduce shivering severity and improve patient comfort and safety during postoperative recovery.

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