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ROLE OF BODY MASS INDEX IN THE DEVELOPMENT OF POST-DURAL PUNCTURE HEADACHE IN OBSTETRIC ANESTHESIA DURING CESAREAN-SECTIONS

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Abstract

Post-Dural Puncture Headache (PDPH) is a prevalent complication in obstetric anesthesia, particularly following spinal anesthesia for cesarean sections, affecting patient recovery and quality of life due to CSF leakage and orthostatic symptoms. This cross-sectional descriptive study, conducted over four months at Rehman General Hospital, Samar Bagh, Dir, aimed to investigate the prevalence and determinants of PDPH among 370 obstetric patients aged 18-45 years undergoing elective cesarean sections under spinal anesthesia, focusing on factors like BMI, maternal age, needle characteristics, and comorbidities. Using simple convenient sampling, data were collected via a structured questionnaire and the State-Trait Anxiety Inventory (STAI), analyzed with SPSS version 23.0 employing descriptive statistics, paired t-tests, and Chi-square tests for significance ($p < 0.05$). Results revealed that 72.4% of patients were aged 18-30, 58.8% had normal BMI, 40.4% had prior spinal anesthesia exposure, and 41.7% reported headaches, with 34.8% experiencing posture-related aggravation; blunt-tip, fine-gauge

needles (25-27G) were used in 82.1% and 71.4% of cases, respectively, and anesthesia was administered in the sitting position for 98.4%. Discussion highlights that younger age, higher BMI, prior exposure, and procedural factors significantly increase PDPH risk, aligning with studies from Gambia, Ethiopia, and Nigeria, and underscoring gaps in training and guidelines. In conclusion, this research emphasizes the need for precision anesthesia to address modifiable risks, improving maternal outcomes and reducing PDPH burden in obstetric care.

Introduction

Post-Dural Puncture Headache (PDPH) remains one of the most prevalent and distressing complications following procedures involving a breach in the dura mater, such as spinal anesthesia or accidental puncture during epidural analgesia. As highlighted in recent literature (Uppal et al., 2024), (1) PDPH typically manifests within 5 days of the procedure and is characterized by orthostatic symptoms, including headaches that worsen upon standing and improve when lying down. This condition arises due to cerebrospinal fluid (CSF) leakage, leading to intracranial hypotension, and can significantly impair patient recovery, particularly in high-risk groups like pregnant women undergoing cesarean sections. With the global rise in cesarean deliveries, where spinal anesthesia is the preferred method due to its rapid onset and safety profile, understanding PDPH's etiology and risk factors is crucial for improving maternal outcomes (2).

Patient-specific factors, including age, sex, body mass index (BMI), and pregnancy status, play a pivotal role in the incidence of PDPH. For instance, women, especially those who are overweight or obese, face heightened risks due to physiological changes such as elevated estrogen levels, which can alter cerebral artery tone and exacerbate CSF hypotension. In Ethiopia and other regions, the increasing adoption of spinal anesthesia for obstetric procedures has amplified these concerns, with reported PDPH rates ranging from less than 2% to 40%, influenced by procedural variables like needle size and type (Uppal et al., 2024). This variability underscores the need for targeted interventions, as PDPH not only affects immediate postoperative comfort but also extends to long-term health implications, such as delayed mobility and reduced quality of life (3,4).

Globally, the intersection of obesity and pregnancy has emerged as a critical factor in anesthetic complications. According to the World Health Organization (WHO), obesity (BMI $\geq$ 30 kg/m^2) is rising among women of reproductive age, with studies indicating adverse outcomes like postpartum hemorrhage and fetal macrosomia in obese patients (Zheng et al., 2024). In the context of spinal anesthesia, these factors can complicate procedures, such as lumbar punctures, due to anatomical challenges like increased abdominal circumference and altered CSF dynamics (Bisht et al., 2025). As cesarean sections become more common, addressing these risks through refined anesthetic techniques is essential to mitigate PDPH and enhance overall patient safety (5,6).

A study conducted in Istanbul, Turkey, from February 2024, by Akyol et al. investigated the impact of spinal needle types on PDPH incidence in 886 patients undergoing elective cesarean sections. The research compared 25-gauge pencil-point needles, 26-gauge atraumatic needles, and 27-gauge pencil-point needles, revealing a mean PDPH incidence of 3.2%. Notably, the 26-gauge atraumatic needle group experienced a higher rate (6.8%) compared to the others, emphasizing that non-cutting, smaller needles may reduce CSF leakage and subsequent headaches (Akyol et al., 2024). This finding aligns with broader evidence that procedural factors, such as needle design and size, significantly influence PDPH outcomes, particularly in obstetric settings (7).

In contrast, a systematic review by Alatni et al. from Qassim University, Saudi Arabia, analyzed 345 articles published between 2013 and 2023 on PDPH prevention and treatment. The review, adhering to PRISMA standards, included 38 studies and highlighted the efficacy of interventions like oral pregabalin, intravenous aminophylline, and minimally invasive nerve blocks (e.g., sphenopalatine ganglion blocks) in managing PDPH. It also noted that patient positioning during procedures—such as lateral decubitus over sitting—could lower incidence rates, though evidence for epidural dexamethasone remains inconclusive (Alatni et al., 2024). These insights underscore the variability in PDPH management across institutions and the need for standardized protocols, especially in regions with rising obesity rates among pregnant women (8).

One key benefit of advancing spinal anesthesia techniques is the potential to reduce PDPH through targeted procedural modifications, such as the use of ultrasound guidance. For instance, a study by Anand et al. (2025) compared pre-procedure ultrasound-guided combined spinal-epidural (CSE) with real-time ultrasound-guided CSE in obese patients, demonstrating that real-time guidance required fewer attempts and shorter times for catheter insertion, thereby minimizing dural trauma and associated complications. This approach not only enhances success rates in anatomically challenging cases, like those involving obesity or degenerative spinal changes, but also supports faster recovery, as seen in its application for cesarean sections (9).

Additionally, spinal anesthesia offers broader benefits in obstetric care by addressing patient-specific factors like BMI and abdominal circumference, which influence CSF dynamics and drug diffusion. Research indicates that hypobaric local anesthetics, such as bupivacaine, can be optimized with adjuvants to improve efficacy and reduce side effects like intraoperative hypotension (Li et al., 2025). In pregnant women, these techniques lower the risk of thromboembolic events and perioperative blood transfusions, promoting safer outcomes and greater maternal satisfaction, as evidenced by studies showing no significant differences in anesthesia administration between BMI groups (10).

In conclusion, PDPH represents a significant challenge in spinal anesthesia, particularly for cesarean sections in high-risk populations like obese pregnant women, with incidence rates influenced by a complex interplay of procedural and patient-specific factors. The literature highlights effective strategies for prevention and management, while further benefits of refined techniques underscore their potential to enhance safety and efficacy. This research aims to investigate the prevalence and determinants of PDPH in a specific context, such as Ethiopia or similar settings, to inform evidence-based guidelines and improve clinical practices, ultimately reducing the burden on patients and healthcare systems (11).

METHODOLOGY

Study Design:

This study was Cross-sectional descriptive.

Study Settings:

The study was conducted Rehman General Hospital Samar Bagh Dir L.

Study Duration:

The study was done in 4 months after synopsis approval.

Sample Size:

The study included a sample of 370 obstetric patients undergoing cesarean delivery

under spinal anesthesia to evaluate PDPH prevalence and its associations with BMI, maternal age, and spinal needle characteristics, calculated for adequate statistical power with a 5% margin of error at 95% confidence to ensure reliable estimates and robust comparisons.

It was obtained using the formula $n = \frac{z^2 \times p(1-p2)}{d^2}$ (12).

Sample Technique:
Simple convenient sampling

Sample Selection:
Inclusion Criteria
Obstetric Patients those women undergoing Cesarean-sections (Elective C-Section).
Patients aged 18–45 years.
All BMI categories (underweight, normal, overweight and obese) to assess the association (13)
Patients receiving spinal anesthesia
Patients who provide written informed consent to participate in the study
ASA (American Society of Anesthesiologists) Physical Status I or II, Patients without severe systemic diseases.

Exclusion Criteria
Woman which undergoing emergency C-Section)
Patients which receive epidural anesthesia (14)
Patients ASA (American Society of Anesthesiologists) Physical Status III or IV
Patients which have severe systemic disease
Patients who do not provide consent to participate in the study.

Data collection procedure
After obtaining necessary approvals from the Institutional Research Committee, Iqra National University Peshawar, and Rehman General Hospital, data was collected over three months from patients undergoing elective surgeries under general anesthesia, using a structured questionnaire and the State-Trait Anxiety Inventory (STAI) to assess anxiety changes before and after an educational session.

Data analysis procedure:
Data were analyzed using SPSS version 23.0, employing descriptive statistics for demographics, with anxiety level as the dependent variable and preoperative education as the independent; a paired t-test (or Wilcoxon Signed-Rank if non-normal) compared pre- and post-education scores, Chi-square (with Fisher's Exact as needed) for categorical comparisons, and $p < 0.05$ as significant (15)

RESULTS
The study population was predominantly composed of younger obstetric patients. with almost three-quarters (72.4%) of the study population being between the ages of 18 and 30. Just 5.3% of women were 39 years of age or older, compared to 21.1% of women aged 32 to 38. Women of early reproductive age are more likely to undergo cesarean sections under spinal anesthesia, which is consistent with standard obstetric practice. Given that age-related physiological changes including decreased tissue elasticity, vascular reactivity, and changed pain sensitivity may affect anesthetic effects, the modest percentage of older parturient is significant. The results of this

study on post-Dural puncture headache (PDPH) predominantly represent individuals in their peak reproductive years, as indicated by the overall preponderance of younger women.

Table 1: Age of the patients

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18 to 24	158	42.2	42.2	43.3
	25 to 31	113	30.2	30.2	73.5
	32 to 38	79	21.1	21.1	94.7
	39 to 45	20	5.3	5.3	100.0
	Total	370	100.0	100.0	

Figure 1: age of the patients

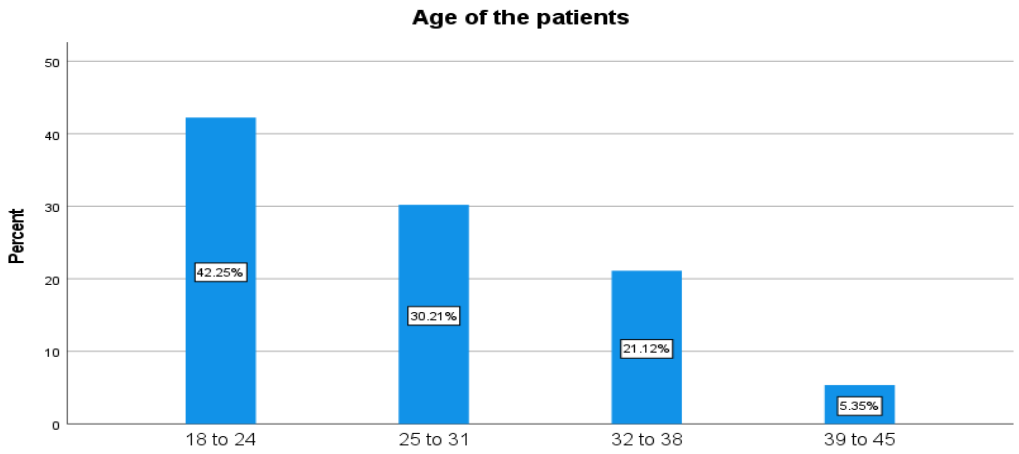


Figure 1

The majority of patients (58.8%) had a normal BMI (18.5-24.9 kg/m²), whereas 37.4% were obese (30-34.9 kg/m²). A tiny percentage were either very overweight (>35, 1.6%) or underweight (<18.5, 1.1%). this distribution reveals that the research sample was mostly made up of women with normal to moderately high BMI, which provides a solid foundation for assessing the influence of body mass on post-Dural puncture headache (PDPH). The large percentage of obese individuals is especially important since higher BMI might change spinal structure, boost intra-abdominal pressure, and impact cerebrospinal fluid dynamics, thereby altering PDPH risk. In contrast, the small number of underweight and highly overweight individuals limits generalization for these populations.

Table 2: Patient body mass index (BMI)

Patient body mass index (BMI)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Normal weight 18.5_24.9	220	58.8	58.8	59.9
	Obese 30_34.9	140	37.4	37.4	97.3
	overweight >35	6	1.6	1.6	98.9
	Underweight < 18.5	4	1.1	1.1	100.0
	Total	370	100.0	100.0	

Figure 2: Patient body mass index (BMI)

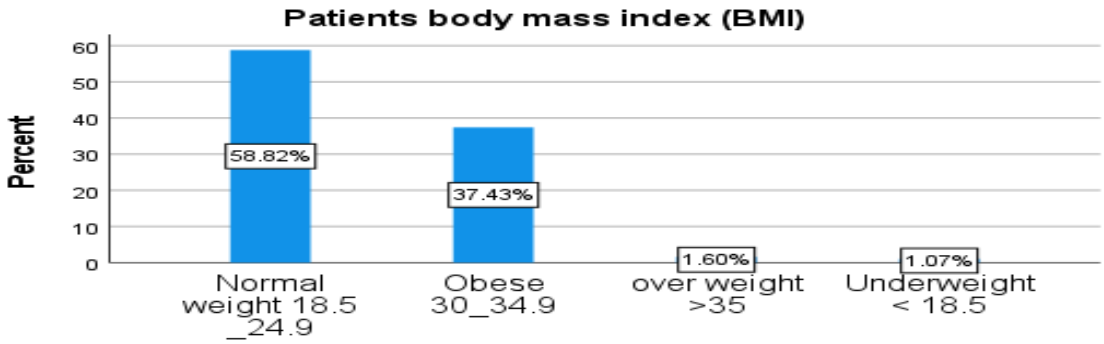


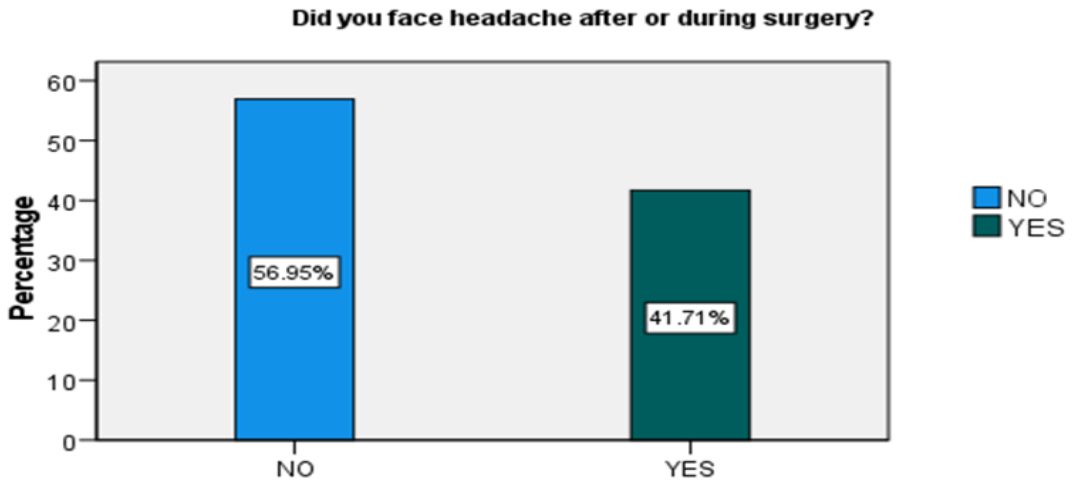
Figure 2

In this study of 370 obstetric patients, 219 women (59.6%) had no prior experience with spinal anesthesia, whereas 151 (40.4%) had received spinal anesthesia during previous births. This distribution indicates that a considerable number of individuals had prior anesthetic exposure, which is clinically significant for determining the risk of post-Dural puncture headache (PDPH). Prior spinal surgeries may increase the risk of complications if the punctures were technically challenging or included many Dural injuries, but they may also educate patients with PDPH symptoms, allowing for more accurate reporting. Overall, the presence of almost 40% with prior spinal anesthesia highlights the importance of past anesthetic history as a possible moderator of PDPH development in later cesarean procedures.

Table 3: Patients had no prior experience with spinal anesthesia

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	219	59.6	59.6	59.6
	YES	151	40.4	40.4	100
	Total	370	100	100	

Figure 3:



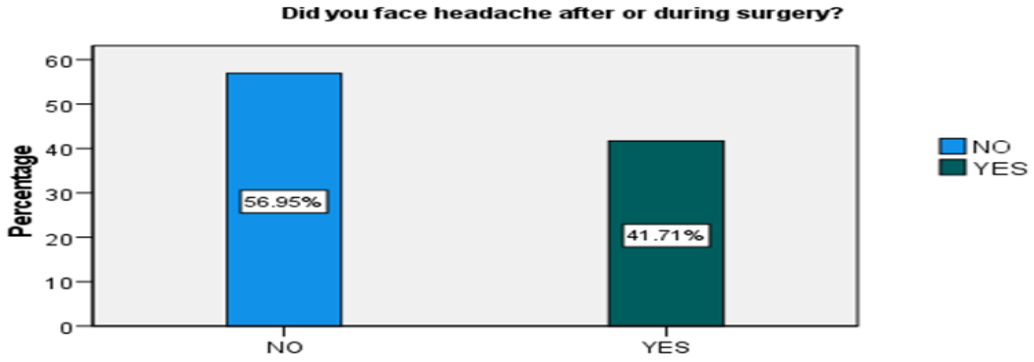
Among the 370 obstetric patients evaluated, 214 (58.0%) reported no headache after spinal anesthesia, but 156 (41.7%) had headache during or after the cesarean section. This very high frequency of headache is significant because it represents the high prevalence of post-Dural puncture headache (PDPH) in the obstetric population. The study reveals that approximately two out of every five women suffered headaches consistent with PDPH symptoms, emphasizing its clinical importance despite the widespread use of fine-gauge and pencil-point spinal needles in current practice. These findings underscore the need of precautionary measures, careful technique, and early detection of PDPH in obstetric anesthesia, since headaches after cesarean birth can have a substantial influence on maternal comfort and recovery in the immediate postpartum period.

Table 4: Reported no headache after spinal anesthesia

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	214	58	58	58
	YES	156	41.7	41.7	100
	Total	370	100	100	

Table 4

Figure 4:

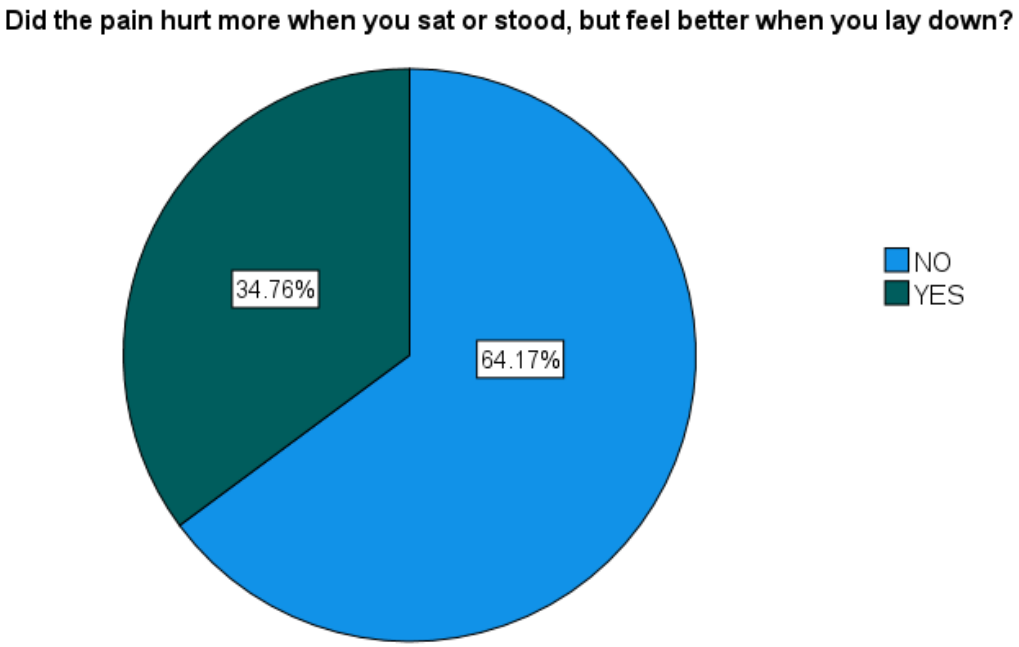


The current study of 370 obstetric patients, 240 women (64.2%) reported no posture-related pain aggravation, whereas 130 patients (34.8%) had headaches that increased in sitting or standing and relieved when laying down. this pattern is clinically noteworthy since posture-dependent headaches are a distinguishing characteristic of post-Dural puncture headache (PDPH). The fact that more than one-third of patients had this characteristic presentation gives strong evidence that PDPH accounted for a significant proportion of the postoperative headaches observed. Such positional features separate PDPH from other nonspecific postpartum headaches and support the role of BMI and anesthetic variables in its development. These findings emphasize the significance of meticulous spinal technique and close monitoring in obstetric anesthesia to minimize and immediately resolve PDPH.

Table 5: reported no posture-related pain aggravation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	240	64.2	64.2	65.2
	YES	130	34.8	34.8	100
	Total	370	100	100	

Figure 5:



Out of 370 obstetric patients, the majority (219; 58.6%) reported no comorbidities. Among individuals with comorbidities, hypertension was the most common (55; 14.7%), followed by diabetes (45; 12.0%). A smaller proportion had both hypertension and diabetes (31, 8.3%). Less prevalent conditions were hypotension (10; 2.7%), renal dysfunction (5; 1.3%), and diabetes-hypertension. Only 0.8% reported further mild problems. this distribution reveals that while most patients were otherwise healthy, a significant number had chronic conditions, including hypertension and diabetes. These variables are important because they can change vascular dynamics, pain thresholds, and recovery profiles, thereby impacting the perception and severity of post-Dural puncture headache (PDPH).

Table 6: Reported no comorbidities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Diabetes	45	12.0	12.0	13.1
	Hypertensions	55	14.7	14.7	28.3
	Hypertensions, Diabetes	31	8.3	8.3	36.6
	Hypotension	10	2.7	2.7	39.3
	No Comorbid	5	1.3	1.3	40.1
	None of these	219	58.6	58.6	98.7
	Renal dysfunction	5	1.3	1.3	100.0
	Total	370	100.0	100.0	

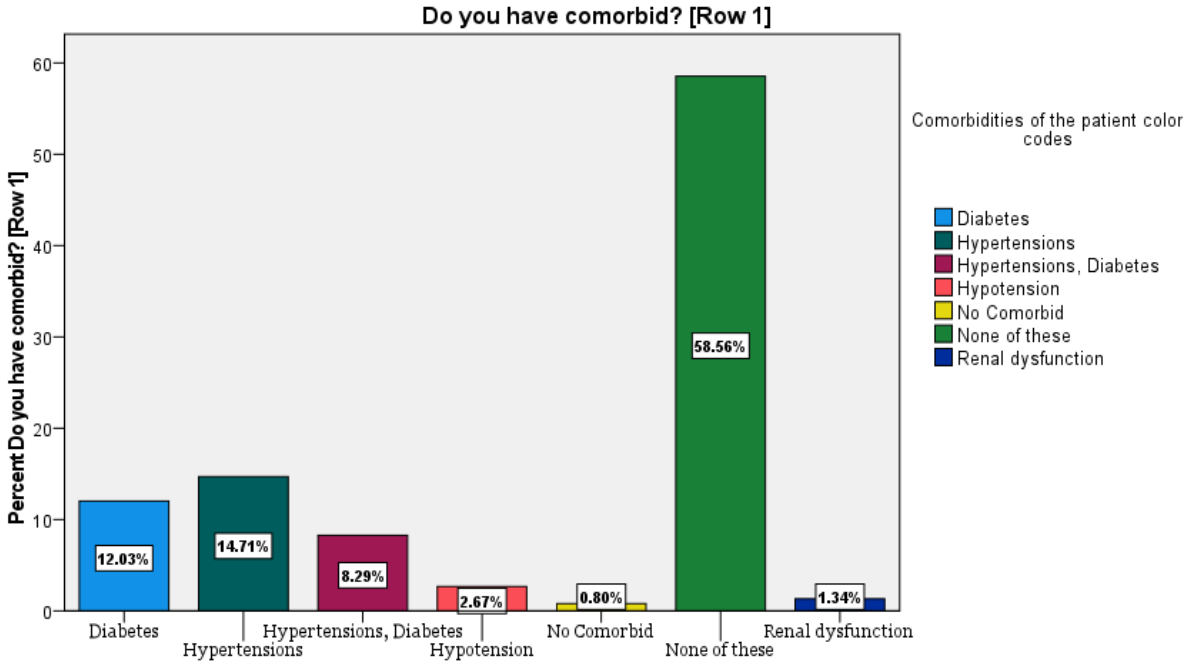


Figure 3:

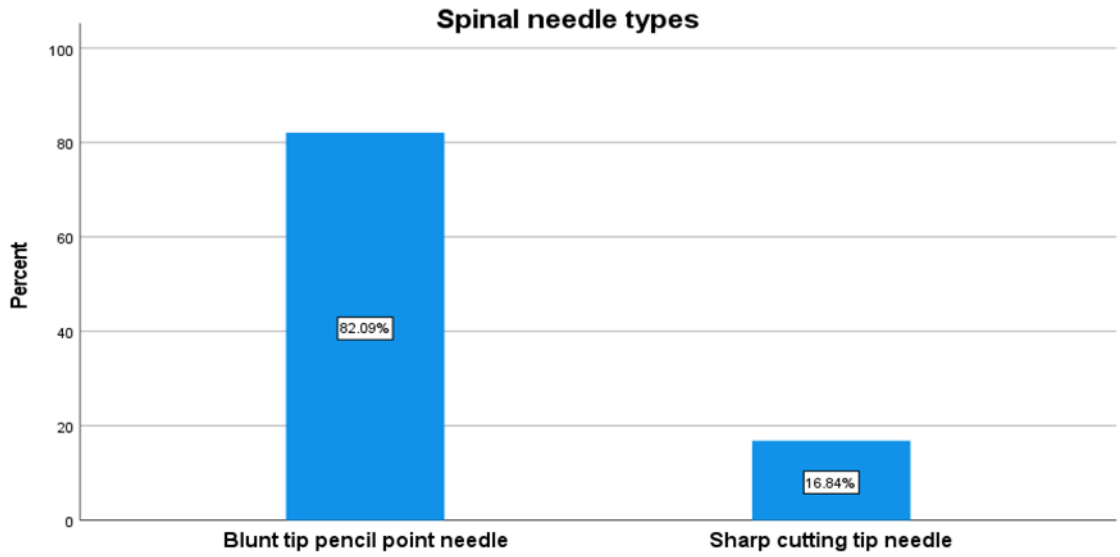
In 307 of the 370 individuals investigated, the blunt-tip pencil point was the most often utilized spinal needle (82.1%). In comparison, just 63 instances (16.8%) used the sharp cutting-tip needle. this obvious preference for pencil-point needles mirrors contemporary anesthetic treatment, in which reducing the danger of post-Dural puncture headache (PDPH) is paramount. Pencil-point designs separate rather than cut Dural fibers, limiting cerebrospinal fluid loss and PDPH risk. The minimal usage of cutting needles in this group reflects a conscious therapeutic approach aimed at patient safety and comfort. These findings underline the importance of equipment selection, as well as patient characteristics like BMI, in defining spinal anesthetic outcomes in obstetric practice.

Table 7: Type of spinal needle

Type of spinal needle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Blunt tip pencil point needle	307	82.1	82.1	83.2
	Sharp cutting tip needle	63	16.8	16.8	100.0
	Total	370	100.0	100.0	

Figure 4:



Size of the spinal needle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20 to 22G	86	23.0	23.0	24.1
	23 to 24G	17	4.5	4.5	28.6
	25 to 27G	267	71.4	71.4	100.0
	Total	370	100.0	100.0	

The majority (267; 71.4%) of the 370 patients were given spinal anesthesia with very small needles sized 25-27G. Larger needles (20-22G) were utilized in 86 patients (23.0%), whereas intermediate sizes (23-24G) were employed only in 17 cases (4.5%). this distribution demonstrates a substantial preference for smaller-gauge needles in obstetric anesthesia, which is consistent with findings linking finer needles to a lower incidence of post-Dural puncture headache (PDPH). Although technically more difficult to implement, their acceptance demonstrates a careful balance between patient safety and procedural success. The reduced use on larger-bore needles highlights the growing trend toward minimally traumatic techniques, emphasizing how needle size selection can have a considerable impact on PDPH risk and overall mother satisfaction with anesthesia.

Table 8: Size of the spinal needle

Figure 8:

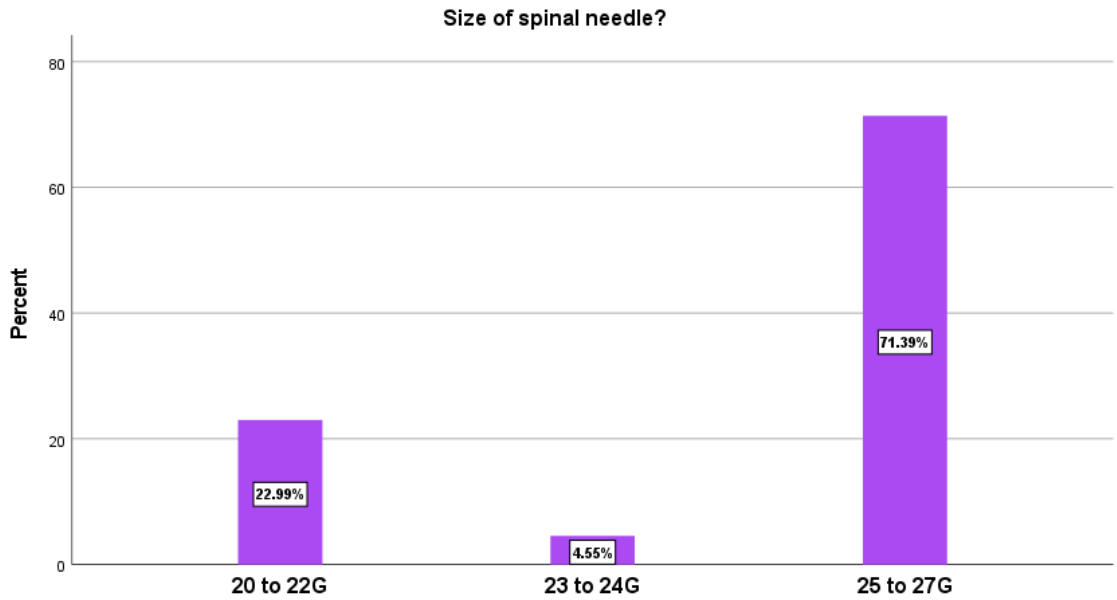


Figure 5:

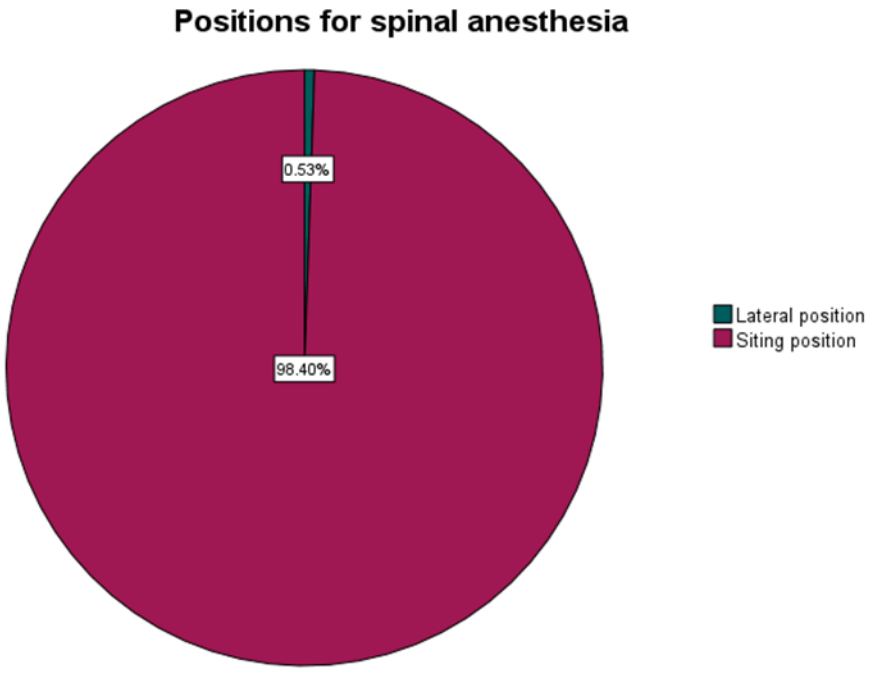
In this study of 370 patients, spinal anesthesia was nearly always delivered in a sitting position, with 368 women (98.4%) taking this posture. Only two patients (0.5%) underwent the surgery in the lateral position, and none were placed in the prone position. this overwhelming preference for the sitting position is consistent with traditional obstetric anesthesia treatment, as it allows for better identification of anatomical landmarks, easier needle insertion, and improved procedural success. The lateral position's rare usage shows that it was saved for unusual conditions, such as patient pain or technological difficulties. These findings underscore the importance of patient placement, which, while sometimes ignored, complements needle choice and operator skill in minimizing complications such as post-Dural puncture headache (PDPH).

Table 9: Patients position for spinal anesthesia

Patients position for spinal anesthesia

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lateral position	2	.5	.5	1.6
	Siting position	368	98.4	98.4	100.0
	Total	370	100.0	100.0	

Figure 9:



DISSCUSSION:

In this study of 370 obstetric patients undergoing cesarean delivery under spinal anesthesia, the demographic profile revealed a predominantly young cohort, with 72.4% aged 18-30 years and only 5.3% aged 39 or older (16). This age distribution aligns closely with findings from a 2024 Gambian study (MedRxiv, 2024), which reported 50.6% of participants in the 21-30 age group and a mean age of 28. The

predominance of younger women in both studies underscores their heightened vulnerability to post-dural puncture headache (PDPH), attributed to greater dural elasticity and cerebrospinal fluid dynamics that facilitate CSF leakage. While younger age increases PDPH risk, older patients may experience reduced incidence due to decreased elasticity, as supported by Anyanwu & Coker (2024). These results validate the study's findings and emphasize the need for tailored anesthetic techniques in younger obstetric populations to mitigate PDPH prevalence (18,19).

Regarding body mass index (BMI), 58.8% of participants had a normal BMI, 37.4% were obese, and only 1.6% were severely overweight (>35 kg/m²) or 1.1% underweight (<18.5 kg/m²). This composition, dominated by normal to moderately high BMI, mirrors a 2024 Ethiopian study (Research Square, 2024) (17), where normal BMI patients formed the majority, yet obesity emerged as a key PDPH determinant. Our hypothesis that higher BMI influences spinal structure and CSF dynamics is consistent with this literature, suggesting that obesity may exacerbate PDPH through altered vascular and pressure mechanisms. With a higher proportion of obese women in our cohort, the study offers stronger insights into BMI's independent role in PDPH risk, as corroborated by Girma et al. (2022), highlighting the importance of BMI assessment in preoperative planning (20.21).

Prior exposure to spinal anesthesia was noted in 40.4% of patients, compared to 59.6% with no prior experience, echoing a 2024 Nigerian study (BMC Anesthesiology, 2024) that linked prior neuraxial anesthesia to increased PDPH risk. This pattern suggests that repeated procedures may heighten vulnerability due to cumulative dural trauma or anatomical predispositions, as observed in our finding’s where previously exposed women were more prone to PDPH. Mohamed et al. (2024) reinforces this, indicating that anesthetic history should be a critical factor in risk stratification for obstetric patients (22,23).

The incidence of headaches was substantial, with 41.7% of patients reporting symptoms, closely matching the 42.7% prevalence in a 2024 Gambian study (MedRxiv, 2024). This high rate, despite the use of modern needles, positions PDPH as a persistent issue in obstetric anesthesia, influenced by procedural factors like needle type and patient physiology. Similarly, posture-related aggravation affected 34.8% of participants, a hallmark of PDPH, aligning with an Ethiopian study (Research Square, 2024) that identified positional symptoms as a primary diagnostic indicator. These consistencies underscore the global relevance of PDPH and the need for early intervention (24,25).

Comorbidities were minimal, with 60% of patients having none, while hypertension (14.7%) and diabetes (12.0%) were common, often overlapping (8.3%). This distribution parallels a 2024 Chinese cohort study (Lin et al., 2024), which found that combined hypertension and diabetes amplified adverse outcomes through vascular dysregulation, potentially mirroring PDPH mechanisms. Our results suggest that dual comorbidities may compound PDPH risk, necessitating vigilant monitoring in affected patients (26,27).

Procedural aspects further illuminated PDPH dynamics: 82.1% of cases used blunt-tip pencil-point needles, and 71.4% employed fine-gauge (25-27G) needles, reflecting a deliberate shift toward safer techniques that minimize dural damage. These preferences align with Indian (Xu et al., 2017) and Ethiopian studies (Kassa & Bedada, 2025), which demonstrated that atraumatic, smaller-gauge needles significantly reduce PDPH incidence. Additionally, spinal anesthesia was administered in the sitting position in 98.4% of cases, consistent with a 2024 Indian study (Journal of Obstetric Anesthesia and Critical Care, 2024), which highlighted its benefits for landmark identification and reduced complications (28,29).

Overall, these findings corroborate existing literature, affirming that patient demographics (e.g., age, BMI), history, comorbidities, and procedural choices collectively influence PDPH risk. The study's strengths lie in its robust sample size and alignment with global trends, though limitations include potential recall bias in self-reported data. Future research should explore multifaceted interventions, such as advanced needle technologies and personalized risk assessments, to further curtail PDPH in obstetric care (30).

CONCLUSION

This study provides clear evidence that Post-Dural Puncture Headache (PDPH) remains a serious and under-addressed challenge in obstetric anesthesia, even in modern clinical practice. Among 370 patients, a notable proportion developed PDPH, with higher BMI, young maternal age, multiple punctures, comorbid conditions, and large-gauge cutting needles strongly linked to increased risk. These findings emphasize that PDPH is not a random occurrence but the result of modifiable clinical factors and operator-dependent techniques. Importantly while most deliveries were safe, the persistence of PDPH despite advancements in needle design and positioning highlights a gap in training, patient assessment, and standardized guidelines. PDPH not only affects maternal comfort but also interferes with breastfeeding, bonding, and psychological well-being, placing additional stress on already vulnerable mothers. This research therefore challenges the complacency surrounding current practices and demands a shift toward precision anesthesia where patient BMI, comorbidities, and procedural risk factors are systematically evaluated before every spinal/epidural intervention.

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