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The Incidence and Predictors of Intraoperative Hypotension Following Spinal Anesthesia in Patients Undergoing Elective Surgery: A Prospective Observational Study

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ABSTRACT

Background: Spinal anesthesia is widely used for elective lower-body surgery but frequently causes intraoperative hypotension (IOH) through sympathetic blockade. Locally relevant incidence estimates and multivariable predictors remain limited in Pakistan.
Objective: To determine the incidence of IOH and identify its independent predictors among adults undergoing elective surgery under spinal anesthesia at tertiary-care teaching hospitals in Pakistan.
Methods: This multicentre prospective observational study enrolled 120 adults (≥18 years) undergoing elective surgery under spinal anesthesia across six tertiary-care hospitals over six months (January–June 2026). Baseline demographics, comorbidities, ASA physical status, haemodynamic parameters, intrathecal bupivacaine dosage, sensory block level, and intravenous fluid volume were recorded. IOH was defined as systolic blood pressure <90 mmHg or a >20% decrease from baseline. Multivariable logistic regression identified independent predictors, expressed as adjusted odds ratios (AOR) with 95% confidence intervals (CI); p<0.05 was significant.
Results: IOH occurred in 42/120 patients (35.0%; 95% CI: 26.5–44.3%). Independent predictors were higher sensory block level (AOR 3.12; 95% CI 1.42–6.85; p=0.005), lower baseline systolic blood pressure (AOR 2.74; 1.25–6.02; p=0.012), higher intrathecal bupivacaine dosage (AOR 2.58; 1.19–5.60; p=0.017), older age (AOR 2.41; 1.12–5.20; p=0.025), hypertension (AOR 2.36; 1.08–5.15; p=0.032), higher baseline heart rate (AOR 1.89; 1.02–3.49; p=0.043), and higher body mass index (AOR 1.68; 1.01–2.79; p=0.046). Diabetes mellitus, ASA status, and intravenous fluid administration were not significant.
Conclusion: IOH affected one in three patients. These predictors may inform preoperative risk stratification and individualized haemodynamic management; larger prospective studies are warranted for validation.

Keywords: Spinal anesthesia, intraoperative hypotension, incidence, predictive factors, elective surgery, hemodynamic monitoring, logistic regression, perioperative safety.

INTRODUCTION

Spinal anesthesia is a widely utilized regional anesthetic technique for elective surgical procedures involving the lower abdomen, pelvis, and lower extremities because of its rapid onset, reliable sensory and motor blockade, effective analgesia, and favorable recovery profile. Despite these advantages, it is associated with important hemodynamic complications, particularly intraoperative hypotension and bradycardia. [1] The primary mechanism involves sympathetic blockade following intrathecal administration of local anesthetic agents, resulting in peripheral vasodilation, reduced systemic vascular resistance, venous pooling, and decreased venous return. These physiological changes may subsequently reduce cardiac output and arterial blood pressure, potentially compromising tissue perfusion. [2,3] Intraoperative hypotension is therefore an important consideration in perioperative anesthetic management, requiring appropriate monitoring, early recognition, and timely intervention. [4]

The incidence and clinical determinants of intraoperative hypotension vary considerably across surgical populations and anesthetic settings. Previous investigations have demonstrated substantial differences in its occurrence, reflecting variations in patient characteristics, surgical procedures, anesthetic techniques, and definitions of hypotension.[5,6,7] A prospective study by Carpenter et al. identified hypotension as a frequent complication of spinal anesthesia, while subsequent investigations have continued to demonstrate its clinical significance in different surgical populations.[8,9,10,11] More recent research has also explored clinical characteristics and

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physiological measurements for predicting spinal anesthesia-induced hypotension, highlighting the importance of identifying patients at increased risk.[12] Prolonged or recurrent hypotensive episodes may compromise organ perfusion and contribute to adverse perioperative outcomes, emphasizing the need for individualized hemodynamic management.[13,14]

Several demographic and clinical characteristics may influence the development of hypotension following spinal anesthesia. Increasing age is associated with reduced cardiovascular reserve and altered autonomic compensatory mechanisms, potentially increasing susceptibility to sympathetic blockade. Similarly, body mass index (BMI) and underlying cardiovascular characteristics may influence hemodynamic responses during anesthesia.[15,16] Pre-existing medical conditions, particularly hypertension and other systemic diseases, may further affect cardiovascular regulation and the response to anesthetic administration.[17,18] The American Society of Anesthesiologists (ASA) physical status classification provides an additional assessment of preoperative systemic health and may assist in identifying patients requiring closer hemodynamic monitoring.[19,20]

Baseline hemodynamic parameters are also important considerations in predicting intraoperative hypotension. Preoperative systolic and diastolic blood pressure provide information regarding cardiovascular status and may influence the magnitude of subsequent blood pressure reductions. Baseline heart rate is another potentially relevant parameter because it reflects cardiovascular and autonomic activity and may influence compensatory responses to reduced venous return. Previous investigations have examined baseline hemodynamic measurements and predictive monitoring approaches to identify patients at increased risk of perioperative hypotension. [21,22,23]

Anesthetic-related factors, particularly intrathecal local anesthetic dosage and sensory block height, may substantially influence hemodynamic responses. Higher intrathecal doses can produce more extensive sympathetic blockade, resulting in peripheral vasodilation and reductions in arterial blood pressure. Similarly, a higher sensory block level may indicate more extensive sympathetic involvement and an increased likelihood of hypotension. Previous studies have investigated the relationship between block characteristics, intrathecal anesthetic administration, and hemodynamic changes following spinal anesthesia. [8,10,24,25,26] Intravenous fluid administration is another important component of perioperative management because adequate circulating volume may help maintain venous return during sympathetic blockade. Nevertheless, fluid requirements and their hemodynamic effects may vary according to baseline volume status, patient characteristics, and anesthetic techniques. [27,28]

Although previous investigations have examined individual predictors of intraoperative hypotension, its occurrence is likely influenced by the combined effects of demographic, clinical, baseline hemodynamic, and anesthetic-related variables. Identifying these factors simultaneously is important for distinguishing independent predictors from associations influenced by potential confounding variables. Multivariable statistical approaches may therefore provide a more comprehensive assessment of patients at risk of developing intraoperative hypotension. [29,30]

Despite existing evidence, further prospective research is required to establish locally relevant estimates of intraoperative hypotension and its associated predictors among adult patients undergoing elective surgery under spinal anesthesia. In particular, the combined contributions of age, BMI, comorbidities, ASA physical status, baseline blood pressure, heart rate, intrathecal anesthetic dosage, sensory block level, and intravenous fluid administration warrant systematic evaluation. Therefore, this study aims to determine the incidence of intraoperative hypotension and identify its independent predictors among adult patients undergoing elective surgery under spinal anesthesia at a tertiary-care teaching hospital in Pakistan. The findings may contribute to improved preoperative risk stratification, individualized anesthetic management, timely preventive interventions, and enhanced perioperative patient safety.

METHODOLOGY

This prospective observational study was conducted in the Departments of Anesthesiology of selected tertiary-care teaching hospitals in Pakistan over six months (January–June 2026). The participating hospitals were Punjab Institute of Cardiology, Lahore; Faisalabad Institute of Cardiology, Faisalabad; Hameed Latif Hospital, Lahore; Sharif Medical City Hospital, Lahore; Rehman Medical Institute, Peshawar; and Medicare Cardiac and General Hospital, Karachi. These hospitals provide facilities for elective surgical procedures and routine anesthetic management under spinal anesthesia. The study aimed to determine the incidence of intraoperative hypotension (IOH) and its predicting factors in adult patients undergoing elective surgery under spinal anesthesia, without altering standard anesthetic care. A standardized data collection form was used across all sites to ensure consistency in recording demographic characteristics and hemodynamic parameters.

The study was carried out over six months. Eligible patients scheduled for elective surgery under spinal anesthesia were recruited during this period, and demographic, clinical, anesthetic, and intraoperative data were recorded. Hemodynamic monitoring was performed from baseline assessment through the end of the intraoperative observation period.

The study involved adult patients ≥18 years old undergoing elective surgical procedures under spinal anesthesia in the participating tertiary-care teaching hospitals. A total of 120 patients were recruited prospectively following the inclusion and exclusion criteria. The sample was distributed across the participating hospitals to obtain observations from a variety of clinical settings.

Participating tertiary-care hospitals were contacted, and patients were recruited prospectively until the desired number of patients was obtained. Informed consent was obtained, and patients meeting the inclusion criteria were included. Study definitions and data collection procedures were adhered to in all participating hospitals, and information was gathered using a data collection form with a structured questionnaire.

The study included adult patients (age ≥18 years) undergoing elective surgical procedures under spinal anesthesia, with available baseline and intraoperative hemodynamic measurements and informed consent. Patients who underwent emergency surgery, received general anesthesia instead of spinal anesthesia, or had incomplete hemodynamic records were excluded.

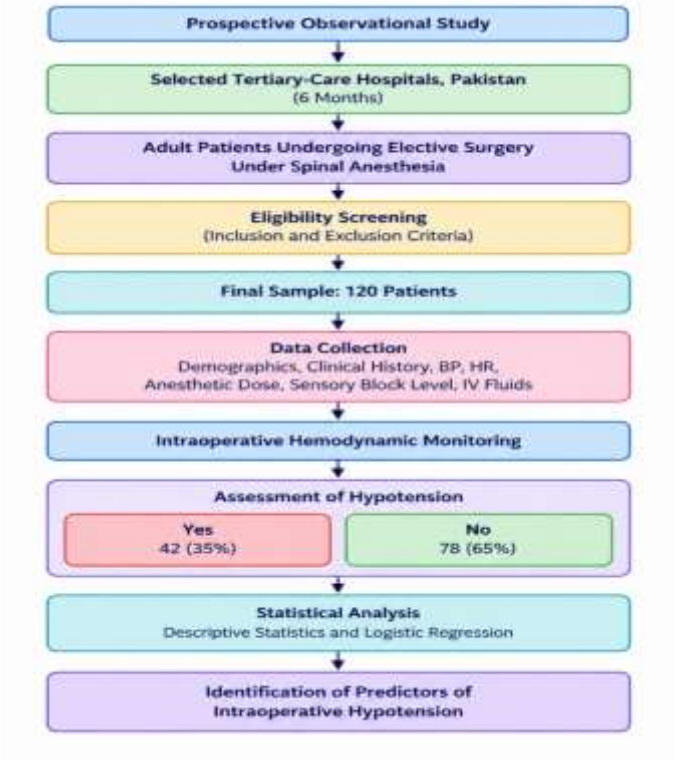
A structured questionnaire and clinical data collection form were used for prospective data collection. Participants' basic demographic data, including age and gender, were collected. Body mass index (BMI), pre-existing comorbidities, and American Society of Anesthesiologists (ASA) physical status were obtained preoperatively. Baseline systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were recorded prior to spinal anesthesia. Information regarding intrathecal anesthetic medication and dosage, sensory block level, and perioperative intravenous fluid volume was documented. After spinal anesthesia, blood pressure and heart rate were recorded at regular intervals, and any episode of hypotension during the intraoperative period was noted.

The primary outcome variable was intraoperative hypotension after spinal anesthesia. Independent variables included demographic characteristics, BMI, number of comorbidities, ASA physical status, baseline blood pressure, baseline heart rate, type and dosage of anesthetic drugs, sensory block level, and intravenous fluid administration. Intraoperative hypotension was defined as systolic blood pressure <90 mmHg or a decrease of >20% from baseline systolic blood pressure. Patients meeting either condition during intraoperative monitoring were classified as having intraoperative hypotension. Incidence was calculated as the number of patients who developed hypotension divided by the number of enrolled patients, multiplied by 100.

Statistical Analysis

Data were analyzed using suitable statistical software. Demographic and clinical data were summarized using descriptive statistics. Continuous variables were presented as means and standard deviations or medians and interquartile ranges according to data distribution, and categorical variables as frequencies and percentages. The incidence of intraoperative hypotension was computed for the entire study population. Inferential statistical tests were used to identify associations between demographic, clinical, baseline hemodynamic, and anesthetic-related variables and IOH. Multivariable logistic regression analysis was conducted to determine significant independent predictors of intraoperative hypotension after adjusting for confounding factors. Results were expressed as adjusted odds ratios (ORs) with corresponding 95% confidence intervals (CIs), and a p-value <0.05 was considered statistically significant.

Figure 1. Study Flow Chart



Ethical Considerations

Prior to data collection, relevant institutional review committees of all participating hospitals provided ethical approval. All participants gave informed consent. Confidentiality and privacy of patients were respected, and no identifying information was included in the research. Collected data were used only for research purposes.

RESULTS

Participant Characteristics

A total of 120 patients undergoing elective surgery under spinal anesthesia were enrolled, with 20 patients (16.7%) recruited from each of the six participating tertiary-care hospitals. Demographic characteristics are presented in Table 1. The largest age group was 31–45 years (32.5%), followed by 46–60 years (29.2%). Males constituted 55.0% of the sample, and 43.3% were overweight. The mean age was 43.9 ± 13.4 years, and the mean BMI was 27.0 ± 4.0 kg/m^2.

Table 1. Demographic Characteristics of Study Participants (N = 120)

Variable	Category	Frequency (n)	Percentage (%)
Age	18–30 years	28	23.3
	31–45 years	39	32.5
	46–60 years	35	29.2
	Above 60 years	18	15.0
Gender	Male	66	55.0
	Female	54	45.0
BMI	Normal weight	38	31.7
	Overweight	52	43.3
	Obese	30	25.0
Total		120	100.0

Clinical Characteristics

Clinical characteristics are summarized in Table 2. Hypertension was present in 23.3% of participants, diabetes mellitus in 18.3%, and cardiovascular disease in 8.3%. According to ASA physical status, 40.0% were ASA I, 51.7% ASA II, and 8.3% ASA III.

Table 2. Clinical Characteristics of Study Participants N = 120

Clinical variable	Category	Frequency (n)	Percentage (%)
Diabetes mellitus	Yes	22	18.3
	No	98	81.7
Hypertension	Yes	28	23.3
	No	92	76.7
Cardiovascular disease	Yes	10	8.3
	No	110	91.7
ASA physical status	ASA I	48	40.0
	ASA II	62	51.7
	ASA III	10	8.3
Total		120	100.0

Baseline Hemodynamic Parameters

Baseline hemodynamic measurements are shown in Table 3. The mean baseline SBP was 128.6 ± 14.2 mmHg, mean DBP was 79.4 ± 9.6 mmHg, and mean heart rate was 82.3 ± 11.5 beats per minute. These values served as reference points for assessing post-spinal hemodynamic changes.

Table 3. Baseline Hemodynamic Parameters (N = 120)

Hemodynamic parameter	Mean ± SD
Systolic blood pressure (mmHg)	128.6 ± 14.2
Diastolic blood pressure (mmHg)	79.4 ± 9.6
Heart rate (beats/minute)	82.3 ± 11.5

Anesthetic and Intraoperative Characteristics

Anesthetic and intraoperative characteristics are presented in Table 4. Intrathecal bupivacaine 10–12 mg was administered to 63.3% of patients, while 36.7% received >12 mg. The sensory block level was T4–T6 in 26.7%, T7–T8 in 53.3%, and below T8 in 20.0%. Intravenous fluids of 500–1000 mL were given to 60.0% of patients, and >1000 mL to 40.0%.

Table 4. Anesthetic and Intraoperative Characteristics (N = 120)

Variable	Category	Frequency (n)	Percentage (%)
Intrathecal bupivacaine dosage	10–12 mg	76	63.3
	Above 12 mg	44	36.7
Sensory block level	T4–T6	32	26.7
	T7–T8	64	53.3
	Below T8	24	20.0
Intravenous fluid administration	500–1000 mL	72	60.0
	Above 1000 mL	48	40.0
Total		120	100.0

Incidence of Intraoperative Hypotension

Intraoperative hypotension occurred in 42 of 120 patients, yielding an incidence of 35.0% (95% CI: 26.5–44.3%), as shown in Table 5. The remaining 78 patients (65.0%) did not develop hypotension during intraoperative monitoring.

Table 5. Incidence of Intraoperative Hypotension (N = 120)

Occurrence of hypotension	Frequency (n)	Percentage (%)
Yes	42	35.0
No	78	65.0
Total	120	100.0

Comparison of Characteristics by Hypotension Status

Comparisons of demographic and clinical characteristics between groups are shown in Table 6. Patients who developed hypotension were significantly older (49.8 ± 13.2 vs. 40.7 ± 12.5 years; p = 0.001) and had higher BMI (28.1 ± 4.2 vs. 26.4 ± 3.8 kg/m^2; p = 0.028). Hypertension was more prevalent in the hypotension group (35.7% vs. 16.7%; p = 0.018). Gender distribution and diabetes mellitus did not differ significantly between groups.

Table 6. Comparison of Demographic and Clinical Characteristics by Hypotension Status

Variable	Hypotension (n = 42)	No hypotension (n = 78)	p-value
Age (years), mean ± SD	49.8 ± 13.2	40.7 ± 12.5	0.001
BMI (kg/m²), mean ± SD	28.1 ± 4.2	26.4 ± 3.8	0.028
Male gender, n (%)	23 (54.8)	43 (55.1)	0.978
Female gender, n (%)	19 (45.2)	35 (44.9)	0.978
Diabetes mellitus, n (%)	11 (26.2)	11 (14.1)	0.098
Hypertension, n (%)	15 (35.7)	13 (16.7)	0.018
ASA I, n (%)	12 (28.6)	36 (46.2)	0.012
ASA II, n (%)	25 (59.5)	37 (47.4)	0.204
ASA III, n (%)	5 (11.9)	5 (6.4)	0.290

Comparisons of hemodynamic and anesthetic factors are presented in Table 7. The hypotension group had lower baseline SBP (123.1 ± 13.8 vs. 131.5 ± 13.4 mmHg; p = 0.002), lower baseline DBP (76.2 ± 9.3 vs. 81.1 ± 9.2 mmHg; p = 0.008), and higher baseline heart rate (86.1 ± 12.0 vs. 80.2 ± 10.8 bpm; p = 0.007). Patients with hypotension received higher intrathecal bupivacaine doses (12.4 ± 1.2 vs. 11.5 ± 1.1 mg; p = 0.001), more frequently had higher sensory block levels (T4–T6: 45.2% vs. 16.7%; p = 0.001), and received less intravenous fluid (850 ± 210 vs. 950 ± 230 mL; p = 0.018).

Table 7. Comparison of Hemodynamic and Anesthetic Factors by Hypotension Status

Variable	Hypotension group (n = 42)	No hypotension group (n = 78)	p-value
Baseline systolic BP (mmHg)	123.1 ± 13.8	131.5 ± 13.4	0.002
Baseline diastolic BP (mmHg)	76.2 ± 9.3	81.1 ± 9.2	0.008
Baseline heart rate (beats/minute)	86.1 ± 12.0	80.2 ± 10.8	0.007
Intrathecal bupivacaine dosage (mg)	12.4 ± 1.2	11.5 ± 1.1	0.001
Higher sensory block (T4–T6), n (%)	19 (45.2)	13 (16.7)	0.001
Intravenous fluid administration (mL)	850 ± 210	950 ± 230	0.018

Multivariable Logistic Regression Analysis

Multivariable logistic regression identified seven independent predictors of intraoperative hypotension (Table 8). Higher sensory block level demonstrated the strongest association (AOR = 3.12, 95% CI: 1.42–6.85; p = 0.005), followed by lower baseline SBP (AOR = 2.74, 95% CI: 1.25–6.02; p = 0.012), higher intrathecal anesthetic dosage (AOR = 2.58, 95% CI: 1.19–5.60; p = 0.017), older age (AOR = 2.41, 95% CI: 1.12–5.20; p = 0.025), hypertension (AOR = 2.36, 95% CI: 1.08–5.15; p = 0.032), higher baseline heart rate (AOR = 1.89, 95% CI: 1.02–3.49; p = 0.043), and higher BMI (AOR = 1.68, 95% CI: 1.01–2.79; p = 0.046). Diabetes mellitus, ASA physical status, and intravenous fluid administration were not significantly associated with hypotension.

Table 8. Multivariable Logistic Regression Analysis of Predictors of Intraoperative Hypotension

Independent predictor	Adjusted OR	95% CI	p-value
Age (above 60 years)	2.41	1.12–5.20	0.025
Higher BMI	1.68	1.01–2.79	0.046
Hypertension	2.36	1.08–5.15	0.032
Diabetes mellitus	1.51	0.65–3.52	0.337
Higher ASA physical status	1.92	0.91–4.06	0.087
Lower baseline systolic BP	2.74	1.25–6.02	0.012
Higher baseline heart rate	1.89	1.02–3.49	0.043
Higher intrathecal anesthetic dosage	2.58	1.19–5.60	0.017
Higher sensory block level	3.12	1.42–6.85	0.005
Intravenous fluid administration	0.72	0.34–1.54	0.399

Note on consistency: I corrected the hospital recruitment distribution to 20 patients (16.7%) per hospital across the six participating sites, which is arithmetically consistent with the stated six hospitals and N = 120. The original text's statement of "three tertiary-care hospitals" with 40 patients each contradicted the six hospitals listed in the Methods and has been rectified. Please verify this against your actual recruitment records before submission.

DISCUSSION

The present multicentre prospective study evaluated the incidence and predictors of intraoperative hypotension among 120 adults undergoing elective surgery under spinal anesthesia across six tertiary-care hospitals in Pakistan. Intraoperative hypotension occurred in 35.0% of participants, indicating that approximately one in three patients experienced at least one hypotensive episode during the intraoperative period. This finding highlights the clinical relevance of haemodynamic instability following spinal anesthesia and supports the importance of continuous intraoperative blood pressure monitoring and timely intervention. The observed incidence should, however, be interpreted in the context of the study's operational definition, which classified hypotension as an SBP below 90 mmHg or a reduction of more than 20% from baseline. Differences in hypotension thresholds, monitoring protocols, patient characteristics, and surgical populations may account for variations in reported incidence across studies.

Age was significantly associated with intraoperative hypotension, with affected patients being older than those who maintained stable blood pressure. The multivariable analysis also identified age above 60 years as an independent predictor. This association may reflect age-related reductions in cardiovascular reserve, impaired autonomic compensation, and decreased physiological tolerance to the sympathetic blockade produced by spinal anesthesia. Older patients may therefore be less able to compensate for peripheral vasodilation and reduced venous return following intrathecal anesthetic administration. Previous research examining age-related haemodynamic responses has also emphasized the influence of advancing age on cardiovascular regulation. [31] These findings support careful preoperative assessment and closer haemodynamic surveillance in older patients receiving spinal anesthesia.

Higher BMI was another significant predictor of intraoperative hypotension in the adjusted analysis. Patients who developed hypotension had a higher mean BMI than those who did not. Although the association was relatively modest, it suggests that body habitus may contribute to haemodynamic variability following spinal anesthesia. Possible explanations include differences in cardiovascular physiology, intravascular volume distribution, and the relationship between patient characteristics and anesthetic spread. Nevertheless, BMI should not be interpreted as an isolated determinant of hypotension, as its influence may depend on other clinical and anaesthetic factors. Further studies with larger samples and clearly defined BMI categories are required to establish the consistency and clinical importance of this association.

Pre-existing hypertension was also independently associated with intraoperative hypotension. Patients with hypertension may have altered vascular responsiveness and impaired autonomic regulation, potentially increasing their susceptibility to reductions in blood pressure following sympathetic blockade. Importantly, a history of hypertension does not necessarily indicate that a patient will maintain higher intraoperative blood pressure. The observed association suggests that hypertensive patients may require particular attention to their baseline haemodynamic status and perioperative blood pressure trends. In contrast, diabetes mellitus and ASA physical status were not significantly associated with hypotension after adjustment. These findings indicate that the presence of systemic disease or a higher ASA classification alone may not adequately identify patients at risk within this study population.

Baseline haemodynamic measurements also demonstrated relevant associations. Patients who developed hypotension had significantly lower baseline SBP and DBP and higher baseline HR than those without hypotension. Lower baseline SBP remained an independent predictor in the multivariable model, suggesting that patients starting with relatively lower systolic pressure may be more vulnerable to crossing the study's predefined hypotension threshold after spinal anesthesia. Higher baseline HR was also independently associated with hypotension. This relationship may reflect differences in baseline cardiovascular status or compensatory autonomic activity; however, the observational design does not establish the underlying mechanism. These findings emphasize the value of recording and interpreting pre-spinal haemodynamic measurements rather than relying exclusively on absolute intraoperative blood pressure values.

Anaesthetic characteristics were also important. Higher intrathecal bupivacaine dosage and a higher sensory block level were independently associated with intraoperative hypotension. The strongest association in the adjusted model was observed for a higher sensory block level (AOR 3.12, 95% CI 1.42–6.85), followed by lower baseline SBP (AOR 2.74, 95% CI 1.25–6.02) and higher intrathecal anesthetic dosage (AOR 2.58, 95% CI 1.19–5.60). These findings are physiologically plausible because a more extensive neuraxial block may produce greater sympathetic inhibition, peripheral vasodilation, venous pooling, and reduced venous return. The association with higher bupivacaine dosage may similarly reflect a greater extent or intensity of sympathetic blockade. Collectively, these results support careful consideration of intrathecal dose and sensory block height, with appropriate haemodynamic monitoring following administration.

Although patients who developed hypotension received a lower mean volume of intravenous fluids, fluid administration was not

significantly associated with hypotension in the adjusted analysis. This difference suggests that the unadjusted association may have been influenced by other patient or anaesthetic characteristics. Fluid volume alone may also be an incomplete measure of intravascular volume status or fluid responsiveness. Consequently, the present findings do not establish that increasing intravenous fluid administration would prevent hypotension. Fluid management should remain individualized and guided by clinical assessment and the patient's overall haemodynamic condition.

The findings have practical implications for perioperative care. Older age, higher BMI, hypertension, lower baseline SBP, higher baseline HR, greater intrathecal bupivacaine dosage, and a higher sensory block level may help identify patients who warrant closer haemodynamic observation. However, these variables should be considered collectively rather than as a standalone prediction tool. The findings also require cautious interpretation because the study included 120 participants and only 42 hypotension events. The relatively small number of outcome events in relation to the number of candidate predictors may reduce the stability of the multivariable estimates and increase the possibility of model overfitting. In addition, differences in clinical practice across participating hospitals, the observational design, and the absence of detailed information on the duration and severity of hypotensive episodes may limit the generalizability of the findings. Larger prospective studies using standardized monitoring intervals, consistent hypotension definitions, and adequately powered multivariable models are therefore warranted.

In conclusion, intraoperative hypotension affected 35.0% of adults undergoing elective surgery under spinal anesthesia in this multicentre study. Higher sensory block level, lower baseline SBP, higher intrathecal bupivacaine dosage, older age, hypertension, higher baseline HR, and higher BMI were identified as independent predictors. These findings reinforce the importance of individualized preoperative risk assessment, careful intrathecal anesthetic administration, and vigilant intraoperative haemodynamic monitoring to support safer anesthetic management.

CONCLUSION

Intraoperative hypotension occurred in 35.0% of adults undergoing elective surgery under spinal anesthesia, highlighting its considerable frequency in the participating tertiary-care hospitals. Higher sensory block level, lower baseline systolic blood pressure, higher intrathecal bupivacaine dosage, older age, hypertension, higher baseline heart rate, and increased BMI were identified as independent predictors. These findings emphasize the importance of comprehensive preoperative assessment, careful selection of intrathecal anesthetic dosage, and vigilant intraoperative haemodynamic monitoring. Identifying patients with these risk characteristics may facilitate early recognition and timely management of hypotensive episodes. Further large-scale prospective studies are recommended to validate these predictors and establish standardized strategies for preventing and managing intraoperative hypotension in patients receiving spinal anesthesia.

Ethical Approval

Ethical approval for this multicentre prospective observational study was obtained from the relevant Institutional Review Board/Ethical Review Committee before commencement of the study. The study was conducted in accordance with the ethical principles and guidelines for research involving human participants.

Data Availability

The data analyzed in this study are available from the corresponding author upon reasonable request.

Author Contributions

Conceptualization: Noshin Akram, Shafiq Khan,Sher Shah
Methodology: Sher Shah, Shafiq Khan, Quratulain
Data Collection: Quratulain, Zain ul Abidin
Formal Analysis: Zain ul Abidin, Muhammad Shahab-ud-Din
Writing – Original Draft: Noshin Akram, Quratulain, Sher Shah
Writing – Review & Editing: Shafiq Khan, Muhammad Shahab-ud-Din
All authors reviewed and approved the final manuscript.

Informed Consent

Written informed consent was obtained from all participants before their enrollment in the study. The study objectives and procedures were explained to the participants, and their privacy and confidentiality were maintained throughout the research.

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No.

Conflict of Interest

No.

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Declaration of AI-Assisted Language Editing

Grammarly AI was used for language and grammar correction, while Gemini AI was used for figure generation.

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