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Prevalence, factors associated, and adverse maternal outcomes of spinal induced hypotension among mothers undergoing caesarean section at a tertiary hospital South-Western Uganda

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Abstract

Background Spinal induced Hypotension during caesarean section remains common and is a serious complication which may lead to serious outcomes like cardiac arrest, morbidity and mortality. The study aimed to determine the prevalence of, factors associated with, and adverse maternal outcomes of spinal-induced hypotension following caesarean section at Mbarara Regional Referral Hospital.

Methods and materials A hospital based cross-sectional study at Mbarara Regional Referral Hospital for the period of August 2022 to October 2022 was conducted on 394 mothers who underwent spinal anaesthesia during caesarean section. Systematic random sampling was used where we enrolled each second woman who had been delivered by caesarean section under spinal anaesthesia. Participant socio-demographic, baseline clinical, obstetric characteristics, intraoperative data and anaesthetic characteristics were obtained from the participant's medical record. The prevalence of spinal-induced hypotension was the proportion of women with spinal-induced hypotension. Logistic regression analysis was used to determine the factors associated with spinal-induced hypotension. The adverse maternal outcomes of spinal-induced hypotension were reported as proportions and frequencies. The level of significance was set at 5%.

Results Participants had a mean age of 26.71 ± 5.7 years and most women were multigravida (II-IV). The prevalence of spinal-induced hypotension was 67.5% (95% CI 62.7–71.9). At multivariable logistic regression, having a spinal block height proximal to T6 [aOR 1.92 95% C.I (1.09–3.39), $p=0.024$], being given intrathecal bupivacaine dose above 10 mg [aOR 1.74 95% C.I (1.04–2.89), $p=0.034$], emergency caesarean section [aOR 2.32 95% C.I (1.20–4.46), $p=0.012$], and not receiving a prophylactic vasopressor [aOR 1.66 95% C.I (1.02–2.68), $p=0.039$] were independently associated with Spinal-induced hypotension. Seven of our participants got high spinal.

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Conclusion The prevalence of spinal-induced hypotension among mothers undergoing caesarean section at MRRH is high. We recommend routine administration of prophylactic vasopressor during all caesarean sections and clinicians to recognize these factors associated with spinal induced hypotension.

Keywords Prevalence, Factors, Adverse Maternal Outcomes, Spinal Induced Hypotension Mothers, Caesarean Section, Mbarara Regional Referral Hospital, Uganda

Background

Spinal-Induced Hypotension (SIH) is defined as a decrease in systolic blood pressure greater than 20% from the baseline following administration of spinal anaesthesia [1, 2]. It is the most common side effect of spinal anaesthesia during surgery [3]. Spinally administered local anesthetics induce a vasomotor sympathectomy, resulting in decreased systemic vascular resistance (SVR) and redistributed blood volume to the splanchnic and lower extremity circulations leading to a drop in blood pressure [4, 5].

Caesarean section is the most common major operation carried out globally, accounting for about 22.9% of deliveries [6]. The picture remains the same in the Africa 7.3% [7] and 11.8% in Uganda [8]. Mbarara Regional Referral Hospital in particular, reports a higher caesarean section rate of 40% [9]. Globally, Spinal anaesthesia is the commonest anaesthetic technique used for caesarean Sect [10]. In Africa, 95.2% of caesarean delivery are done under spinal anaesthesia [11]. It is the preferred method of anaesthesia for women undergoing caesarean delivery over general anaesthesia due to its relative ease of administration, safety and faster onset of action [12].

SIH is a common physiological complication with an incidence ranging from 25 to 75% among general population, and a little higher in patients undergoing caesarean section [13]. The global prevalence of spinal-induced hypotension among women undergoing spinal anaesthesia for caesarean section has been found to range from 7.4 to 74% [14]. Pregnant women are at an increased risk of developing SIH compared to non-obstetric patients because of the aortocaval compression from the gravid uterus and the vasodilation from the placental hormones (relaxin and progesterone) ([10, 15]. At Siriraj hospital, Mahidol University in Thailand, the prevalence of SIH among women undergoing spinal anaesthesia for caesarean section was 65.1% [16]. A study done in Ethiopia found a prevalence of 64% among women undergoing spinal-anaesthesia for caesarean section [17].

Spinal-induced hypotension affects both mother and fetus. Effects to the mother include nausea and vomiting, light-headedness, shivering, high spinal, cardiac arrest and death [18]. Due to uterine hypoperfusion, the fetus is predisposed to hypoxia which may lead to fetal acidosis and birth asphyxia [19].

Vasopressors are part of the armamentarium in the management of spinal-induced hypotension and they

comprise of phenylephrine, ephedrine, adrenaline and noradrenaline [20]. Phenylephrine is the most preferred drug for managing spinal anaesthesia related hypotension in caesarean delivery and does not cross the placenta hence better fetal outcomes [21].

Several factors have been associated with Spinal-induced hypotension for example newborn weight ≥ 4 kg, the time interval between spinal induction and skin incision > 6 min, anaesthesia provider experience, baseline systolic blood pressure less than 120 mmHg and sensory block height greater than T6 [17]. There is paucity of data in Uganda about SIH during caesarean sections as well as other operations done under spinal anaesthesia.

Caesarean section is the most common operation done at MRRH and majority of these cases are performed under spinal anaesthesia. During the caesarean section, some mothers get SIH which may lead to serious adverse outcomes like cardiac arrest and death. From hospital record review for the period of August to October 2020, 900 out of the 928 caesarean Sect. (97%) were done under spinal anaesthesia. Out of these 900 mothers, 3 mothers experienced cardiac arrest and were resuscitated however one mother died on table while the other two mothers were admitted to ICU for mechanical ventilation and later discharged with neurological sequelae.

Despite these observed undesirable effects of SIH, the proportion of mothers who develop SIH and which mothers are likely to develop SIH has not been documented. Therefore, this study seeks to determine the prevalence of, factors associated with, and the adverse maternal outcomes of SIH following caesarean section at MRRH.

Methods and materials

Study design

This was a hospital based cross sectional study among women who were delivered by caesarean section at Mbarara Regional Referral Hospital.

Study site

The study was conducted from August 2022 to October 2022 at Post Anaesthesia Care Unit of Mbarara Regional Referral Hospital operating theatre. MRRH is located in Mbarara City, 260 km southwest of Uganda's capital Kampala. The hospital serves the following districts; Buhweju, Bushenyi, Ibanda, Isingiro, Kazo, Kiruhura, Mitooma, Ntungamo, Rubirizi, Rwampara, Sheema and

Mbarara city. It also receives patients from the neighboring districts of Lyantonde, Kabale and Fort Portal, and neighboring countries of Burundi, Democratic Republic of Congo (DRC), Rwanda and Tanzania. MRRH is the teaching hospital for Faculty of Medicine Mbarara University of Science and Technology, and other health training institutions, such as Bishop Stuart University and Mayanja Memorial Training Institute.

Different specialized services are provided in the medical disciplines of Anaesthesia and critical care, Internal medicine, Obstetrics and Gynecology, Pediatrics and Surgery. The caesarean section services are done in the operating theatre of MRRH.

The operating theatre has 4 operating rooms numbered 1 to 4. Caesarean sections are done majorly in rooms 1 and 2. The department of Anaesthesia and Critical Care has 6 qualified Anaesthesiologists, 9 Senior Nursing Officers and 3 anaesthetic officers who are responsible for anaesthesia services of mothers undergoing caesarean deliveries.

From the operating theatre records of MRRH, about 300 mothers are operated monthly due to caesarean delivery, more than 90% being emergency operations. About 12 mothers are done caesarean operation on a daily basis.

The common anaesthetic technique used for these mothers is spinal anesthesia. After the operation, mothers are taken to Post Anaesthesia Care Room (PACU) which is located within the operating theatre of MRRH from where they are monitored until when haemodynamically stable before being transferred to maternity ward. PACU has 4 functional beds. While in PACU, these mothers are monitored by residents in department of Anaesthesia and Critical care who are usually on a weekly rotational schedule with in PACU. Mothers who get transferred to Intensive Care Unit (ICU) are those who remain haemodynamically unstable following antepartum haemorrhage, post-partum haemorrhage, ruptured uterus or an anaesthesia related complication.

Study population

All women delivered by caesarean section under spinal anaesthesia.

Eligibility criteria

Inclusion criteria

All women who had caesarean section under spinal anaesthesia.

Exclusion criteria

Mothers who had combined modes of anaesthesia; that was both spinal and general anaesthesia.

Patient who received sedation on top of spinal anaesthesia in order to complete the caesarean section.

Sample size

Sample size calculation was done using Kish Leslie formula for proportion.

$N = Z^2 p (1-p) / d^2$. N is the required sample size. Z is the cut off points along the X-axis of the standard normal probability distribution that represents probabilities matching the 95% confidence interval (1.96). p = Proportion of mothers undergoing caesarean delivery who develop spinal anesthesia induced hypotension = 0.64. This prevalence was picked from a similar study done at Gandhi Memorial Hospital Addis Ababa, Ethiopia [17]. $(1-p) = 1-0.64 = 0.36$, d is precision of study set at 0.05. Thus upon replacement of the appropriate values in the formula, the sample size was calculated as; Sample size $N = ((1.96)^2 \times 0.64 \times 0.36) / 0.0025 = 354$ mothers undergoing caesarean deliveries. Adding a 10% non-response group = $354 / (1-0.1) = 394$. The sample size came to 394 mothers undergoing caesarean deliveries. For the sample size calculation for factors associated with SIH, we used openepi software [22]. We considered a cross sectional study done at Gandhi Memorial Hospital, Ethiopia among women undergoing caesarean section under spinal anaesthesia [17]. In this study, the proportion of mothers who had hypotension was 50.5% and 77.4% in those with a sensory height block below T6 and above T6 respectively. Taking mothers with a sensory height block above T6 as the exposed group, and assuming 95% confidence level and statistical power of 80%, we obtained 112 participants as per the above openepi output. Since this calculated sample size was lower than the one obtained for prevalence, we therefore used the larger sample size which is 394.

Sampling method

Systematic random sampling was used where each second woman delivered by caesarean section at Mbarara Regional Referral Hospital until required sample size was reached.

On average, about 300 caesarean section are conducted at MRRH per month. Using the month of August 2020 theatre record, there were 309 patients delivered by caesarean section. In a period of 3 months = $3 \times 309 = 927$ women.

Required number of participants = 394.

Sampling interval (k) = $927 / 394$.

$k = 2.35$.

We therefore enrolled each second woman who delivered by caesarean section under spinal anaesthesia.

If the second mother was an exclusion, we enrolled the immediate next mother, thereafter maintain every 2 mother.

Study variables

The dependent variable was spinal induced hypotension (SIH) which was calculated by getting a percentage drop in SBP (baseline SBP- lowest SBP intraoperatively) $\times$ 100 divided by baseline SBP. Participants who had less than 20% drop in SBP were considered not having SIH and those who had more than 20% drop in SBP were considered to have SIH.

The independent variables included;

- Socio-demographic factors such as age, area of residence, level of education.
- Pre-surgical factors such as baseline systolic blood pressure and baseline pulse rate.
- Intraoperative factors such as newborn weight, estimated blood loss, route and dose of oxytocin given.
- Obstetric factors such as gravidity, urgency of caesarean section, referral status, and preeclampsia.
- Anaesthesia factors such as dose of intrathecal bupivacaine given, level of spinal anaesthetic given, spinal block height, prophylactic vasopressor, time interval from spinal induction to the lowest SBP recorded intra-operatively.

Data collection tool

The data tool used in this study was developed after an extensive literature of published related studies done elsewhere [23–28]. The tool consisted of 22 items. The developed tool was reviewed by content experts from Anesthesiology and obstetrics. In regards to the psychometric properties, the content validity index from the experts review was 0.87. In regards to the reliability, the coefficient of reliability or Cronbach's alpha was 0.761 up on piloting at Masaka Regional referral Hospital, a similar setting like that of the study hospital. The tool captured the participants' information right from maternity ward and continued to theatre. The data captured in maternity ward included but not limited to: date and time on which the caesarean section has been sanctioned, age of the participant, ASA status, referral status, type and time last oral intake, maternal weight, height, and body mass index, baseline vital parameters including blood pressure, mean arterial pressure, oxygen saturation, pulse rate, respiratory rate and fetal heart rate, maternal history including previous surgeries, gravidity, indications for caesarean sections, duration of labour among others. Theatre information captured included baseline physiological vital parameters, premedications given, level of spinal anaesthetic given, height of spinal anaesthetic blockade, intraoperative physiological vital parameters, among others. The data collection tool has been uploaded in the supplementary file.

Data collection procedure

Following a decision for caesarean section, patient got consented for an operation. The clinicians (Specialists, residents and intern doctors in the department of obstetrics and gynecology and anaesthesia providers) were continuously reminded to record the clinical information of interest in the patient clinical charts such that there was no missing data. This information is routinely captured during the care of the patients.

The clinicians recorded the following information; date and time on which caesarean section was sanctioned, age of the patient, urgency of the caesarean section (emergency or elective), the American Society of Anaesthesiologists (ASA) classification 2 or 3; where ASA 2 was a patient with mild systemic disease for which pregnancy status assumes and ASA 3 was a patient with severe systemic disease for example mothers who had preeclampsia. Obstetric clinicians also noted whether a mother had been referred or not, maternal vitals (BP, PR, SPO₂), fetal heart rate, gravidity, parity, indication for caesarean section.

The spinal anaesthesia was conducted by different anaesthesia providers of different cadres (anaesthesia residents, bachelors students and anaesthetic officers). Basic monitors were attached to the mother; the anaesthesia providers explained the technique of spinal anaesthesia. Mother in a sitting up position; aseptic technique observed, local anaesthetic given at L3/L4 or L4/L5 levels of lumbar space depending on the anaesthesia provider, a 25 gauge quincke spinal needle was used, a mixture of 0.5% heavy bupivacaine and intrathecal morphine 100mcg were given, mothers were placed in a supine then lateral tilt position after the conduction of the spinal block.

While in the operating room, the anaesthesia providers recorded the following information in the anaesthesia charts; baseline vitals (BP, HR, SPO₂, RR) and time when they were taken, any premedications given (antibiotics or anti emetics), Cadre of the anaesthesia provider, the level of spinal anaesthetic injection, dose of spinal anaesthetic and time at which it was given, dose of intrathecal opioid given, whether spinal anaesthetic was repeated and with how much, height of spinal of anaesthesia block, intraoperative patient vitals which were recorded every after 2.5 min for 45 min, the lowest SBP intraoperatively, time at which the lowest SBP was recorded, time interval between spinal anaesthesia induction to when the lowest SBP was recorded or observed, incision time, time of delivery of the baby, weight of the baby, time interval between spinal puncture and delivery, total volume of fluids given intra operatively, maternal spinal anaesthetic side effects, need for oxygen and reason for addition of oxygen to the patient, maternal spinal anaesthesia complications, prophylactic vasopressor given and which vasopressor was given. Total amount of oxytocin,

estimated blood loss, end of surgery time, duration of caesarean operation.

Following completion of surgery, mothers were taken to the Post Anaesthesia Care Unit (PACU) or to the waiting area with their charts. The research assistants came to study these participants while they were in the PACU or waiting area, and only those who had received spinal anaesthesia for caesarean section were enrolled. Once a patient was due to be discharged to the ward, we approached them and consented them for our study. We decided to consent our participants after surgery because majority of them were in labor contracting and experiencing pain hence would be perceived as coercion. Participants' information of interest was collected before and during surgery and was explained to them. We consented and enrolled every second woman who had been delivered by caesarean section under spinal anaesthesia. Data was then entered in the pretested questionnaire Fig. 1.

Data quality assurance

A questionnaire was designed, tested and used to collect data on the prevalence, associated factors and adverse maternal outcomes among mothers who had caesarean delivery under spinal anaesthesia at MRRH.

The consent form was translated in to the local languages (Runyankole/Rukiga) to ensure uniformity during data collection.

Calibrated the patient monitors in theatre at the start of the research.

To ensure quality of data, research assistants were selected from the health workers that was: midwives and theatre assistants and trained on data collection.

In the operating theatre, two nurses on rotational schedules for both day and night to ensure adequate capture information of interest in the patient's charts into a pretested questionnaire.

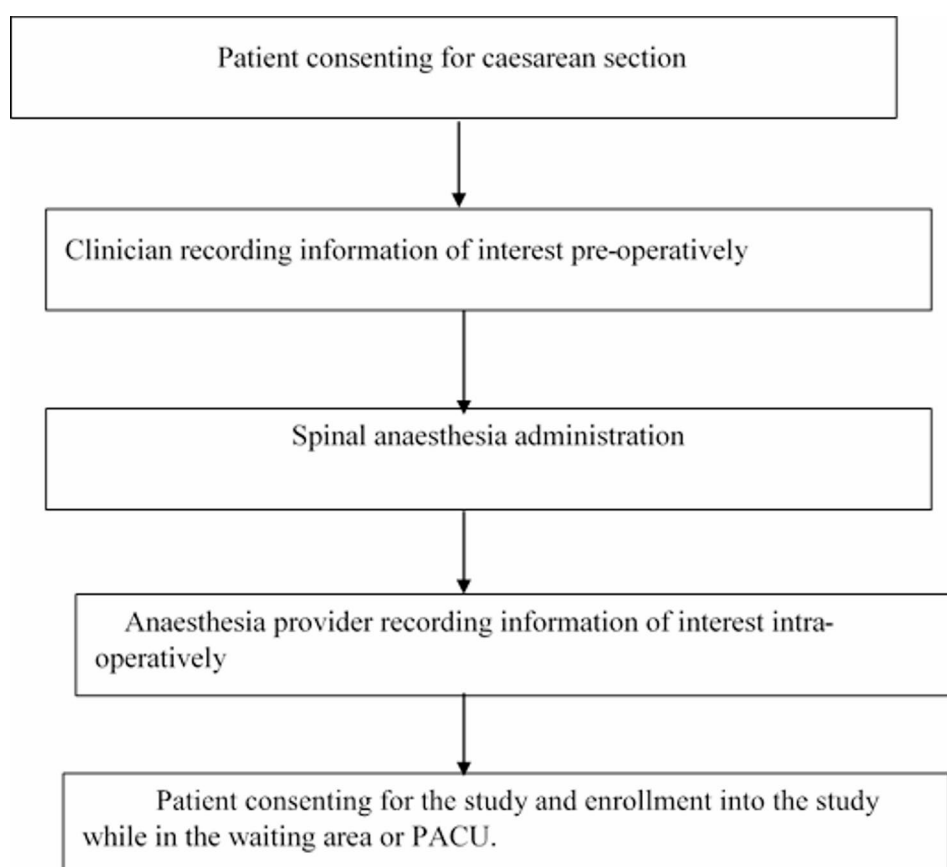


Fig. 1 Study flow diagram: Following completion of surgery, mothers were taken to the Post Anaesthesia Care Unit (PACU) or to the waiting area with their charts. The research assistants came to study these participants while they were in the PACU or waiting area, and only those who had received spinal anaesthesia for caesarean section were enrolled. Once a patient was due to be discharged to the ward, we approached them and consented them for our study. We decided to consent our participants after surgery because majority of them were in labor contracting and experiencing pain hence would be perceived as coercion. Participants' information of interest was collected before and during surgery and was explained to them. We consented and enrolled every second woman who had been delivered by caesarean section under spinal anaesthesia. Data was then entered in the pretested questionnaire

Data management and statistical analysis

Data completeness was checked by reviewing the filled questionnaires and use of database prompts during entry. Data was entered using Redcap software and later exported to STATA version 15 for data cleaning and analysis.

Data was described using descriptive statistics. Categorical variables were presented as proportions while continuous variables were summarized by means and standard deviations. The prevalence of SIH among women delivered by caesarean section under spinal anaesthesia was calculated as the number of women with SIH expressed as percentage of the total participants. The prevalence was reported with its 95% confidence interval. The factors associated with SIH among women delivered by caesarean section under spinal anaesthesia, we used binary logistic regression analysis to evaluate associations between independent variables and the dependent variable. Variables with a p -value < 0.2 at binary logistic regression model and those that were biologically plausible were entered into a final multivariable logistic regression model. Those variables with a p -value < 0.05 at this level were considered significant. Odds ratios, 95% confidence intervals and p -values were obtained. The adverse maternal outcomes of SIH among women delivered by caesarean section under spinal anaesthesia at MRRH were obtained and reported as proportions and frequencies.

Results

Socio-demographic characteristics of participants

The study enrolled 394 women undergoing caesarean section under spinal anaesthesia. The mean age was 26.7 ± 5.7 years, with the majority (79.7%) aged between 20 and 34 years. Most participants were classified as ASA II (95.7%), while 56.3% had been referred from peripheral health facilities. There were no statistically significant differences in age, ASA classification, or referral status

between women who developed spinal-induced hypotension and those who did not ($p > 0.05$). The socio-demographic characteristics are summarized in Table 1.

Obstetric characteristics of participants

Most participants were multigravida (59.9%) and had singleton pregnancies (97.5%). Emergency caesarean sections accounted for the majority of procedures (87.6%), while 34.0% of women had a previous caesarean delivery. Most mothers experienced blood loss below 500 mL (93.4%) and delivered neonates weighing between 2.5 and 3.9 kg (84.0%). Among the obstetric variables assessed, only the urgency of caesarean section was significantly associated with spinal-induced hypotension, with emergency procedures occurring more frequently among women who developed hypotension (90.6% versus 81.3%, $p = 0.008$), Table 2.

Participants' baseline and intraoperative variables

Women who developed spinal-induced hypotension had significantly higher baseline systolic blood pressure, diastolic blood pressure, and mean arterial pressure compared with those who did not develop hypotension (all $p < 0.001$). They also experienced significantly lower intraoperative systolic and diastolic blood pressures. Furthermore, the mean time from spinal induction to the occurrence of the lowest systolic blood pressure was shorter among women who developed hypotension compared to those who did not (13.1 versus 17.8 min, $p < 0.001$), Table 3.

Systolic blood pressure at baseline and at the lowest intraoperative systolic blood pressure

The mean baseline SBP for participants with SIH was 124mmHg whereas those without SIH was 112mmHg. The mean lowest SBP for participants with SIH was 81mmHg whereas those without SIH was 100mmHg, Fig. 2.

Table 1 Socio demographic characteristics of participants

Characteristics	Overall N=394 n/N (%)	No SIH N=128 n/N (%)	SIH N=266 n/N (%)	p-value
Age(years), Mean ($\pm$ S.D)	26.71(5.68)	26.44(5.49)	26.84(5.78)	0.520
Age categories (years)				0.560
<20	37 (9.4%)	10 (7.8%)	27 (10.2%)	
20-34yrs	314 (79.7%)	106 (82.8%)	208 (78.2%)	
≥ 35 years	43 (10.9%)	12 (9.4%)	31 (11.7%)	
ASA status				0.061
2	376 (95.7%)	126 (98.4%)	250 (94.3%)	
3	17 (4.3%)	2 (1.6%)	15 (5.7%)	
Referral status				0.530
Yes	222 (56.3%)	53 (41.4%)	119 (44.7%)	
No	172 (43.7%)	75 (58.6%)	147 (55.3%)	

Table 2 Obstetric characteristics of participants

Characteristics	Overall No	SIH	SIH	p-value
	N = 394	N = 128	N = 266	
	n/N (%)	n/N (%)	n/N (%)	
Gravidity				0.760
Primigravida (I)	102 (25.9%)	35 (27.3%)	67 (25.2%)	
Multigravida (II-IV)	236 (59.9%)	77 (60.2%)	159 (59.8%)	
Grand gravid (≥ IV)	56 (14.2%)	16 (12.5%)	40 (15.0%)	
Multiple pregnancy				0.060
No	384 (97.5%)	122 (95.3%)	262 (98.5%)	
Yes	10 (2.5%)	6 (4.7%)	4 (1.5%)	
Indications of caesarean section				0.042
Previous caesarean section	134 (34.0%)	46 (35.9%)	88 (33.1%)	
Obstructed/prolonged labor	32 (8.1%)	13 (10.2%)	19 (7.1%)	
Contracted pelvis	91 (23.1%)	26 (20.3%)	65 (24.4%)	
Big baby	43 (10.9%)	9 (7.0%)	34 (12.8%)	
Preeclampsia/eclampsia	18 (4.6%)	2 (1.6%)	16 (6.0%)	
Multiple pregnancy	10 (2.5%)	6 (4.7%)	4 (1.5%)	
Others	66 (16.8%)	26 (20.3%)	40 (15.0%)	
Urgency of caesarean section				0.008*
Elective	49 (12.4%)	24 (18.8%)	25 (9.4%)	
Emergency	345 (87.6%)	104 (81.3%)	241 (90%)	
Estimated blood loss (in millilitres)				0.810
< 500mls	368 (93.4%)	119 (93.0%)	249 (93.6%)	
≥ 500mls	26 (6.6%)	9 (7.0%)	17 (6.4%)	
Weight of delivery of the baby (in kg)				0.600
< 2.5	41 (10.4%)	14 (10.9%)	27 (10.2%)	
2.5–3.9	331 (84.0%)	109 (85.2%)	222 (83.5%)	
≥ 4.0	22 (5.6%)	5 (3.9%)	17 (6.4%)	

Table 3 Participants baseline and intraoperative variables

Characteristic	Overall	No SIH	SIH	p-value
	N = 394	N = 128	N = 266	
	n/N (%)	n/N (%)	n/N (%)	
Baseline vitals				
Systolic BP (mmHg) mean (± S.D)	120.55 (15.13)	112.65 (16.64)	124.36 (12.77)	< 0.001*
Diastolic BP (mmHg) mean (± S.D)	76.45 (11.21)	72.32 (10.23)	78.44 (11.15)	< 0.001*
Mean arterial pressure (mmHg) mean (± S.D)	91.03 (12.59)	86.64 (11.76)	93.15 (12.45)	< 0.001*
Oxygen saturation (%) mean (± S.D)	97.89 (2.56)	97.58 (3.71)	98.05 (1.74)	0.087
Pulse rate (bpm) mean (± S.D)	89.25 (13.47)	88.87 (11.86)	89.44 (14.20)	0.700
Respiratory Rate (bpm) mean (± S.D)	18.54 (1.69)	18.41 (1.57)	18.61 (1.74)	0.270
Intraoperative vital signs				
Lowest systolic BP (mmHg) mean (± S.D)	129.31 (17.46)	100.01 (11.30)	81.51 (12.15)	< 0.001*
Lowest diastolic BP (mmHg) mean (± S.D)	80.76 (14.85)	54.07 (14.10)	44.30 (10.133)	< 0.001*
Heart rate (bpm) mean (± S.D)	97.28 (15.60)	95.99 (15.31)	97.89 (15.73)	0.260
Oxygen saturation (%) mean (± S.D)	98.11 (4.88)	98.16 (2.86)	98.09 (5.60)	0.900
Respiratory Rate (bpm) mean (± S.D)	18.71 (5.14)	18.26 (1.62)	18.93 (6.14)	0.220
Time interval between spinal induction to the lowest SBP recorded intraoperatively (mins) mean (± S.D)		17.78 (14.52)	13.10 (11.27)	< 0.001*

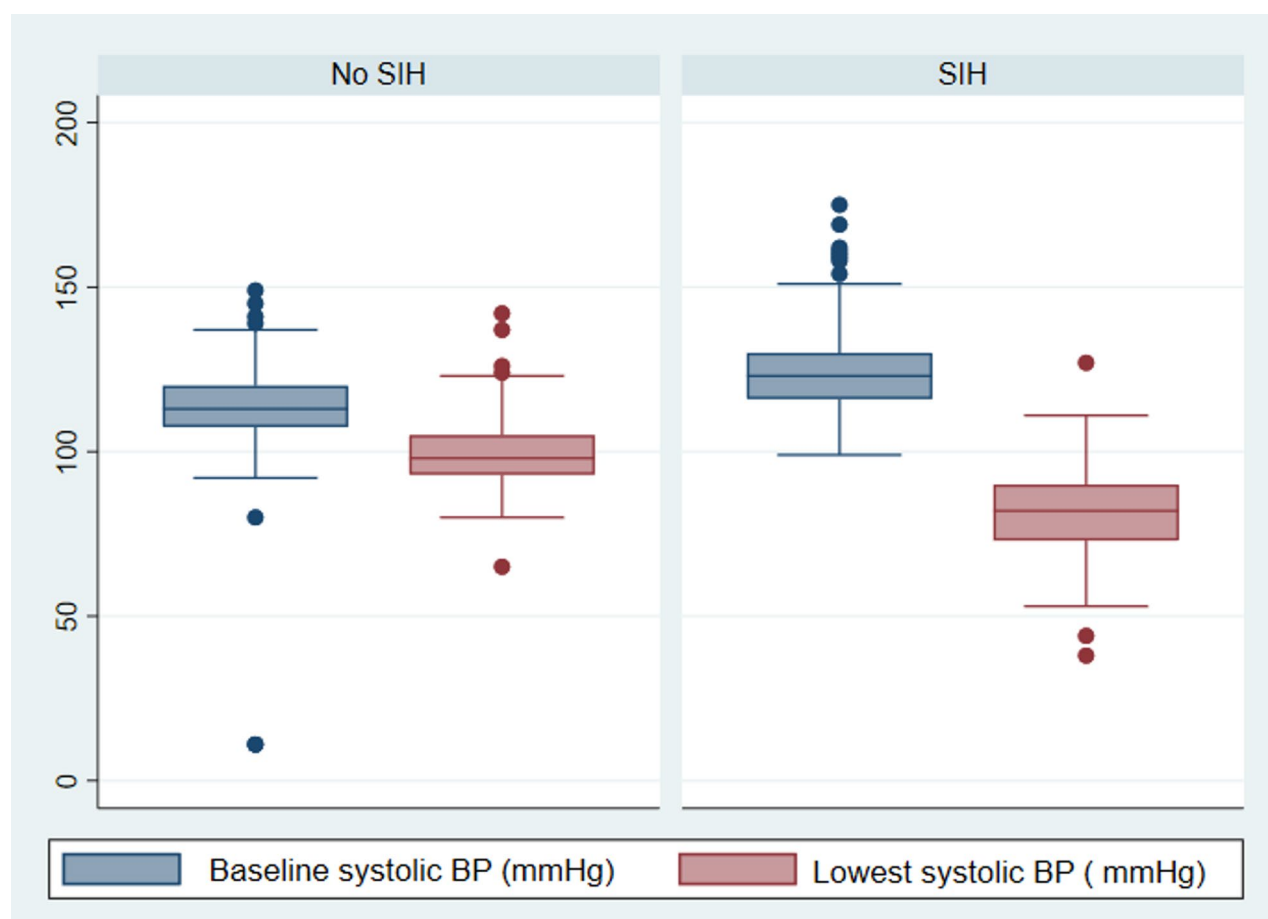


Fig. 2 Box plot of systolic blood pressure at baseline and at the lowest intra-operative systolic blood pressure

Diastolic blood pressure at baseline and at the lowest intra-operative diastolic blood pressure

The mean baseline DSB for participants with SIH was 78.44mmHg whereas those without SIH was 72.32mmHg. The mean lowest DBP for participants with SIH was 44.30mmHg whereas those without SIH was 54.07mmHg Fig. 3.

Anaesthesia factors of participants

Anaesthetic officers administered spinal anaesthesia in the largest proportion of participants (39.1%), and the L3/L4 interspace was the most commonly used site for spinal injection (62.9%). Most women received 10 mg of intrathecal bupivacaine (62.7%), 100 µg of intrathecal morphine (95.7%), and one litre of intravenous fluid intraoperatively (54.6%). Women with a spinal block height proximal to T6 were significantly more likely to develop spinal-induced hypotension compared with those whose block remained below T6 (30.5% versus 16.4%, $p=0.003$). Similarly, hypotension occurred more frequently among women receiving bupivacaine doses greater than 10 mg and among those who did not receive prophylactic vasopressors, Table 4.

Prevalence of spinal induced hypotension

Out of the 394 participants recruited, 266 had SIH giving us the prevalence of 67.51% (95% CI 62.7–71.9) as shown in Fig. 4.

Socio-demographic and obstetric factors associated with spinal-induced hypotension following caesarean section at Bivariate analysis

At bivariate analysis, emergency caesarean section was the only socio-demographic or obstetric factor significantly associated with spinal-induced hypotension. Women undergoing emergency caesarean section had more than twice the odds of developing hypotension compared with those undergoing elective procedures (cOR=2.22, 95% CI: 1.21–4.08, $p=0.010$). No significant associations were observed for age, referral status, gravidity, multiple pregnancy, estimated blood loss, or neonatal birth weight Table 5.

Anaesthesia factors associated with spinal-induced hypotension following caesarean section at bivariate analysis

Several anaesthesia-related factors were significantly associated with spinal-induced hypotension at

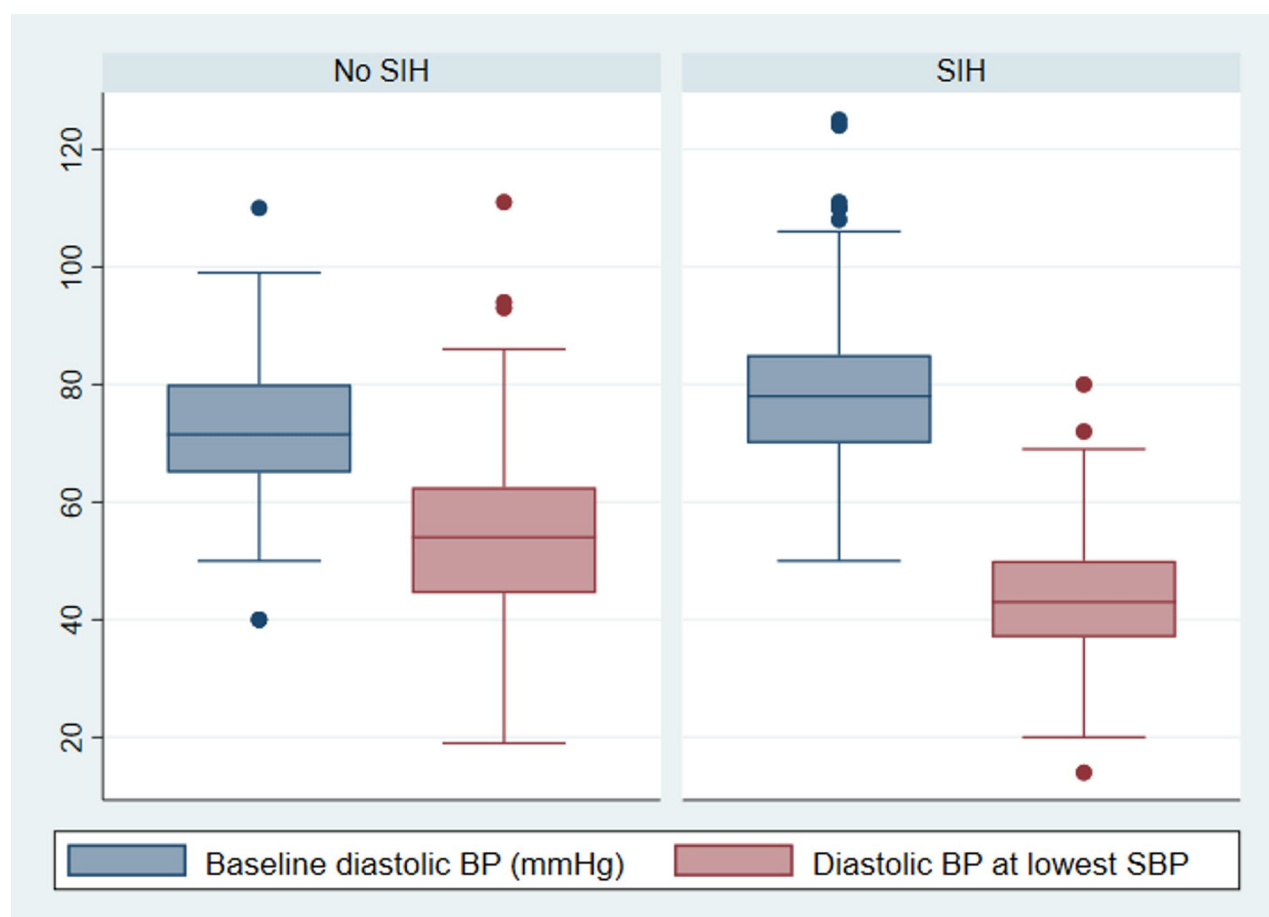


Fig. 3 Box plot of diastolic blood pressure at baseline and at the lowest intra-operative diastolic blood pressure

bivariate analysis. A spinal block height proximal to T6 increased the odds of hypotension by more than two-fold ($cOR=2.23$, 95% CI: 1.31–3.81, $p=0.003$). Women receiving intrathecal bupivacaine doses greater than 10 mg were more likely to develop hypotension ($cOR=1.56$, 95% CI: 0.99–2.44, $p=0.034$), while the absence of prophylactic vasopressor administration increased the odds of hypotension by 60% ($cOR=1.60$, 95% CI: 1.04–2.48, $p=0.033$). Other anaesthesia-related variables were not significantly associated with hypotension, Table 6.

Factors associated with spinal induced hypotension at multivariable logistic

After adjustment for potential confounding factors, four variables remained independently associated with spinal-induced hypotension. Women with a spinal block height proximal to T6 had nearly twice the odds of developing hypotension ($aOR=1.92$, 95% CI: 1.09–3.39, $p=0.024$). Administration of intrathecal bupivacaine doses greater than 10 mg was associated with a 74% increase in the odds of hypotension ($aOR=1.74$, 95% CI: 1.04–2.89, $p=0.034$). Emergency caesarean section increased the likelihood of hypotension more than two-fold

($aOR=2.32$, 95% CI: 1.20–4.46, $p=0.012$), while failure to administer a prophylactic vasopressor increased the odds by 66% ($aOR=1.66$, 95% CI: 1.02–2.68, $p=0.039$), Table 7.

Side effects and adverse maternal outcomes of spinal-induced hypotension

Among the 266 women who developed spinal-induced hypotension, shivering was the most frequently reported side effect occurring in 162 participants (60.9%), followed by nausea in 46 participants (17.3%), vomiting in 36 participants (13.5%), light-headedness in 20 participants (7.5%), and bradycardia in 4 participants (1.5%). Regarding serious maternal adverse outcomes, seven women (2.6%) developed high spinal anaesthesia. No participant experienced total spinal anaesthesia or cardiac arrest, Table 8.

Discussion

In this study, the prevalence of SIH was 67.5% and the factors associated with SIH were emergency caesarean delivery, sensory block height higher than T6, not receiving a prophylactic vasopressor and receiving intrathecal

Table 4 Anaesthesia factors of participants

Characteristics	Overall N = 394 n/N (%)	No SIH N = 128 n/N (%)	SIH N = 266 n/N (%)	p-value
Cadre of anaesthesia provider				0.100
Anaesthesia Resident	115 (29.2%)	39 (30.5%)	76 (28.6%)	
Bachelors Anaesthesia student	125 (31.7%)	48 (37.5%)	77 (28.9%)	
Anaesthetic officer	154 (39.1%)	41 (32.0%)	113 (42.5%)	
Level of spinal anaesthetic injection				0.210
L5/S1	5 (1.3%)	3 (2.3%)	2 (0.8%)	
L4/L5	130 (33.0%)	48 (37.5%)	82 (30.8%)	
L3/L4	248 (62.9%)	75 (58.6%)	173 (65.0%)	
L3/L2	11 (2.8%)	2 (1.6%)	9 (3.4%)	
Dose of intrathecal bupivacaine administered (in mg)				0.051
10.0 mg	247 (62.7%)	89 (69.5%)	158 (59.4%)	
> 10.0	147 (37.3%)	39 (30.5%)	108 (40.6%)	
Intrathecal opioid to the Spinal anaesthetic (in mcg)				0.830
0	10 (2.5%)	8 (6.2%)	2 (1.8%)	
50	5 (1.3%)	4 (3.1%)	1 (0.4%)	
100	377 (95.7%)	115 (89.8%)	262 (98.5%)	
150	2 (0.8%)	1 (0.9%)	1 (0.4%)	
Repeat spinal anaesthesia				0.560
No	387 (98.2%)	125 (97.6%)	262 (98.4%)	
Yes	7 (1.8%)	3 (2.4%)	4 (1.6%)	
Spinal block height				0.003
Proximal to T6	102 (25.9%)	21 (16.4%)	81 (30.5%)	
Caudal to T6	292 (74.1%)	107 (83.7%)	185 (69.5%)	
Spinal anaesthesia to delivery interval (minutes)				0.780
≤ 5	11 (2.8%)	4 (3.1%)	7 (2.6%)	
> 5	383 (97.2%)	124 (96.9%)	259 (97.4%)	
Total amount of oxytocin given (IU)				0.370
10	364 (92.4%)	120 (93.8%)	244 (91.7%)	
20	26 (6.6%)	6 (4.7%)	20 (7.5%)	
25	4 (1.1%)	2 (1.6%)	2 (0.8%)	
Fluid given intra-operatively (litres)				0.640
1	215 (54.6%)	67 (52.3%)	148 (55.6%)	
2	114 (28.9%)	41 (32.0%)	73 (27.4%)	
> 2	65 (16.5%)	20 (15.6%)	45 (16.9%)	

bupivacaine dose greater than 10 mg. High spinal was the only adverse maternal outcome in our participants.

The prevalence of spinal-induced hypotension following caesarean section under spinal anaesthesia at Mbarara Regional Referral Hospital is 67.5%. This prevalence is higher than what was found in a study conducted at University of Gondar, Northwest, Ethiopia which was 56.8% [24]. Our prevalence was lower compared to a study conducted at Siriraj Hospital, Mahidol University which was 76.7% [29]. This could be explained by the fact that we recruited both elective and emergency caesarean cases in our study whereas in the Ethiopian study they only recruited emergencies. Emergency caesarean mothers experience a lot of labor pains and are more anxious compared to elective mothers. There is also lack of labour analgesia at Mbarara Regional Referral Hospital.

Anxiety and labor pains are known to cause generalized sympathetic activation which increases heart rate and women with higher levels of sympathetic activation are more likely to have hypotension after induction of spinal anesthesia [30]. Emergency caesarean mothers also labour for quite long period of time with minimal or no oral fluid intake making them dehydrated which reduces their intravascular fluid volume hence predisposing them more to SIH [31].

Furthermore, the difference could have been due to a difference in the definition of SIH in the two studies. Chumpathong defined SIH as the lowest SBP ≤ 100 mmHg which was higher than what was used in our study.

Regarding factors associated with SIH, The sensory height block higher than T6 resulted in 1.9 times more risk in developing spinal induced hypotension. This

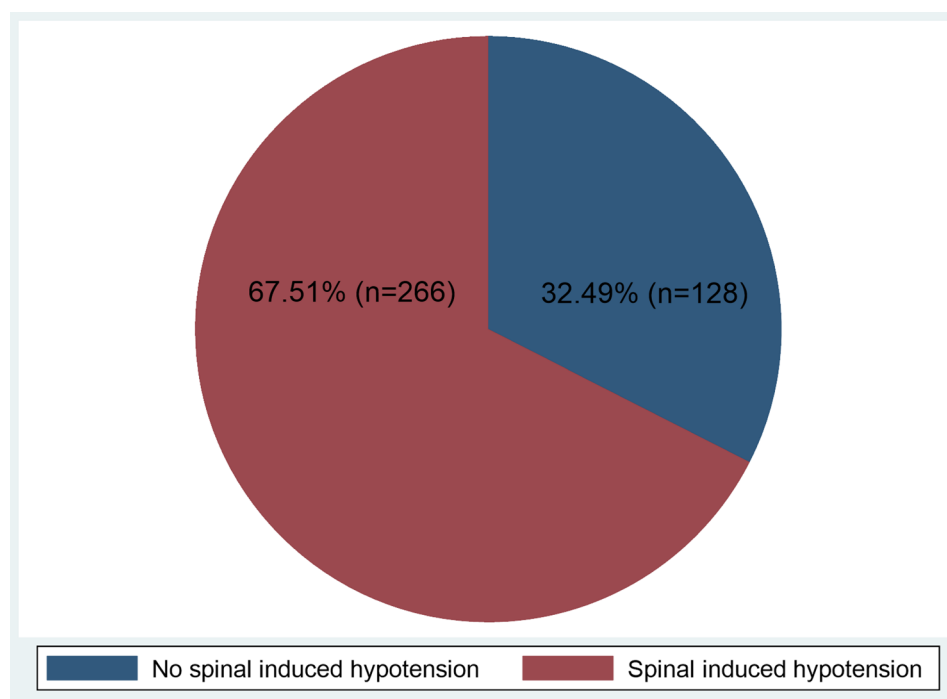


Fig. 4 Pie chart showing the prevalence of spinal induced hypotension

finding agrees with the previous findings in Addis Ababa, Ethiopia at Ghandi Memorial hospital by Tewoderos Shitemaw [23]. Similarly a study from Iran demonstrated that sensory block height greater than T_4 in anaesthesia was significantly associated with hypotension [25].

The possible explanation related to sensory block height is due to blockade of thoracolumbar fibres to the heart and a bigger sympathectomy resulting in more autonomic blockade hence causing hypotension [32]. Furthermore, higher sensory levels of analgesia correlated with a.

Emergency caesarean sections were twice as likely to result in SIH compared to elective procedures in this present study. This finding agrees with the study done at Siriraj Hospital in Bangkok, Thailand [16]. In addition findings from Ethiopia reported the incidence SIH to be high among mothers who underwent emergency caesarean section found at 56.8% (95% CI; 50.2–63.4) [24]. The possible explanation of emergency cases being at more risk of developing spinal induced hypotension could be because these mothers labour for quite long period of time with minimal or no oral fluid intake making them dehydrated which reduces their intravascular fluid volume hence predisposing them more to SIH. Another reason could be due to emergency caesarean delivery mothers have increased anxiety and labor pains which are known to cause generalized sympathetic activation increasing heart rate hence likely to have hypotension after induction of spinal anaesthesia [30].

Receiving intrathecal bupivacaine dose above 10 mg exposed mothers to developing spinal induced hypotension compared to those who received intrathecal bupivacaine dose 10 mg and below. These findings are consistent with those from a retrospective study conducted in Israel where it was demonstrated that Low-dose (≤ 8 mg) hyperbaric bupivacaine for spinal anaesthesia during caesarean delivery results in reduced efficacy, yet as a secondary outcome was associated with reduced frequency of spinal-induced hypotension [33]. The explanation for this observed effect is that Intrathecal bupivacaine dose > 10 mg is associated with more spread of the drug to the higher thoracolumbar fibres causing autonomic blockade hence spinal hypotension [2].

Not receiving a prophylactic vasopressor for prevention of spinal induced hypotension was 1.7 times likely to predispose a mother to developing spinal induced hypotension compared to those who received a prophylactic vasopressor. Though routine, not all mothers received a prophylactic vasopressor. This could be due to stock outs of the available vasopressors in our facility. Our study showed that receiving a prophylactic vasopressor following induction of spinal anaesthesia during caesarean delivery was protective against SIH. The findings of this study on the effect of prophylactic vasopressor is in agreement with those from a narrative review which reported that judicious use of vasopressors like phenylephrine in conjunction with ondansetron, along with lowering the anesthetic dose, can significantly reduce the incidence of SA-induced hypotension and the potential

Table 5 Socio-demographic and obstetric factors associated with Spinal-Induced Hypotension following caesarean section at Bivariate analysis

Variable	No SIH	SIH	Bivariate analysis	p-value
	N = 128	N = 266	cOR (95% C.I.)	
	n/N (%)	n/N (%)		
Age (years)				
< 20	10 (7.8%)	27 (10.2%)	1.38 (0.64–2.95)	0.412
20–34	106 (82.8%)	208 (78.2%)	Ref.	
≥ 35	12 (9.4%)	31 (11.7%)	1.32 (0.65–2.67)	0.445
Referral status				
Yes	53 (41.4%)	119 (44.7%)	1.15 (0.75–1.76)	0.533
No	75 (58.6%)	147 (55.3%)	Ref.	
Gravidity				
Primigravida (I)	35 (27.3%)	67 (25.2%)	0.92 (0.57–1.51)	0.762
Multigravida (II–IV)	77 (60.2%)	159 (59.8%)	Ref.	
Grand gravid (≥ IV)	16 (12.5%)	40 (15.0%)	1.21 (0.64–2.29)	0.558
Multiple pregnancy				
No	122 (95.3%)	262 (98.5%)	Ref.	
Yes	6 (4.7%)	4 (1.5%)	0.31 (0.09–1.12)	0.074
Urgency of caesarean section				
Elective	24 (18.8%)	25 (9.4%)	Ref.	
Emergency	104 (81.3%)	241 (90.6%)	2.22 (1.21–4.08)	0.010*
Estimated blood loss (in millilitres)				
< 500mls	119 (93.0%)	249 (93.6%)	Ref.	
≥ 500mls	9 (7.0%)	17 (6.4%)	0.90 (0.39–2.08)	0.811
Birth weight(kg)				
< 2.5	14 (10.9%)	27 (10.2%)	Ref.	
2.5–3.9	109 (85.2%)	222 (83.5%)	1.06 (0.53–2.09)	0.876
≥ 4.0	5 (3.9%)	17 (6.4%)	1.76 (0.54–5.78)	0.349

cOR crude Odds Ratio, Ref Reference group, CI Confidence Interval

* $p < 0.05$ ** $p < 0.001$

adverse maternal and fetal implications [34]. In addition findings from the United States of America demonstrated that Norepinephrine and epinephrine to be effectiveness in maintaining blood pressure while reducing adverse maternal outcomes following delivery [35]. Furthermore, findings from Pakistan demonstrated that Phenylephrine was the vasopressor of choice for both prophylaxis (33.1%) and treatment (57%) for spinal-induced hypotension for elective caesarean section [36]. The possible explanation for this observed effect of prophylactic vasopressor could be due to a prophylactic vasopressor counteract the sympathectomy caused by spinal anaesthetic drug hence protecting against SIH [37, 38].

On adverse maternal outcomes of spinal-induced hypotension, In our study, 7 of the 266 women who developed spinal-induced hypotension experienced high spinal anaesthesia, representing 2.6% of hypotensive mothers and 1.8% of the overall study population. Although no cases of total spinal anaesthesia or cardiac arrest occurred, the occurrence of high spinal remains clinically important because it can rapidly progress to respiratory compromise, severe haemodynamic instability, and

the need for airway support if not recognized promptly. Furthermore, a substantial proportion of mothers experienced symptoms associated with hypotension including shivering (60.9%), nausea (17.3%), vomiting (13.5%), and light-headedness (7.5%). This could be due to some of our participants got bupivacaine dose of more than 10 mg. Larger doses of bupivacaine are associated with blockade of higher spinal cord fibres hence predisposing a patient to high spinal [39]. None of our participants got cardiac arrest because the anaesthesia providers have done several cases with enough expertise. These findings highlight that even when catastrophic outcomes are uncommon, spinal-induced hypotension contributes significantly to maternal discomfort and may negatively affect the child-birth experience.

The findings of this study have important implications for obstetric anaesthesia practice and maternal safety globally. Spinal anaesthesia remains the preferred anaesthetic technique for caesarean delivery because it avoids airway-related complications associated with general anaesthesia and allows mothers to remain awake during childbirth [21]. However, spinal-induced hypotension

Table 6 Anaesthesia factors associated with Spinal-Induced Hypotension following caesarean section at bivariate analysis

Variable	No SIH	SIH	Bivariate analysis	p-value
	N = 128	N = 266	cOR (95% C.I.)	
	n/N (%)	n/N (%)		
Cadre of anaesthesia provider				
Resident	39 (30.5%)	76 (28.6%)	Ref.	
Bachelors student	48 (37.5%)	77 (28.9%)	0.82 (0.49–1.40)	0.470
Anaesthetic officer	41 (32.0%)	113 (42.5%)	1.41 (0.83–2.39)	0.197
Level of spinal anaesthetic injection				
L5/S1	3 (2.3%)	2 (0.8%)	Ref.	
L4/L5	48 (37.5%)	82 (30.8%)	2.56 (0.41–15.88)	0.312
L3/L4	75 (58.6%)	173 (65.0%)	3.46 (0.57–21.13)	0.179
L2/L3	2 (1.6%)	9 (3.4%)	6.7 (0.64–71.17)	0.112
Spinal block height				
Proximal to T6	21 (16.4%)	81 (30.5%)	2.23 (1.31–3.81)	0.003*
Caudal to T6	107 (83.6%)	185 (69.5%)	Ref.	
Dose of Bupivacaine administered (in mg)				
10.0 mg	89 (69.5%)	158 (59.4%)	Ref.	
> 10.0 mg	39 (30.5%)	108 (40.6%)	1.56 (0.99–2.44)	0.034*
Repeat spinal anaesthesia				
No	125 (97.6%)	262 (98.4%)	Ref.	
Yes	3 (2.4%)	4 (1.6%)	0.64 (0.14–2.91)	0.563
Spinal anaesthesia to delivery interval (minutes)				
≤ 5	4 (3.1%)	7 (2.6%)	Ref.	
> 5	124 (96.9%)	259 (97.4%)	1.19 (0.34–4.15)	0.781
Prophylactic vasopressor				
Yes	55 (43.0%)	85 (32.0%)	Ref.	
No	73 (57.0%)	181 (68.0%)	1.60 (1.04–2.48)	0.033*

cOR crude Odds Ratio, Ref Reference group, CI Confidence Interval

*p < 0.05

**p < 0.001

continues to be one of the most common complications of neuraxial anaesthesia in obstetric practice [21]. International evidence indicates that the incidence of maternal hypotension may range from 50% to 80% in the absence of effective prophylactic measures, making it a persistent challenge even in high-resource healthcare settings [40, 41]. The prevalence of 67.5% observed in our study therefore demonstrates that spinal-induced hypotension remains a substantial patient-safety concern in our setting and is consistent with the burden reported internationally.

The global significance of spinal-induced hypotension extends beyond transient reductions in blood pressure. According to the International Consensus Statement on the Management of Hypotension with Vasopressors during Caesarean Section under Spinal Anaesthesia, maternal hypotension is associated with adverse maternal effects including nausea, vomiting, dizziness, dyspnoea, altered consciousness, and severe cardiovascular instability [40]. The statement further emphasizes that prolonged or severe hypotension may adversely affect uteroplacental perfusion and neonatal well-being, highlighting the importance of early recognition and prevention

[41]. In the present study, a considerable proportion of women who developed hypotension experienced shivering, nausea, vomiting, and light-headedness, supporting the observation that maternal hypotension substantially contributes to perioperative morbidity and maternal discomfort.

The identification of sensory block height above T6 as an independent predictor of spinal-induced hypotension is clinically important. Higher spinal block levels produce more extensive sympathetic blockade, resulting in vasodilation, reduced venous return, and subsequent hypotension. International guidelines recognize extensive sympathetic blockade as one of the principal mechanisms underlying spinal-induced hypotension during caesarean delivery [41]. Therefore, vigilant monitoring of sensory block height and careful titration of spinal anaesthetic agents are essential components of safe obstetric anaesthesia practice.

Our finding that intrathecal bupivacaine doses greater than 10 mg increased the likelihood of hypotension has important implications for clinical practice. Previous studies have demonstrated that larger doses of intrathecal local anaesthetics are associated with greater cephalad

Table 7 Factors associated with spinal induced hypotension at Multivariable Logistic Regression

Characteristics	Bivariate analysis		p-value	Multivariable analysis	
	SIH (N = 266) n/N (%)	cOR (95% CI)		aOR (95% CI)	p-value
Age (years)					
< 20	27 (10.2%)	1.38 (0.64–2.95)	0.412	0.63 [0.28,1.41]	
20–34	208 (78.2%)	Ref.		Ref.	0.263
≥ 35	31 (11.7%)	1.32 (0.65–2.67)	0.445	0.81 [0.28,2.31]	0.692
Gravidity					
I	67 (25.2%)	0.92 (0.57–1.51)	0.762	0.70 (0.39–1.26)	0.234
II–IV	159 (59.8%)	Ref.		Ref.	
≥ V	40 (15.0%)	1.21 (0.64–2.29)	0.558	1.15 (0.57–2.32)	0.695
Type of pregnancy					
Singleton	262 (98.5%)	Ref.		Ref.	
Multiple	4 (1.5%)	0.31 (0.09–1.12)	0.074	0.42 [0.10,1.68]	0.219
Level of spinal anaesthesia					
L5/S1	2(0.8%)	Ref.		Ref.	
L4/L5	82 (30.8%)	2.56 (0.41–15.88)	0.312	2.62 [0.38,17.99]	0.328
L3/L4	173 (65.0%)	3.46 (0.57–21.13)	0.179	3.12 [0.46,21.07]	0.243
L2/L3	9 (3.4%)	6.75 (0.64–71.17)	0.112	4.16 [0.34,51.32]	0.266
Spinal block height					
Proximal to T6	81 (30.5%)	2.23 (1.31–3.81)	0.003*	1.92[1.09,3.39]	0.024*
Caudal to T6	185 (69.5%)	Ref.		Ref.	
Intrathecal bupivacaine dose (mg)					
10.0	158 (59.4%)	Ref.		Ref.	
> 10.0	108 (40.6%)	1.56 (0.99–2.44)	0.052	1.74[1.04,2.89]	0.034*
Cadre of anesthesia provider					
Anesthesia resident	76 (28.6%)	Ref.		Ref.	
Bachelors student	77 (28.9%)	0.82 (0.49–1.39)	0.470	0.79 [0.45,1.39]	0.414
Anesthetic officer	113 (42.5%)	1.41 (0.84–2.39)	0.197	1.32 [0.73,2.38]	0.350
Type of caesarean section					
Elective	25 (9.4%)	Ref.		Ref.	
Emergency	241 (90.6%)	2.22 (1.21–4.08)	0.010*	2.32[1.20,4.46]	0.012*
Prophylactic vasopressor					
Yes	85(32.0%)	Ref.		Ref.	
No	181 (68.0%)	1.60 (1.04–2.48)	0.033*	1.66 (1.02–2.68)	0.039*

cOR crude Odds Ratio, aOR Adjusted Odds Ratio, Ref Reference group, CI Confidence Interval

*p < 0.05

spread of the block and more profound haemodynamic effects [42]. Consequently, there has been increasing interest in optimizing spinal anaesthetic dosing to achieve adequate surgical anaesthesia while minimizing maternal hypotension and related complications [43]. Tailoring local anaesthetic doses according to maternal characteristics and clinical circumstances may therefore contribute to improved maternal safety outcomes.

A particularly important finding from this study is the protective effect of prophylactic vasopressor administration. International consensus recommendations strongly advocate routine prophylactic vasopressor use during spinal anaesthesia for caesarean section because hypotension is both common and largely preventable [40]. The consensus statement specifically recommends prophylactic vasopressor administration, preferably with

α-adrenergic agonists such as phenylephrine, together with fluid management strategies to maintain maternal blood pressure close to baseline values [41]. The significantly higher odds of hypotension among women who did not receive prophylactic vasopressors in our study reinforce the importance of implementing these evidence-based recommendations in routine clinical practice.

The association between emergency caesarean section and spinal-induced hypotension observed in this study also has broader maternal health implications. Emergency procedures often occur in women with prolonged labour, inadequate hydration, pain, anxiety, or other physiological stressors that may predispose them to haemodynamic instability [44]. In many low- and middle-income countries, emergency caesarean sections

Table 8 Side effects and adverse maternal outcomes of Spinal-Induced Hypotension

	Overall N = 394 n/N (%)	SIH N = 266 n/N (%)	No SIH N = 128 n/N (%)	p-value
Side effects				
Nausea				0.540
No	329(83.5%)	220(82.7%)	109 (85.2%)	
Yes	65 (16.5%)	46 (17.3%)	19 (14.8%)	
Vomiting				0.240
No	346 (87.8%)	230(86.5%)	116 (90.6%)	
Yes	48 (12.2%)	36 (13.5%)	12 (9.4%)	
Bradycardia				0.550
No	389 (98.7%)	262 (98.5%)	127 (99.2%)	
Yes	5(1.3%)	4 (1.5%)	1 (0.8%)	
Shivering				0.300
No	161 (40.9%)	104(39.1%)	57 (44.5%)	
Yes	233 (59.1%)	162(60.9%)	71 (55.5%)	
Light-headedness				0.290
No	368 (93.4%)	246(92.5%)	122(95.3%)	
Yes	26 (6.6%)	20 (7.5%)	6 (4.7%)	
Adverse maternal outcomes				
High spinal				0.064
No	387 (98.2%)	259(97.4%)	128(100.0%)	
Yes	7 (1.8%)	7 (2.6%)	0 (0.0%)	
Total spinal	394 (100.0%)	0 (0.0%)	0 (0.0%)	
Cardiac arrest	394 (100.0%)	0 (0.0%)	0 (0.0%)	

constitute a substantial proportion of obstetric surgical procedures [45, 46]. Therefore, strengthening perioperative preparation, fluid optimization, and haemodynamic monitoring during emergency procedures may provide an opportunity to improve maternal safety and reduce anaesthesia-related morbidity.

Globally, the number of caesarean deliveries continues to rise, with recent estimates suggesting that more than one in five births worldwide are delivered by caesarean section [47]. As the volume of obstetric surgery increases, the prevention and effective management of spinal-induced hypotension will become increasingly important for achieving safer maternal care. The present findings support the implementation of standardized protocols for blood pressure monitoring, prophylactic vasopressor administration, optimization of spinal anaesthetic dosing, and prompt treatment of hypotension. Such interventions have the potential to reduce maternal morbidity and improve the quality and safety of obstetric anaesthesia services, particularly in resource-constrained settings where the burden of emergency caesarean delivery remains high.

Administration of prophylactic vasopressor should be ensured during all emergency caesarean deliveries especially in those where the spinal block is proximal to T6, and those who received intrathecal bupivacaine dose greater than 10 mg. Clinicians should recognize the

factors associated with SIH and be more vigilant to manage the occurrence of hypotension.

Strength and limitations of the study

This present study has several limitations which should be considered while interpreting the findings of this present study. First and foremost, most of the published data on this similar research is based on elective cases hence our findings are likely to be applicable in the low income settings for which emergency caesarean sections are mostly done operations. Secondly, It was difficult to ascertain the exact cause of SIH among the participants. Finally Low dose spinal anaesthesia risks greater pain during caesarean section though this was not experienced in our study.

Conclusion

The prevalence of spinal-induced hypotension among mothers undergoing caesarean section at MRRH is high (67.5%).

Factors independently associated with spinal-induced hypotension among mothers undergoing caesarean section at MRRH were sensory block height proximal to T6, intrathecal bupivacaine dose greater than 10 mg, not receiving a prophylactic vasopressor and emergency caesarean section.

High spinal was the only adverse maternal outcome of spinal-induced hypotension among mothers undergoing caesarean section.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12871-026-04046-v>.

Supplementary Material 1.

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Authors' contributions

B.S, R.A, G.K, J.K, S.T conceptualization of the study, R.A, G.K, J.K, S.T supervision of the study B.S, S.O, R.A, G.K, J.K, S.T, L.T participated in data collection and Analysis, B.S, S.O, R.A, G.K, J.K, S.T, L.T drafted the manuscript, B.S, S.O, R.A, G.K, J.K, S.T, L.T revised the manuscript. All authors read and approved the final version of the submitted manuscript.

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Data availability

Data from this study will be made available by the corresponding authors on a reasonable request.

Declarations

Ethical approval and consent to participate

Ethical clearance was obtained from the department of Anaesthesia and Critical Care, Faculty Research Committee (FRC), Ethical approval was obtained from the Mbarara University of science and technology Research Ethics Committee (reference number MUST-2022-364), and administrative clearance was sought from the Hospital Director, MRRH.

The patients' consent was sought for their inclusion in the study (signature or thumb print). Patients who participated in the study were reassured that their identities would be kept confidential and the questionnaire did not contain any identity information that was linked back to them. For confidentiality purposes, we used unique patient codes instead of patient names. Upon approval by MUST REC, the study was registered with the Uganda National Council of Science and Technology (reference number HS2562ES). Informed consent was obtained from all study participants. Adherence to the Declaration of Helsinki in regards to human subject protection was ensure throughout the study [48].

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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