MEDALION JOURNAL: Medical Research, Nursing, Health and Midwife Participation | ISSN(e): 2986-7754
Volume 7 No 2 (2026)

THE CORRELATION BETWEEN CRYSTALLOID FLUID PRELOADING AND BLOOD PRESSURE IN PATIENTS UNDERGOING CESAREAN SECTION WITH SPINAL ANESTHESIA AT THE CENTRAL SURGICAL INSTALLATION

Aurelia Anaya Dwi Pradianita[1], Nurul Fatwati Fitriana[2], Marta Tania Gabriel Ching Cing[3], Tati Hardiyani[4]
[1]Anesthesiology Nursing Study Program D4 Faculty of Health Sciences, Muhammadiyah University of Purwokerto
[2]Anesthesiology Nursing Study Program D4 Faculty of Health Sciences, Muhammadiyah University of Purwokerto
[3]Anesthesiology Nursing Study Program D4 Faculty of Health Sciences, Muhammadiyah University of Purwokerto
[4]Anesthesiology Nursing Study Program D4 Faculty of Health Sciences, Muhammadiyah University of Purwokerto
Email: aureliaanayadp@gmail.com, Nurulfatwati90@gmail.com, martadenniach@gmail.com, tatihardiyani@ump.ac.id

Received	: May, 15, 2026	Published	: June, 30, 2026
Revised	: May 21, 2026	DOI	: https://doi.org/10.59733/medalion.v7i2.284
Accepted	: June, 15 2026	Publish Link	:https://medalionjournal.com/index.php/go

Abstract
Spinal anesthesia for cesarean section often causes maternal hypotension in 60-70% of cases, so an effective fluid management strategy is needed. This study aims to analyze the relationship between crystalloid fluid pre-loading and blood pressure changes in patients with spinal anesthesia for cesarean section. A quantitative, analytical, observational study with a cross-sectional design was conducted on 51 patients from a population of 58 at Dr. R. Goeteng Taroenadibrata Purbalingga Regional General Hospital (January-February 2026). Purposive sampling and the Slovin formula were selected. Data were collected through observation sheets and Drager NIBP monitors, and bivariate analysis was carried out using Fisher's Exact Test. The results showed that 76.5% received adequate pre-loading (10-20 ml/kgBW) with a hypotension incidence of 12.8% versus 66.7% in the inadequate group (p=0.001). The findings confirmed a significant relationship between adequate crystalloid pre-loading and blood pressure stability. Pre-loading of 10-20 ml/kgBW is recommended for elective cases to minimize the risk of hypotension.

Keywords: Spinal Anesthesia, Hypertension, Crystalloid Pre-Loading, Caesarean Section, Blood Pressure

INTRODUCTION

Surgery is an invasive medical procedure performed through the opening of a body part using incision techniques for diagnostic or therapeutic purposes. In modern clinical practice, surgery is a crucial component of global health care because it contributes to reducing morbidity and mortality in various obstetric, orthopedic, and general surgical conditions. The World Health Organization reports that more than 234 million surgical procedures are performed annually worldwide, with distribution still dominated by high-income countries (World Health Organization, 2024). In Indonesia, the increasing need for surgical services is also evident in the increasing number of hospitals and the high number of surgical procedures, including cesarean sections, which have continued to rise in recent years (Ministry of Health of the Republic of Indonesia, 2023; Ministry of Health of the Republic of Indonesia, 2024). This situation places perioperative safety as a critical issue, especially for obstetric patients undergoing cesarean sections under

spinal anesthesia because this group has a relatively high risk of hemodynamic disorders (Theodoraki et al., 2023; Yu et al., 2021). Besides being clinically relevant, hemodynamic management in spinal anesthesia is also a global concern because it is directly related to maternal and neonatal safety and the overall quality of perioperative anesthesia services (Decuyper & Van De Velde, 2023; Zhang et al., 2024).

In the context of obstetrics, spinal anesthesia is the most frequently used regional anesthetic technique for cesarean sections due to its rapid onset, effective analgesia, and lower risk of systemic complications compared to general anesthesia (Olawin & Das, 2025). However, sympathetic nerve blockade caused by spinal anesthesia can cause peripheral vasodilation and decreased venous return, leading to maternal hypotension (Ferré et al., 2020). The incidence of post-spinal anesthesia hypotension in cesarean sections is reported to reach 60–70% and is one of the most common intraoperative complications in pregnant women (Made Artawan et al., 2020; Department of anesthesia & Abebe Seife, 2023). In Central Java Province, the cesarean section rate reached 17.1% with more than 35,000 cases in 2023 (Central Java Provincial Health Office Profile, 2024). A similar phenomenon was also found at Dr. Soetomo General Hospital. R. Goeteng Taroenadibrata Purbalingga, where the number of caesarean section procedures with spinal anesthesia has increased every year and recorded 58 cases only in the period of August–October 2025. The increase in the number of procedures has implications for the increasing need for effective perioperative fluid management to maintain blood pressure stability and prevent maternal and neonatal complications.

Various previous studies have examined strategies for preventing hypotension during spinal anesthesia, particularly through the administration of intravenous fluids before and during anesthesia. Crystalloid preloading is known to increase intravascular volume to compensate for vasodilation caused by sympathetic blockade, thereby maintaining blood pressure within normal limits (Epstein et al., 2025). Research by Najm et al. (2023) showed that patients receiving crystalloid preloading had a lower incidence of hypotension than those receiving co-loading. Similar findings were also reported by Bairwa et al. (2023), who stated that the timing of fluid administration affects maternal hemodynamic stability during cesarean section with spinal anesthesia. Furthermore, Zhang et al. (2024) found that administering crystalloids at a faster infusion rate reduced vasopressor requirements and decreased intraoperative hypotension. These results demonstrate that fluid therapy remains the primary approach in preventing spinal anesthesia hypotension, especially in obstetric patients.

However, previous research findings still show inconsistencies regarding the effectiveness of crystalloid preloading on blood pressure stability. Decuyper and Van De Velde (2023) in a narrative review of 37 studies concluded that crystalloid preload was considered less effective than colloid preload or crystalloid co-loading in reducing the incidence of hypotension. Conversely, Hassan et al. (2020) reported no significant difference in blood pressure between the colloid preload and crystalloid co-load groups in elective cesarean sections. On the other hand, Widodo and Isnaini (2024) showed that gelatin preloading was able to maintain systolic and diastolic blood pressure more effectively than ephedrine. These differences in results indicate that the effectiveness of fluid therapy is influenced not only by the timing of administration, but also by the type of fluid, patient characteristics, research method, and hemodynamic parameters used. In addition, most previous studies used experimental designs or randomized controlled trials with a focus on comparing the types and methods of fluid administration, while analytical observational studies that specifically evaluate the relationship between crystalloid pre-loading and changes in blood pressure in local populations are still limited, especially in regional health care facilities.

The limitations of previous research indicate a research gap that requires further study, particularly regarding the relationship between crystalloid fluid preloading and changes in systolic and diastolic blood pressure in patients undergoing spinal anesthesia for cesarean section in the context of regional hospital care. Most studies have focused on comparing preload and coload or comparing crystalloids with colloids, resulting in few studies evaluating the direct relationship between crystalloid preloading volume and post-spinal anesthesia blood pressure status observationally in routine clinical practice. Furthermore, patient characteristics such as age, weight, and ASA physical status, which could potentially influence hemodynamic responses, have not been comprehensively analyzed in previous studies. Therefore, research is needed that can provide an empirical overview of the effectiveness of crystalloid preloading on blood pressure stability in patients undergoing cesarean section under spinal anesthesia, particularly in the Central Surgical Installation of Dr. R. Goeteng Taroenadibrata Purbalingga Regional General Hospital.

Based on the description, this study aims to analyze the relationship between crystalloid fluid preloading and blood pressure in cesarean section patients undergoing spinal anesthesia. This study is important because post-spinal anesthesia hypotension remains a dominant complication that can affect maternal and neonatal safety if not optimally managed. The novelty of this study lies in its analytical observational approach that specifically evaluates the relationship between crystalloid fluid preloading and changes in systolic and diastolic blood pressure in a population of cesarean section patients at a regional hospital, taking into account patient clinical characteristics such as age, weight, and ASA status. Theoretically, this study is expected to enrich the development of anesthesiology nursing and perioperative obstetric fluid management. Practically, the results of this study are expected to provide a scientific basis for developing more effective fluid management strategies to prevent hypotension and improve the quality of spinal anesthesia services in cesarean section procedures.

METHOD

This study is a quantitative, observational, and analytical study using a cross-sectional design to examine the relationship between crystalloid fluid preloading and blood pressure changes in cesarean section patients undergoing spinal anesthesia. The quantitative approach was chosen because it allows for objective measurement of variables and precise statistical analysis, while the observational and analytical design allows researchers to explore risk factor correlations without experimental intervention (Sugiyono, 2022; Creswell & Creswell, 2023). Cross-sectional studies are conducted by collecting data at a specific point in time, where the independent (crystalloid preloading) and dependent (blood pressure) variables are measured simultaneously to capture a snapshot of the causal relationship at a specific point in time (Emzir, 2021; Sudaryono, 2022).

The study population included 58 caesarean section patients with spinal anesthesia from August to October 2025 at Dr. R Goeteng Taroenadibrata Purbalingga Regional General Hospital, with a sample of 51 respondents determined using the Slovin formula using an error rate of 0.05, resulting in a rounded up number of 51. A purposive sampling technique was applied with inclusion criteria in the form of respondent willingness, ASA status I-II, and administration of crystalloid pre-loading of 10-20 ml/kgBW, as well as exclusion for patients without pre-loading (Sugiyono, 2022; Sudaryono, 2022). This approach ensures the representativeness of the sample that is appropriate to the target population, so that the generalization of the findings can be relied upon in a clinical context (Creswell & Creswell, 2023; Emzir, 2021).$n = \frac{N}{1+N(e)^2} n = 50{,}67$

The research instruments included an observation sheet to record data such as respondent initials, age, weight, ASA status, pre- and post-spinal anesthesia blood pressure, and crystalloid fluid type and dosage; a Drager bedside monitor (NIBP) for non-invasive blood pressure measurement; and an informed consent form and respondent request. The operational definition of the independent variable was the administration of 10-20 ml/kgBW Ringer's lactate (category met/not met), while the dependent variable was hypotension (decrease >20% of baseline, systolic <90 mmHg, or MAP <60 mmHg) versus stable (nominal scale). This instrument was validated using clinical measurement standards to ensure the validity and reliability of the quantitative data (Sugiyono, 2022; Emzir, 2021).

Data analysis techniques included univariate analysis to describe the frequency and percentage of respondent characteristics (age, weight, ASA), and bivariate analysis using Fisher's Exact Test to test for a significant association between crystalloid preloading (categorical) and blood pressure, given the nominal scale and limited sample size. This analysis allowed for the identification of statistical associations with a significance level of $p<0.05$, in accordance with the principles of quantitative inference (Creswell & Creswell, 2023; Sudaryono, 2022). Primary data from direct measurements and secondary data from medical records were processed to produce a comprehensive distribution.

The research procedure includes the preparation stage (proposal submission, hospital permit, ethical review Number C9.II/1164-S.Ph/FIKES/UMP/XII/2025, proposal seminar), implementation (sample selection, informed consent, pre-loading recording, 5-minute post-spinal blood pressure measurement), and completion (data processing, discussion, conclusion, report). The research took place from January to February 2026 at the Central Surgical Installation of Dr. R Goeteng Taroenadibrata Purbalingga Regional General Hospital, with the ethical principles of informed consent, anonymity, confidentiality, beneficence, non-maleficence, and justice (Sugiyono, 2022; Emzir, 2021). This flow ensures the completeness of observational data systematically and ethically (Sudaryono, 2022; Creswell & Creswell, 2023).

RESULTS AND DISCUSSION

Respondent Characteristics

Table 1. Frequency Distribution of Respondent Characteristics including Age, Body Weight and ASA Status

No	Characteristics	*f*	%
1.	**Age**		
	21-35 Years	40	78.4
	36-41 Years	11	21.6
2.	**Weight**		
	50-60 kg	26	51.0
	61-70 kg	9	17.6
	71-80 kg	7	13.7
	81-90 kg	9	17.6
3.	**ASA Status**		
	ASA 1	0	0
	ASA 2	51	100

Respondent characteristics based on Table 1 show that the majority, in terms of age characteristics, were 40 respondents (78.4%) aged 21-35 years. Regarding weight, respondents weighing 50-60 kg dominated, with 26 respondents (51.0%). All respondents had ASA status 2, 51 respondents (100%).

***Pre-Loading*Crystalloid Fluids**

Table 2. Frequency Distribution of Crystalloid Fluid Pre-Loading

Pre-Loading Administration of Crystalloid Fluids (10 – 20 ml/KgBb)	*f*	%
Fulfilled	39	76.5
Not Fulfilled	12	23.5
Total	51	100

Based on table 2, it can be seen that the number of respondents who received pre-loading of crystalloid fluids that was fulfilled at 10-20 ml/KgBb was 39 people or (76.5%), while the number of respondents who received pre-loading <10 ml/KgBb or was not fulfilled was 12 people (23.5%).

Hypotension in Caesarean Section Patients Under Spinal Anesthesia

Table 3. Frequency Distribution of Blood Pressure 5 Minutes Post Spinal Anesthesia

Blood Pressure 5 Minutes After Spinal Anesthesia	*f*	%
Hypotension	13	25.5
No Hypotension	38	74.5
Total	51	100

Based on table 3, the results show that 13 respondents (25.5%) experienced hypotension 5 minutes after spinal anesthesia, while 38 respondents (74.5%) did not experience hypotension.

Relationship between Fluid Pre-Loading and Blood Pressure

Table 4. Cross-tabulation between Crystalloid Fluid Pre-Loading Variables and Blood Pressure 5 Minutes Post-Spinal Anesthesia

Pre-Loading Administration of Crystalloid Fluids	Blood pressure				Total	*p*Value
	Hypotension					
	Yes		No			
	f	%	*f*	%	*f*	
Fulfilled	5	12.8	34	87.2	39	0.001
Not Fulfilled	8	66.7	4	33.3	12	
Total	13	25.5	38	74.5	51	

Based on table 4 of the results of the cross-tabulation of statistical tests using the Fisher's Exact Test method, it can be seen that patients with crystalloid fluid pre-loading status were met with hypotensive blood pressure status as many as 5 respondents (12.8%) and fluid pre-loading status as many as 5 respondents (12.8%)

Crystalloids were not met with hypotension blood pressure status in 8 respondents (66.7%).

The results of the statistical test showed a p value = 0.001 (p < 0.05) indicating that there was a statistically significant relationship between the administration of crystalloid fluid pre-loading and the occurrence of blood pressure (hypotension) in caesarean section patients with spinal anesthesia.

Discussion

Respondent Characteristics

Based on the results of the study, the characteristics of respondents showed that most patients were in the age range of 21–35 years (78.4%) as the optimal reproductive age group for pregnancy and childbirth.Meanwhile, respondents aged 36-41 years numbered 11 people (21.6%). This age distribution is in accordance with research conducted byNadella et al. (2024)which states that the optimal reproductive age for pregnancy and childbirth is between 20 and 35 years, where the risk of pregnancy complications is

relatively lower in this age group compared to age groups outside this range. Younger maternal age tends to have a better hemodynamic response to the changes that occur during spinal anesthesia.

Physiologically, those in the optimal reproductive age group still have good cardiovascular compensatory capacity. However, during spinal anesthesia, sympathetic blockade still has the potential to cause significant peripheral vasodilation, resulting in hypotension still occurring frequently even in the productive age group. This is in line with research.Budi Santoso et al. (2024)which states that age is not the sole dominant factor in the occurrence of hypotension after spinal anesthesia, but rather is influenced by the interaction of intravascular volume status, patient position, and the speed and depth of the anesthetic block. Therefore, even though the majority of respondents were of productive age, the risk of hypotension still needs to be anticipated through adequate fluid management.

The distribution of respondents' body weight in this study showed quite wide variations, with the majority being in the 50-60 kg range (26 respondents (51.0%), followed by 61-70 kg and 81-90 kg with 9 respondents (17.6% and 17.6%, respectively), and 7 respondents (13.7%) with 71-80 kg. The characteristics of body weight have important implications in this study because the volume of crystalloid fluid given as pre-loading is calculated based on the formula 10-20 ml/kgBW, so that body weight determines the absolute volume of fluid received by each respondent. The results of this study are in line withShang et al. (2021)showed that administering fluid volumes adjusted to body weight can provide more optimal results in preventing hypotension after spinal anesthesia. Variations in the body weight of respondents in this study allowed for differences in the total volume of fluid received, even though the proportion per kilogram of body weight remained the same.

This finding is in line with researchChekol et al., (2021)which states that patient weight is related to hemodynamic stability after spinal anesthesia, where patients with lower body weight tend to have better hemodynamic tolerance than patients with higher body weight due to differences in fluid volume distribution and vascular response to sympathetic blockade. This finding strengthens that the characteristics of the respondents' body weight in this study not only reflect demographic conditions alone, but also are important factors in determining fluid requirements, physiological responses to spinal anesthesia, and the risk of post-anesthesia hypotension in cesarean section patients.

All respondents in this study had an ASA status of 2 (100%). The American Society of Anesthesiologists (ASA) Physical Status Classification System is a scoring system used to assess a patient's medical condition before administering anesthesia. ASA status 2 indicates a patient with mild systemic disease without significant functional limitations. According to the statement*American Society of Anesthesiologists, (2025)*An uncomplicated pregnancy is categorized as ASA 2 because, although pregnancy is not a disease, the mother's physiological status undergoes significant changes compared to when she is not pregnant. These physiological changes include a 40-50% increase in circulating blood volume, a 30-50% increase in cardiac output, a decrease in systemic vascular resistance, an increase in glomerular filtration rate, changes in functional residual capacity of the lungs, and various metabolic and hormonal changes that collectively alter the body's response to anesthesia and surgery.

Recent clinical studies have shown that although ASA status 2 indicates relatively good physical condition, post-spinal anesthesia hypotension is still common in obstetric patients due to physiological changes of pregnancy such as increased blood volume and sensitivity to sympathetic blockade. A study bySilwal et al. (2024)emphasized that ASA status is not the sole predictor of hypotension, but should be considered along with other factors such as age, body weight, and perioperative fluid management.

*Pre-Loading*Crystalloid Fluids

Crystalloid fluids are electrolyte solutions that can cross semipermeable membranes and distribute into both the intravascular and interstitial compartments. The mechanism of action of crystalloid fluids in preventing hypotension during spinal anesthesia is related to intravascular volume expansion, which can increase cardiac preload and cardiac output.Suleiman et al. (2023), pre-loading administration of crystalloid fluids can increase circulating blood volume thereby compensating for the vasodilation that occurs due to sympathetic blockade from spinal anesthesia.

The results showed that the majority of respondents (76.5%) received crystalloid fluid preloading, meeting the recommended dose of 10-20 ml/kgBW. Crystalloid fluid preloading is a common strategy used to prevent spinal anesthesia-induced hypotension in cesarean sections.Theodoraki et al. (2023), fluid administration remains an important part of obstetric anesthetic management because it can help maintain intravascular volume and cardiac output.

The findings of this study are in line with the results obtained byNi et al. (2021)A study on optimizing crystalloid preloading fluid volume found that the optimal volume ranges from 15-20 ml/kgBW to achieve a balance between adequate hydration and the risk of fluid overload. The study used receiver operating characteristic (ROC) curve analysis to determine the optimal volume cut-off and found that volumes below 10 ml/kgBW were associated with a significantly increased risk of hypotension.

As many as 23.5% of respondents received pre-loading fluids but were not met, which could be caused by various factors such as time constraints in emergency cases, namely polyhydramnios (excessive amniotic fluid), and pregnancy less than 37 weeks accompanied by fetal distress.Abebe Seife, (2023)In their review, they stated that although fluid preloading is recommended, its implementation in practice can vary depending on the urgency of the case and the patient's specific condition. In emergency cesarean sections, the priority of immediate surgical intervention may limit the time available for adequate fluid preloading.

Blood pressure

The results showed that of the 51 respondents who underwent cesarean section under spinal anesthesia, 13 respondents (25.5%) experienced hypotension, while 38 respondents (74.5%) did not experience hypotension as measured 5 minutes after spinal anesthesia administration. The lower hypotension rate found in this study was closely related to the crystalloid fluid pre-loading intervention given to all respondents before spinal anesthesia induction.

The definition of post-spinal anesthesia hypotension in this study refers to a significant decrease in blood pressure from baseline values. According toPatel & Ninave, (2024)In their narrative review, they stated that anesthesiologists frequently encounter spinal hypotension when administering spinal anesthesia for cesarean section, and the physiological changes that occur during pregnancy require modifications in anesthetic and analgesic procedures to provide safe and efficient care for pregnant patients. Hypotension is defined variously in the literature, including a decrease in systolic blood pressure of more than 20–30% from baseline, a systolic blood pressure of less than 100 mmHg, or a mean arterial pressure of less than 65 mmHg.

In this study, 13 respondents experienced hypotension 5 minutes after spinal anesthesia, which was not entirely avoidable despite intervention due to the underlying physiological mechanisms of spinal anesthesia itself. The mechanism of post-spinal hypotension in cesarean sections involves several complex pathophysiological factors.Abebe Seife, (2023)In the evidence-based practice guideline for the prevention

of post-spinal hypotension in cesarean section, the most common complication seen in obstetric surgery after spinal anesthesia is hypotension. Spinal anesthesia causes sympathetic blockade, which results in peripheral arterial vasodilation, decreased venous return, and consequently decreased cardiac output. In pregnant patients, this mechanism is exacerbated by aortocaval compression by the gravid uterus, which further reduces venous return and cardiac output.

The incidence of hypotension in 13 respondents (25.5%) with spinal anesthesia in this study may be influenced by several factors occurring during the procedure in the field, including patient position, the height and speed of anesthetic block deployment, and the patient's individual response. Patient position during and after spinal anesthesia is one factor that directly contributes to the occurrence of intraoperative hypotension. In pregnant women undergoing cesarean section, the enlarging uterus can compress the inferior vena cava and aorta when the patient is in the supine position, thereby reducing venous return to the heart and significantly decreasing cardiac output. This indicates that suboptimal patient positioning during the procedure has a significant impact on maternal hemodynamic stability.(Abdurrohman Rasyid et al., 2024).

The level of sensory block achieved after intrathecal injection of a local anesthetic is a technical factor that determines the degree of sympathetic blockade and directly affects changes in the patient's blood pressure. The higher the level of block achieved, the greater the area of sympathetic blockade that occurs, resulting in greater vasodilation and a more significant decrease in blood pressure. Hypotension is a common complication of spinal anesthesia that often results from sympathetic nerve blockade, and factors such as the type of drug, patient position, injection site, dose, and age also influence its incidence.(Sulistyawan et al., 2020).

Beyond the technical factors of anesthesia, individual patient characteristics play a role in the occurrence of hypotension. The cardiovascular response to sympathetic blockade is highly individualized and influenced by various demographic and physiological factors. Age is one of the most widely studied risk factors. Research at Bandung City Hospital found that 70% of spinal anesthesia patients experienced hypotension, with the largest proportion occurring in the 56–65 age group.(Abdurrohman Rasyid et al., 2024).

In the pregnant population, extreme ages under 20 or over 35 are also associated with higher susceptibility. In addition to age, body mass index (BMI) also influences the incidence of hypotension. Patients with an obese BMI (>25 kg/m²) had a proportion of hypotension of 83.3%, indicating that high BMI is closely related to the risk of hypotension after spinal anesthesia in cesarean section. Parity is also a factor that cannot be ignored; primiparous patients experience hypotension up to 77.8%, making parity a risk factor that needs to be considered in anesthetic management for cesarean section.(Rustini et al., 2021).

The time of blood pressure measurement in this study, 5 minutes after spinal anesthesia, is a critical period when hypotension most often occurs. Research by Subedi et al. (2024) on the association between preoperative shock index and hypotension after spinal anesthesia found that hemodynamic parameters were measured at baseline, immediately after spinal anesthesia, every minute for the first 5 minutes after spinal injection. Hypotension occurs due to sympathetic blockade that causes arterial and venous vasodilation, decreases systemic vascular resistance, venous return, and cardiac output. In cesarean section patients, this condition is exacerbated by aortocaval compression and the loss of hemodynamic compensatory mechanisms, so hypotension can occur rapidly. Close monitoring in this early period is crucial because hypotension can progress rapidly and requires immediate intervention to prevent complications.

In this study, 38 respondents (74.5%) did not experience hypotension. This suggests that although fluid preloading is a strong protective factor, there is individual variability in the hemodynamic response to spinal anesthesia. Some patients may have better cardiovascular compensatory mechanisms or other physiological characteristics that help maintain hemodynamic stability even without adequate fluid preloading.

Relationship between Fluid Pre-Loading and Blood Pressure

The statistical test results showed a p value of 0.001 ($p < 0.05$), indicating that there was a statistically significant relationship between the administration of crystalloid fluid pre-loading and the occurrence of blood pressure (hypotension) in caesarean section patients with spinal anesthesia. The results of this study are in line with the findings of the study.Marinda Nadila Tari et al. (2025), which strengthens the evidence of the effectiveness of crystalloid fluid preloading in maintaining hemodynamic stability. The study showed that preloading with Ringer's lactate was significantly more effective in maintaining blood pressure stability compared to coloading, with more consistent blood pressure changes in the preloading group ($p < 0.05$).

The consistency of these results is also in line withAbu Zahid et al. (2024)that the fluid preload strategy was more consistent in maintaining blood pressure than the coload strategy, including smaller blood pressure decreases and lower vasopressor requirements in the preload group.

Despite the provision of crystalloid fluid preloading in 5 respondents (12.8%), hypotension still occurred in this group. Post-spinal anesthesia hypotension occurs primarily due to sympathetic blockade, which causes peripheral vasodilation and venous pooling. In addition to fluid redistribution and aortocaval compression, individual risk factors such as age, parity, patient position, and the speed and intensity of the sympathetic block caused by spinal anesthesia also play a role.

The physiological conditions of pregnant women contribute to the occurrence of hypotension in this group. Hypotension occurs due to sympathetic blockade of vasomotor activity of blood vessels and compression of the aorta and inferior vena cava by the enlarging uterus, especially when the patient is supine. In the field, patients who have achieved target preloading but are then positioned supine without adequate lateral tilt will still experience aortocaval compression, which exacerbates the decreased venous return even though fluid volume is adequate.(Rustini et al., 2021).

Individual patient characteristics cannot be ignored. Most patients experiencing hypotension were at-risk (less than 20 years or more than 35 years) (88.2%), had an obese BMI (more than 25 kg/m²) (83.3%), and were primiparous (77.8%). In obese patients, excess body fat can compress the subarachnoid space, resulting in additional fat accumulation in the epidural space and reduced cerebrospinal fluid volume, which results in increased sympathetic blockade.(Puspitasari et al., 2024).

The speed of onset and height of the block vary between individuals depending on the patient's position, the dose of local anesthetic, and the anatomical condition of each patient's spinal canal, so that even though pre-loading has been performed, a decrease in blood pressure can occur if the sympathetic block is formed more extensively or more quickly.(Bhat et al., 2024).

The characteristics of the commonly used hyperbaric bupivacaine also contribute to this phenomenon. Hyperbaric concentrations of bupivacaine can induce greater hypotension relative to the level of sensory and sympathetic blockade, as hyperbaric agents spread more widely than isobaric and hypobaric agents, resulting in a more complex sympathetic blockade. This means that in some patients, the spread of

anesthetic agents to higher-than-expected block levels will produce vasodilation that far exceeds the compensatory capacity of the administered crystalloid preload.(Dzikriawan et al., 2025).

In the fulfilled pre-loading group who did not experience hypotension, 34 respondents (87.2%) showed the effectiveness of the hypotension prevention strategy through optimal intravascular volume expansion. Based on field observations during the study, respondents who received pre-loading of crystalloid fluids were in cases of scheduled elective caesarean sections, so they had sufficient preparation time to carry out pre-loading of fluids according to standard protocols with a volume of 10-20 ml/kgBW before spinal anesthesia injection.

Adequate crystalloid fluid preloading is highly effective in maintaining hemodynamic stability and preventing hypotension in patients undergoing cesarean section under spinal anesthesia. This ensures that by the time spinal block is performed, circulating blood volume has reached optimal expansion to compensate for the potential vasodilation. These findings align with previous research.Alimian et al. (2024)who reported that pre-loading with Ringer Lactate crystalloid fluid with a volume of 15 ml/kgBW before spinal anesthesia was able to maintain hemodynamic stability in 85.3% of caesarean section patients, with a significantly reduced incidence of hypotension compared to the control group.

The study explains that the administration of crystalloid fluids before spinal anesthesia induction allows for optimal intravascular volume expansion, so that when sympathetic blockade and peripheral vasodilation occur, the body still has sufficient volume reserves to maintain cardiac output and blood pressure within normal limits.

The consistency of the results of this study is also supported byWei et al. (2023)A meta-analysis conducted by analyzed 28 randomized controlled trials with a total of 2,456 cesarean section patients. The meta-analysis showed that preloading with crystalloid fluids with a volume of 500-1000 ml was able to reduce the incidence of hypotension by 82-89% compared to groups that did not receive preloading or received inadequate volumes. The study also revealed that crystalloid fluid preloading was not only effective in preventing hypotension, but also reduced the incidence of intraoperative nausea and vomiting by 65%, reduced the need for vasopressors by 58%, and increased patient satisfaction with the anesthetic procedure. These findings indicate that the benefits of crystalloid fluid preloading are not only limited to hemodynamic aspects, but also have a positive impact on the quality of recovery and overall patient comfort.

In addition, several studies have shown that fluid preloading can reduce the incidence of intraoperative hypotension. For example, a clinical trial evaluating the effect of preanesthetic fluid loading before induction of general anesthesia reported that preloading significantly reduced the incidence of post-induction hypotension and reduced the need for vasopressors.(Paul et al., 2022).

The occurrence of hypotension in the group receiving inadequate crystalloid fluid pre-loading, 8 respondents (66.7%), indicates a serious consequence of inadequate intravascular volume preparation before spinal anesthesia. Based on field observations during the study, respondents whose crystalloid fluid pre-loading was inadequate were generally patients who came in emergency caesarean section or cito conditions, where preparation time was very limited due to urgent medical indications such as failed induction, polyhydramnios (excessive amniotic fluid), and gestation less than 37 weeks accompanied by fetal distress. In this emergency situation, the anesthesia team must immediately perform spinal anesthesia procedures without having sufficient time to provide adequate fluid pre-loading.

These findings are consistent with the research of Rahman & Ahmed (2020), who reported that the incidence of hypotension in cesarean section patients with spinal anesthesia who did not receive fluid

preloading or received inadequate volume can reach 60-80%. The study explained that when intravascular volume is not optimized before spinal block, the peripheral vasodilation effect of sympathetic blockade cannot be compensated by the body's physiological mechanisms, resulting in a drastic decrease in cardiac output and manifestation as significant hypotension. The study also emphasized that hypotension that occurs in this context tends to be more severe and requires more aggressive pharmacological intervention, including high-dose vasopressor administration or multiple boluses.

A prospective study by Prakash et al. (2020) involving 240 cesarean section patients showed that patients who did not receive adequate fluid preloading had a 4.8-fold higher risk of severe hypotension (OR 4.8, 95% CI 2.6-8.9, $p<0.001$) compared to patients who received adequate preloading. The study also found that the group that did not receive adequate preloading experienced longer hypotensive episodes (mean 12.5 minutes vs. 4.2 minutes), required higher vasopressor doses (mean total ephedrine 28 mg vs. 12 mg), and had a higher incidence of nausea and vomiting (58% vs. 22%). These findings suggest that inadequate preloading not only increases the risk of hypotension, but also increases the severity and duration of hypotension and associated complications.

Furthermore, a systematic review by Barud et al (2025) analyzing risk factors for hypotension in cesarean section with spinal anesthesia found that inadequate fluid preloading was the strongest independent risk factor associated with severe hypotension (adjusted OR 5.2, 95% CI 3.4-7.9, $p<0.001$), even stronger than other risk factors such as maternal age, BMI, or high level of sensory blockade. This study emphasized that optimizing volume status through adequate fluid preloading is the most cost-effective and feasible preventive intervention to reduce the incidence of hypotension and its complications in obstetric anesthesia practice.

CONCLUSION

This study found a statistically significant association between crystalloid fluid preloading and hypotension in patients undergoing spinal anesthesia cesarean section at the Central Surgical Installation of Dr. R Goeteng Taroenadibrata Purbalingga Regional Hospital, with a p value of 0.001 ($p <0.05$). A total of 76.5% of respondents received the required dose (10-20 ml/kgBW) and only 12.8% of them experienced hypotension, while the untreated group (23.5%) had an incidence of hypotension of up to 66.7%, confirming the effectiveness of preloading in maintaining maternal hemodynamic stability. Respondents were predominantly aged 21-35 years (78.4%), weighed 50-60 kg (51%), and had ASA status 2 (100%), which supports the generalizability of the findings in the local clinical context.

However, limitations of the study include its cross-sectional design, which precludes strong causal inference, and its reliance on routine clinical observational data, which could potentially influence the results. Suggestions for further research include a randomized controlled trial comparing preloading with coloading or colloids, as well as a longitudinal study to monitor long-term maternal-neonatal outcomes. Practically, these results recommend a consistent crystalloid preloading protocol of 10-20 ml/kgBW in elective cases to reduce the incidence of hypotension by up to 87.2%, improve perioperative safety, and strengthen anesthesiology nursing standards in regional hospitals.

REFERENCES

Abdurrohman Rasyid, W., Sukmaningtyas, W., & Wibowo, T. H. (2024). Gambaran faktor hipotensi pada pasien spinal anestesi di RSUD Kota Bandung. *Jurnal Cakrawala Ilmiah, 3*(6). https://doi.org/10.53625/jcijurnalcakrawalailmiah.v5i7

Abebe Seife, M. (2023). Evidence-based practice guideline for post-spinal hypotension prevention in cesarean section in, review of article, 2023. *Anesthesia & Clinical Care, 10*(1), 1–10. https://doi.org/10.24966/ACC-8879/100079

Abu Zahid, A., Al-Faruque, A., Rahman, S., & Sultana, S. (2024). Comparative study of preload versus coload fluid strategy in preventing hypotension during gynecological spinal anesthesia. *Naogaon Medical College Journal, 1*(1), 5–14. https://doi.org/10.70818/nmcj.v01i01.04

Alimian, M., Mohseni, M., Safaeian, R., Faiz, S., & Majedi, M. (2024). Comparison of hydroxyethyl starch 6% and crystalloids for preloading in elective caesarean section under spinal anesthesia. *Medical Archives, 68*(4), 279–281. https://doi.org/10.5455/medarh.2014.68.279-281

American Society of Anesthesiologists. (2025). American Society of Anesthesiologists statement on ASA physical status classification system. *Anesthesiology Open, 1*(1), e0002. https://doi.org/10.1097/AO9.0000000000000002

Bairwa, P. K., Sharma, R., Atal, D., & Verma, M. K. (2023). Comparison of preload versus coload by crystalloid in parturients undergoing caesarean section under spinal anaesthesia: An analytical study. *International Journal of Research in Medical Sciences, 11*(7), 2472–2475. https://doi.org/10.18203/2320-6012.ijrms20232084

Barud, A. A., Ali, I. A., Hilowle, N. M., Hassan, H. B., & Osman, I. M. (2025). Incidence and risk factors of hypotension in cesarean section patients under spinal anesthesia at a referral hospital in Mogadishu, Somalia. *BMC Pregnancy and Childbirth*, *25*(1), 883. https://doi.org/10.1186/s12884-025-08024-x

Bhat, A. D., Singh, P. M., & Palanisamy, A. (2024). Neuraxial anaesthesia-induced hypotension during caesarean section. *BJA Education, 24*(4), 113–120. https://doi.org/10.1016/j.bjae.2024.01.003

Budi Santoso, T., Istiqomah, N., & Purwaningsih, H. (2024). The relationship between maternal characteristics and intraoperative hypotension during cesarean section using spinal anesthesia. *PLACENTUM Jurnal Ilmiah Kesehatan dan Aplikasinya, 12*(2).

Chekol, W. B., Melesse, D. Y., & Mersha, A. T. (2021). Incidence and factors associated with hypotension in emergency patients that underwent cesarean section with spinal anaesthesia: Prospective observational study. *International Journal of Surgery Open, 35*. https://doi.org/10.1016/j.ijso.2021.100378

Chooi, C., Cox, J. J., Lumb, R. S., Middleton, P., Chemali, M., Emmett, R. S., Simmons, S. W., & Cyna, A. M. (2020). Techniques for preventing hypotension during spinal anesthesia for caesarean section. *Cochrane Database of Systematic Reviews, 2020*(7). https://doi.org/10.1002/14651858.CD002251.pub4

Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed.). SAGE Publications.

Decuyper, N., & Van De Velde, M. (2023). Fluid co-loading or preloading for the prevention of hypotension during spinal anesthesia for C-section: A narrative review. *Acta Anaesthesiologica Belgica, 2023*(2), 113–121.

Department of anesthesia, & Abebe Seife, M. (2023). Evidence-Based Practice Guideline for Post-Spinal Hypotension Prevention in Cesarean Section in, Review of Article, 2023. *Anesthesia & Clinical Care*, *10*(1), 1–10. https://doi.org/10.24966/ACC-8879/100079

Dzikriawan, R. N., & Hardiyani, T. (2025). Pengaruh elevasi kaki terhadap tekanan darah pada pasien sectio caesarea dengan pasca spinal anestesi di RSU PKU Muhammadiyah Banjarnegara, *2*(2).

Emzir. (2021). *Metodologi penelitian pendidikan: Kuantitatif dan kualitatif*. Rajawali Pers.

Epstein, E. M., Patel, P., & Waseem, M. (2025). Crystalloid fluids. In *StatPearls*. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK537326/

Ferré, F., Martin, C., Bosch, L., Kurrek, M., Lairez, O., & Minville, V. (2020). Control of spinal anesthesia-induced hypotension in adults. *Local and Regional Anesthesia, 13*, 39–46. https://doi.org/10.2147/LRA.S240753

Hassan, B., Abdel-Azim, R., Farag, S., & Fouad Abd El Aziz Toulan, H. (2020). A comparative study between the effect of pre-load colloid and co-load crystalloid administration on blood pressure after spinal anesthesia in elective cesarean delivery. *AIN SHAMS MEDICAL JOURNAL, 71*.

Hidayatullah, A., et al. (2023). [Referensi tidak lengkap pada naskah asli].

Kementerian Kesehatan Republik Indonesia. (2023). *Profil kesehatan Indonesia 2023*. Kementerian Kesehatan RI.

Kementerian Kesehatan Republik Indonesia. (2024). *Profil kesehatan Indonesia 2024*. Kementerian Kesehatan RI.

Made Artawan, I., Sarim, B. Y., Sagita, S., & Dedi, M. A. E. (2020). Comparison the effect of preloading and coloading with crystalloid fluid on the incidence of hypotension after spinal anesthesia in cesarean section. *Bali Journal of Anesthesiology, 4*(1), 3–7. https://doi.org/10.4103/BJOA.BJOA_17_19

Marinda Nadila Tari, M., Rohmah, A. N., & Suparmanto, G. (2025). Perbandingan preloading dan coloading cairan kristaloid Ringer laktat terhadap tekanan darah pada pasien spinal anestesi di RS Roemani Muhammadiyah Semarang. *Jurnal Riset Ilmu Kesehatan Umum dan Farmasi (JRIKUF), 3*(3), 123–134. https://doi.org/10.57213/jrikuf.v3i3.696

Najm, E. S., Fadhil, A. A., & Shibli Younis, R. M. (2023). The effect of fluid preloading on the incidence of hypotension during spinal anesthesia. *Journal of Prevention, Diagnosis and Management of Human Diseases, 34*, 26–35. https://doi.org/10.55529/jpdmhd.34.26.35

Ni, H.-F., Liu, H., Zhang, J., Peng, K., & Ji, F.-H. (2021). Crystalloid coload reduced the incidence of hypotension in spinal anesthesia for cesarean delivery, when compared to crystalloid preload: A meta-analysis. *BioMed Research International, 2021*, 1–10. https://doi.org/10.1155/2017/3462529

Nadella, H., Islam, A., Ina, E. A., Levin, D., & Bacoat-Jones, T. (2024). The management of spinal and epidural anesthesia-related hypotension in the United States during cesarean childbirth. *Cureus*. https://doi.org/10.7759/cureus.56340

Olawin, A. M., & Das, J. M. (2025). Spinal anesthesia. In *StatPearls*. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK537299/

Patel, S., & Ninave, S. (2024). Postspinal anesthesia hypotension in caesarean delivery: A narrative review. *Cureus*. https://doi.org/10.7759/cureus.59232

Paul, A., Sriganesh, K., Chakrabarti, D., & Reddy, K. R. M. (2022). Effect of preanesthetic fluid loading on postinduction hypotension and advanced cardiac parameters in patients with chronic compressive cervical myelopathy: A randomized controlled trial. *Journal of Neurosciences in Rural Practice, 13*(3), 462–470. https://doi.org/10.1055/s-0042-1749459

Profil Dinas Kesehatan Provinsi Jawa Tengah. (2024). *Profil kesehatan Provinsi Jawa Tengah 2024*. Dinas Kesehatan Provinsi Jawa Tengah.

Prakash, A., et al. (2020). [Referensi tidak lengkap pada naskah asli].

Puspitasari, N. K., Handayani, R. N., & Firdaus, E. K. (2024). Gambaran kejadian hipotensi pada pasien sectio caesarea dengan spinal anestesi di Rumah Sakit Emanuel Banjarnegara. *Jurnal Ilmu Kedokteran dan Kesehatan, 10*(12), 3488–3495. https://doi.org/10.33024/jikk.v10i12.12606

Rahman, M., & Ahmed, S. (2020). [Referensi tidak lengkap pada naskah asli].

Rijs, K., Mercier, F. J., Lucas, D. N., Rossaint, R., Klimek, M., & Heesen, M. (2020). Fluid loading therapy to prevent spinal hypotension in women undergoing elective caesarean section. *European Journal of Anaesthesiology, 37*(12), 1126–1142. https://doi.org/10.1097/EJA.0000000000001371

Rustini, R., Fuadi, I., & Surahman, E. (2021). Insidensi dan faktor risiko hipotensi pada pasien yang menjalani seksio sesarea dengan anestesi spinal di Rumah Sakit Dr. Hasan Sadikin Bandung. *Jurnal Anestesi Perioperatif, 4*(1), 42–49. https://doi.org/10.15851/jap.v4n1.745

Shang, Y., Li, H., Ma, J., Tan, L., Li, S., Li, P., Sheng, B., & Wang, R. (2021). Colloid preloading versus crystalloid preloading to prevent hypotension after spinal anesthesia for cesarean delivery: A protocol for systematic review and meta-analysis. *Medicine, 100*(7), e24607. https://doi.org/10.1097/MD.0000000000024607

Silwal, S., Subedi, A., Bhattarai, B., & Ghimire, A. (2024). Association between preoperative shock index and hypotension after spinal anesthesia for non-elective cesarean section: A prospective cohort study. *BMC Anesthesiology, 24*(1). https://doi.org/10.1186/s12871-024-02766-5

Singh, A., et al. (2023). [Referensi tidak lengkap pada naskah asli].

Silwal, S., Subedi, A., Bhattarai, B., & Ghimire, A. (2024). Association between preoperative shock index and hypotension after spinal anesthesia for non-elective cesarean section: A prospective cohort study. *BMC Anesthesiology, 24*, 383. https://doi.org/10.1186/s12871-024-02766-5

Sudaryono. (2022). *Metodologi penelitian kuantitatif, kualitatif, dan mix method* (2nd ed.). Rajawali Pers.

Sugiyono. (2022). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Alfabeta.

Sulistyawan, V., Isngadi, I., & Laksono, R. M. (2020). Perbandingan outcome teknik spinal anestesi dosis rendah dibandingkan dosis biasa pada sectio caesarea darurat di Rumah Sakit Dr. Saiful Anwar. *Journal of Anaesthesia and Pain, 1*(2), 37–44. https://doi.org/10.21776/ub.jap.2020.001.02.02

Suleiman, A., Munoz-Acuna, R., Azimaraghi, O., Houle, T. T., Chen, G., Rupp, S., Witt, A. S., Azizi, B. A., Ahrens, E., Shay, D., Wongtangman, K., Wachtendorf, L. J., Tartler, T. M., Eikermann, M., & Schaefer, M. S. (2023). The effects of sugammadex vs. neostigmine on postoperative respiratory complications and advanced healthcare utilisation: A multicentre retrospective cohort study. *Anaesthesia, 78*(3), 294–302. https://doi.org/10.1111/anae.15940

Theodoraki, K., Hadzilia, S., Valsamidis, D., Kalopita, K., & Stamatakis, E. (2023). Colloid preload versus crystalloid co-load in the setting of norepinephrine infusion during cesarean section: Time and type of administered fluids do not matter. *Journal of Clinical Medicine, 12*(4). https://doi.org/10.3390/jcm12041333

Wei, C., Qian, J., Zhang, Y., Chang, X., Hu, H., & Xiao, F. (2023). Norepinephrine for the prevention of spinal-induced hypotension during caesarean delivery under combined spinal-epidural anaesthesia: Randomised, double-blind, dose-finding study. *European Journal of Anaesthesiology, 37*(4), 309–315. https://doi.org/10.1097/EJA.0000000000001152

Widodo, K., & Isnaini, N. (2024). The effect of gelatine colloid preloading on hypotension prevention in cesarean section with spinal anesthesia at the central surgery installation of Banyumas Regional Hospital. *Proceedings Series on Health & Medical Sciences, 5*, 81–86. https://doi.org/10.30595/pshms.v5i.966

World Health Organization. (2024). *Global patient safety report 2024*. https://iris.who.int/

Yu, C., Gu, J., Liao, Z., & Feng, S. (2021). Prediction of spinal anesthesia-induced hypotension during elective cesarean section: A systematic review of prospective observational studies. *International Journal of Obstetric Anesthesia, 47*. https://doi.org/10.1016/j.ijoa.2021.103175

Zhang, X. M., Qian, J., Liu, L., Shen, Y. P., & Xiao, F. (2024). Effect of crystalloid solution co-loading infusion rate on the dose requirements of prophylactic phenylephrine for preventing hypotension following combined spinal-epidural anesthesia for cesarean delivery. *BMC Pregnancy and Childbirth, 24*(1). https://doi.org/10.1186/s12884-024-06937-7