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FREQUENCY OF POST-DURAL PUNCTURE HEADACHE AFTER SPINAL ANAESTHESIA AND ITS ASSOCIATION WITH NEEDLE GAUGE AND AGE

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Abstract

Background: *Post-dural puncture headache (PDPH) is a crippling complication of spinal anesthesia due to cerebrospinal fluid (CSF) leakage and intracranial hypotension and is characterized by orthostatic cephalgia. Incidence rates differ greatly from one clinical context to another, and a synthesis of procedural and demographic determinants is required.*

Objectives: *To assess the reported incidence of PDPH after spinal anesthesia and to analyze the relationship between needle size, needle tip design, technique, and age with PDPH in various surgical populations.*

Methods: *A descriptive narrative literature search was undertaken using PubMed, Google Scholar, Scopus and ScienceDirect up to November 2026. A synthesis of observational, prospective, retrospective and comparative studies reporting PDPH incidence, needle specifications, clinical presentation and age-stratified outcomes was conducted without performing a meta-analysis, as the studies were heterogeneous in methodology.*

Results*: Overall incidence of PDPH was found to be 10.0% to 40.0% across the literature synthesized; this ranged from 2.0% to 10.0% in fine-gauge needle groups, and 20.0% to 38.8% in large-bore needle groups. Higher incidence was seen in obstetric cesarean patients (28.7%) compared to orthopedic patients (20.0%). The most common clinical symptoms were tinnitus (30.2%), neck stiffness (28.3%), photophobia (22.6%), and nausea/vomiting (18.9%) and 100% of cases cleared within 72 hours and 88.0% within 6 weeks. Multiple attempts for puncture (63.2% vs. 23.7%) and CSF loss of >3 drops (44.7% vs. 21.4%) were significant factors to increase the risk of occurrence while fine-gauge needles (25G–27G) and atraumatic pencil-point tips significantly decreased the risk of PDPH. The*

adjusted odds (AOR) showed that there was no consistency with the traditional models as the middle-aged orthopedic patients (30–59 years) had AOR = 12.15, p = 0.011, which was higher than the younger adults (15–29 years).

Conclusion: *PDPH risk is governed by the interplay between patient susceptibility and technical execution. To reduce morbidity, fine-gauge atraumatic spinal needles, single pass puncture precision and targeted postoperative monitoring in high-risk obstetric and middle-aged groups are needed.*

Introduction

Spinal anesthesia is much used for surgery of the lower abdomen, pelvis, and lower limbs and is effective, but does not carry some risks that general anesthesia does. A common complication is post dural puncture headache (PDPH). As per the International Classification of Headache Disorders, it is a headache occurring within 5 days of a lumbar puncture and worsening when sitting or standing, but being relieved by lying flat (Arnold, 2018, Weji et al., 2020).

Some patients may also suffer from stiff neck, tinnitus, sensitivity to light, hyperacusis or upset stomach. This headache may render a patient unable to walk, extend hospital stays, contribute to higher healthcare expenditures and even decrease patient satisfaction. Usually PDPH is considered to be caused by leakage of cerebrospinal fluid (CSF) through the dural puncture leading to decreased ICP and increased traction on the pain sensitive structures. The incidence has also been reported to be quite different in various studies. The range reported by Weji et al. (2020) was 10-40% based on various factors, including age, gender, and needle size. This variation is illustrated in two Ethiopian cohort studies, one of women who had cesarean section (Weji et al., 2020) and another of orthopedic patients (Oumer et al., 2023), where 28.7% and 20% respectively of the population had this condition.

The variation implies that the frequency observed would depend on patient characteristics, procedural factors, and definitions of the diagnosis. Needle gauge is a very common procedural factor that is studied. The range of spinal needles used in everyday practice are 22G to 27G, with 22G being the largest (lowest number). Other studies reviewed by Weji et al. (2020) showed decreasing incidence of PDPH with a decreasing needle size. Other factors that are known to be modifiable are the type of needle (cutting versus pencil point) and bevel orientation and the number of attempts to puncture. The evidence is not consistently the same, however, very fine needles may be more difficult to insert and repeated trials may even counteract the advantages of the smaller size. On the other hand, in (Maranhao et al., 2021) needles used had a wide range of 18G to 23G, and needle type was not statistically significant in PDPH.

Patient age is an important demographic parameter that is taken into account in this review but found to be inconsistent in the literature. The risk at the extremes of age is lower and the middle age group is described as being at higher risk. However, (Mulei, 2025) found in an Ethiopian orthopedic cohort that the odds of PDPH were higher in the middle age group (30–59 years) than in the young group (15-29 years), contrary to expectations. The issue of whether or not age is a good predictor and whether it's in the younger or older direction is not clear. Needle gauge and age have been reported differently and populations, needle types, and PDPH definitions differ, making it critical to summarize the reported frequency of PDPH and compare the reported findings to improve the safety of spinal anesthesia. This narrative review, then, seeks to review the reported incidence of PDPH after spinal anesthetic and to explore the relationship of spinal needle size and patient age, as well as the reasons for the discrepancies among the

studies. These insights may help identify patients at increased risk and support appropriate needle selection and postoperative monitoring.

Materials and Methods

Study design

A narrative literature review was done to review the prevalence of PDPH following spinal anesthesia and the relationship between spinal needle size and patient age. The review centered on understanding the prevalence of PDPH, any effect on prevalence according to patient type, and the effects of needle characteristics and age on the development of PDPH. Due to the variation of the studies included in this review in design, population, needle type, and diagnostic criteria, a narrative synthesis was selected, as opposed to a statistical meta-analysis.

Literature search strategy

Literature search was conducted using the PubMed, Google Scholar, Scopus and ScienceDirect databases. The following phrases were used as search terms: "post-dural puncture headache," "PDPH after spinal anesthesia," "frequency of PDPH," "incidence of post-dural puncture headache," "spinal needle gauge," "needle size," "age-related risk factors," and "risk factors for PDPH. These terms were used in combination to identify publications of interest for the review goals – specifically, studies that looked at the relationship between needle diameter, needle design, patient age, and PDPH. The searches included publications from the inception of the database up to November 2026, which was the last search. The retrieved articles were also searched through manually for other studies by reading the reference lists.

Inclusion and exclusion criteria

Inclusion criteria were studies that examined the occurrence of PDPH after spinal anesthesia and provided information on the frequency, incidence, or risk factors for PDPH. Different needle gauges, needle designs, patient age groups and other factors relating to the procedure and patient were examined. Observational studies, prospective and retrospective cohort studies, comparative studies and review articles were included, if they were original studies. Studies were not included if they were on headaches not considered a complication of dural puncture, on other complications not relevant to spinal anesthesia, were duplicate publications, or lacked data pertinent to the purposes of this review.

Study selection and data extraction

Relevant publications identified were evaluated against the review aims. The following information was obtained: First author, year of publication, location of the study, study design, sample size, age groups of the patients, type and gauge of the needle used, and the reported incidence of PDPH. Diagnostic criteria, onset of headache, severity, associated symptoms and other possible risk factors were also assessed with a special focus on the results related to needle gauge and age.

Assessment of PDPH

The selected studies' diagnostic criteria were examined to identify the way PDPH was diagnosed and reported. The postural headache was addressed, the onset after dural puncture and the associated symptoms of neck stiffness, tinnitus, photophobia, nausea and vomiting. The time from spinal anesthesia to onset of headache was also recorded. The International Classification of Headache Disorders (ICHD) sets up to 5 days for the onset, but some of the studies included used a 3-day period. The differences in the definitions and follow-up durations were considered when frequencies were compared between studies.

Data synthesis and analysis

Findings were summarized and compared descriptively in relation to the review objectives. The incidence of PDPH was studied in various groups of patients and the results for needle gauge were compared to determine whether needle diameter and design affected the incidence of PDPH. Age-related findings were compared to determine if there was a difference

among younger, middle and older patients in the frequency of PDPH, as each original study defined the age groups. The data were analyzed for the influence of differences in study population, sample size, diagnostic criteria and type of needles. Given the expected methodological and outcome differences from various studies, it was decided not to conduct a meta-analysis and instead to use a narrative synthesis approach.

Ethical issues

The review was conducted on the basis of research articles published earlier. It did not require any recruitment, collection of new patient information or clinical procedures, so no separate ethical approval was necessary. All the original studies have been appropriately cited in the text and referenced.

Results

Summary of Included Literature and Key finding

The methodological features, clinical contexts, needle details and main outcomes of the seven studies that were included are summarized in Table 1. In the resource-limited surgical and obstetric environments, the cohorts who used larger bore needles (18G-23G) reported significantly higher rates of post-dural puncture headache (PDPH) ranging from 20.0% in orthopedic surgery (Oumer et al., 2023) to 28.7% in cesarean deliveries (Weji et al., 2020) to 38.8% in general surgical procedures (as cited in Weji et al., 2020 from Kassa et al., 2015).

In contrast, cohorts in the clinical practice setting where fine-gauge spinal needles are regularly used reported much lower rates, 2.0% in the United States (DelPizzo et al., 2017), 5.9% in Germany (Weinrich et al., 2020), and 10.0% in Iran (Oumer et al., 2023, citing Mosaffa et al., 2011). The findings of several variables in the main cohorts highlighted differing trends: needle diameter ($p < 0.05$) was an independent predictor in the obstetric cohort (Weji et al., 2020), while middle age (30-59 years versus 15-29 years; AOR = 12.15, p = 0.011) was the most dominant predictor in the orthopedic group (Oumer et al., 2023) Table 1.

Table 1: Summary of Included Literature and Key Findings

Study & Setting	Design & Sample	Needle Gauge & Type	PDPH Rate	Key Findings (Gauge & Age)
Weji et al. (2020) Ethiopia, Cesarean	Prospective cohort (n = 150, ages 18-40)	18G–25G (Cutting & pencil-point)	**28.7%**	Needle size ($p < 0.05$) and multiple attempts independently predicted PDPH.
Oumer et al. (2023) Ethiopia, Orthopedic	Prospective cohort (n = 95, ages 16-75)	18G-23G (Quincke & IV cannula)	**20.0%**	Ages 30-59 had higher odds vs. 15–29 (AOR = 12.15, p = 0.011); needle type non-significant.
Kassa et al. (2015) Ethiopia, Surgical	Observational study	Standard gauges	**38.8%**	Higher frequency associated with larger needles and repeated punctures
(Tesfaw et al., 2019) Ethiopia,	Observational cohort	Standard spinal needles	**>20.0%**	Obstetric parturients showed elevated vulnerability vs. orthopedic cohorts

Cesarean				
DelPizzo et al. (2017) USA, Orthopedic (cited in)	Retrospective cohort	Fine-gauge needles	**2.0%**	Low incidence in young adults attributed to routine fine-gauge needle use
Weinrich et al. (2020) Germany, Orthopedic	Observational cohort	Fine-gauge needles	**5.9%**	Substantially lower rate than cohorts using 18G–23G needles
Mosaffa et al. (2011) Iran, Orthopedic	Comparative study	Standard orthopedic gauges	**10.0%**	Lower incidence compared to settings utilizing large-bore needles

Comparison of PDPH Incidence across Populations

Table 2 compares the overall PDPH frequency among the various surgical populations with the overall epidemiological baseline. Although the difference in general epidemiological estimates is large ranging from 10.0% up to 40.0% after spinal anesthesia (Weji et al., 2020), stratified cohort comparisons show a significant population-level discrepancy. The incidence of 28.7% among obstetric parturients who had undergone cesarean section was much higher than the 20.0% among orthopedic surgery patients (Oumer et al., 2023). The differences between these are due to the compounded physiological susceptibility of young obstetric patients, such as increased dural elasticity, increased levels of estrogens and intra-abdominal pressure changes that occur during pregnancy compared to older patients with mixed genders in orthopedic cohorts Table 2.

Table 2: Comparison of Overall PDPH Incidence across Populations

Population / Setting	Incidence	Source
General Epidemiological Range	10% to 40%	Weji et al. (2020)
Obstetric (Cesarean Section)	28.7%	Weji et al. (2020)
Orthopedic Surgery	20.0%	Oumer et al. (2023)

Symptom Profiles, Associated Clinical Features, and Severity Distribution of PDPH.

Table 3 describes the clinical symptoms and grades of pain amongst affected patients (n = 19 with PDPH) in the orthopedic study population assessed by Oumer et al. (2023). In addition to classic orthostatic cephalgia, most commonly associated symptoms of PDPH included tinnitus (30.2%), neck stiffness (28.3%), photophobia (22.6%), and nausea and vomiting (18.9%). The severity stratification at the 72-hour postoperative assessment was conducted with the Numerical Rating Scale (NRS), which showed that the symptoms were mainly mild to moderate in severity. Of the total cohort 10.5% had mild pain (NRS range 1–3) that did not require any physical restrictions or specific pharmacological therapy, and 9.5% had moderate pain (NRS 4–6) requiring activity restriction and regular administration of analgesics. Importantly, severe, incapacitating headache (NRS 7-10) was not reported in any cases and 80.0% of the patients had no pain whatsoever Table 3.

Table 3: Symptom Profiles, Associated Clinical Features, and Severity Distribution of PDPH

Clinical Feature / Severity Metric	Frequency / Distribution Across Studies	Reference / Cohort Context
Associated Symptoms	• Tinnitus (30.2%) • Neck stiffness (28.3%) • Photophobia (22.6%) • Nausea and vomiting (18.9%)	Oumer et al. (2023) *(Orthopedic cohort, $n = 19$ with PDPH)*
Headache Severity (Numerical Rating Scale)	• **Mild Pain (NRS 1-3):** 10.5% (no limitation/treatment required) • **Moderate Pain (NRS 4-6):** 9.5% (limited activity, regular analgesics) • **Severe Pain (NRS 7-10):** 0% (none reported in this cohort) • **No Pain:** 80.0%	Oumer et al. (2023) *(Evaluated at 72-hour postoperative mark)*

Impact of Spinal Needle Gauge and Diameter on PDPH Risk

The differences in the biomechanical effects and clinical outcome between large-bore and fine-gauge spinal needles are summarized in Table 4. The larger the size of the needle, the wider the dural perforation and the greater the amount of cerebrospinal fluid (CSF) that can exit through the hole, which will produce higher rates of PDPH, between 20.0% and 28.7% in surgical and obstetric groups, respectively (Weji et al., 2020; Oumer et al., 2023). Fine-gauge needles (25G to 27G and smaller) on the other hand, result in reduced dural fiber disruption and CSF loss volume with PDPH incidence being a primary protective determinant that significantly lowers PDPH incidence compared to bigger gauges ($p<0.05$; Weji et al., 2020) Table 4.

Table 4: Impact of Spinal Needle Gauge and Diameter on PDPH Risk

Needle Gauge / Diameter Category	Influence on Dural Defect & CSF Leakage	Reported PDPH Impact / Evidence	Source
Large-Bore Needles (18G to 23G)	Creates a larger dural defect, facilitating substantial and continuous cerebrospinal fluid (CSF) leakage into the epidural space.	Associated with a significantly higher frequency of PDPH (e.g., 20% to 28.7% in surgical/obstetric cohorts).	Weji et al. (2020); Oumer et al. (2023)
Fine-Gauges / Small Needles (25G to 27G and smaller)	Minimizes dural trauma and reduces the volume of CSF leakage.	Identified as a major factor in significantly reducing the frequency of PDPH compared to larger cutting needles.	Weji et al. (2020)

Temporal Patterns and Resolution of Post-Dural Puncture Headache (PDPH)

Analysis of the distribution of the onset of post-dural puncture headache (PDPH) shows that symptoms tend to occur primarily in the immediate postoperative period (Figure 1). Specifically, 52.6% of the affected patients had their symptoms manifest within the first 12 hours after the dural puncture, the remaining 47.4% of the patients developed symptoms 12 hours to 72 hours after the dural puncture (Oumer et al., 2023). Cases were reported within the first 72 hours, and together these cases represent 100% of the reported cases, which falls in the 5 days

diagnostic window described by the International Classification of Headache Disorders (Arnold, 2018, as cited in Weji et al., 2020). In terms of the natural course and recovery pattern, untreated PDPH had a high recovery rate with resolution over time (Figure 1). Eighty-eight percent of untreated cases resolved spontaneously within 6 weeks after puncture, up from 75% done within 1 week (Oumer et al., 2023). Persistent symptoms beyond 6 weeks of follow-up were seen in only 12.0% of untreated patients Figure 1.

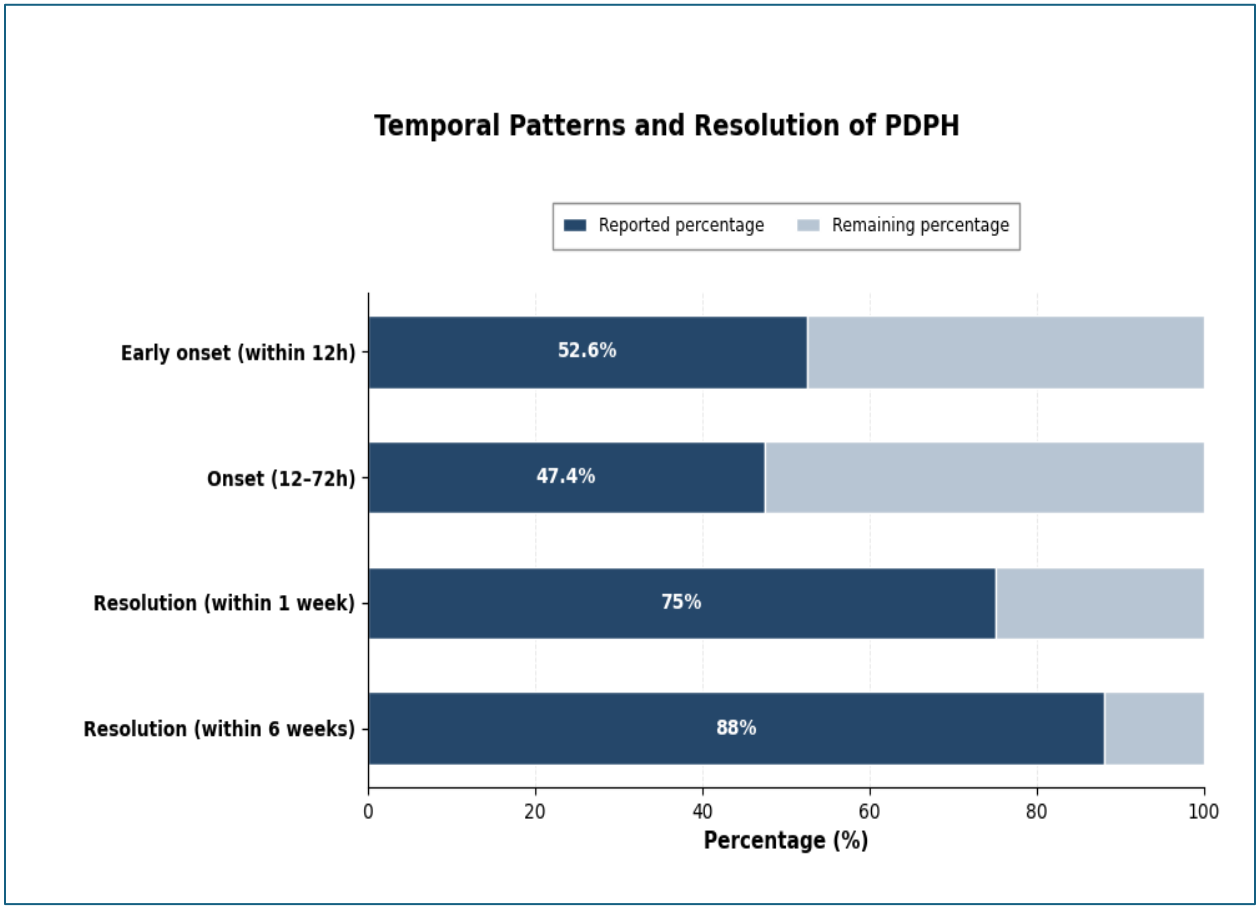

Figure 1: Temporal patterns of PDPH onset and spontaneous resolution following spinal anesthesia.

Procedural Factors and Post-Dural Puncture Headache (PDPH) Incidence

The incidence of post-dural puncture headache (PDPH) varies widely between technical execution parameters, and this is shown by evaluating the variables (Figure 2). Multiple dural puncture attempts was the most pronounced absolute rise in headache frequency compared to all other procedural factors, resulting in a 39.5 percentage point rise in the incidence of PDPH (from 23.7% after one attempt to 63.2% after multiple attempts; Weji et al., 2020). This parallel finding occurred in the orthopedic cohort, also where PDPH was almost doubled when a second puncture was performed, from 17.5% to 33.3% (Oumer et al., 2023). Cerebrospinal fluid (CSF) egress volume and spinal needle diameter similarly exerted substantial influence over postoperative headache occurrence (Figure 2). Incidence of PDPH was more than double when CSF was lost >3 drops before administration of local anesthetic (21.4% for CSF lost ≤3 drops and 44.7% for CSF lost >3 drops) (Weji et al., 2020). Similarly, larger-bore needles (21G/22G)

more than doubled the odds of developing a PDPH (35.0%) versus the use of fine-gauge needles (25G) (16.0%) (Weji et al., 2020). Together, these comparisons demonstrate that cumulative dural trauma from repeated punctures may be as great or greater as the baseline risk of larger needle gauges.

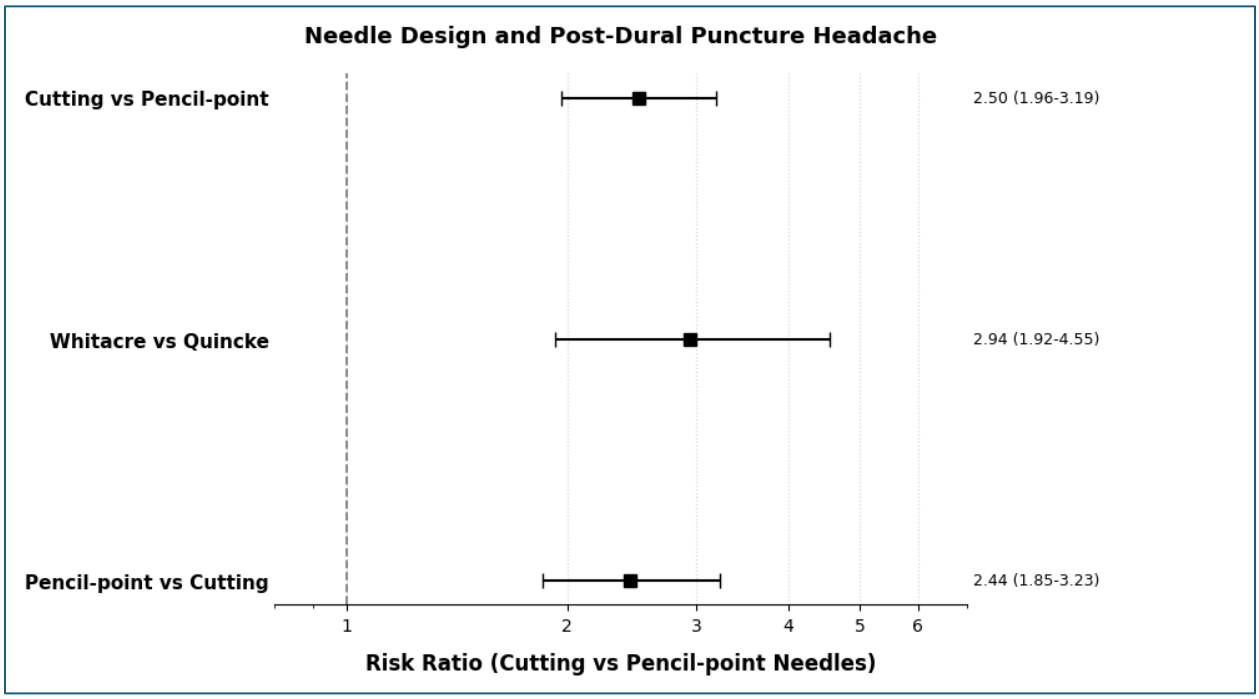

Figure 2: Forest plot comparing PDPH risk across different spinal needle designs using risk ratios and 95% confidence intervals.

Procedural Factors and Post-Dural Puncture Headache (PDPH) Incidence

Incidence of PDPH and Procedural Factors Technical and procedural variables can be analyzed and show significant increases in post-dural puncture headache (PDPH) when there are deviations from optimal single-pass conditions (Figure 3). The highest difference between the different attempts was seen in the incidence of PDPH, which rose from 23.7% for a single pass to 63.2% when multiple passes were needed, a 39.5 percentage point increase (Weji et al., 2020). The orthopedic surgical group had a similar trend with a 17.5% incidence of PDPH in the first surgery compared to 33.3% in the second (Oumer et al., 2023). CSF loss was also a cause of significant increases in incidence of postoperative headache (Figure 3) as was larger needle diameter. If CSF was drained more than three times before injecting the local anesthetic, the incidence of PDPH increased from 21.4% to 44.7%, which is more than a double rate (Weji et al., 2020). Similarly, using larger bore spinal needles (21G/22G) raised the PDPH incidence to 35.0% versus 16.0% with the use of fine gauge spinal needles (25G) (Weji et al., 2020). These all suggest that, at least in some cases, multiple passes of the dural needle or too much fluid removal can have as much or more harm as increased needle gauge.

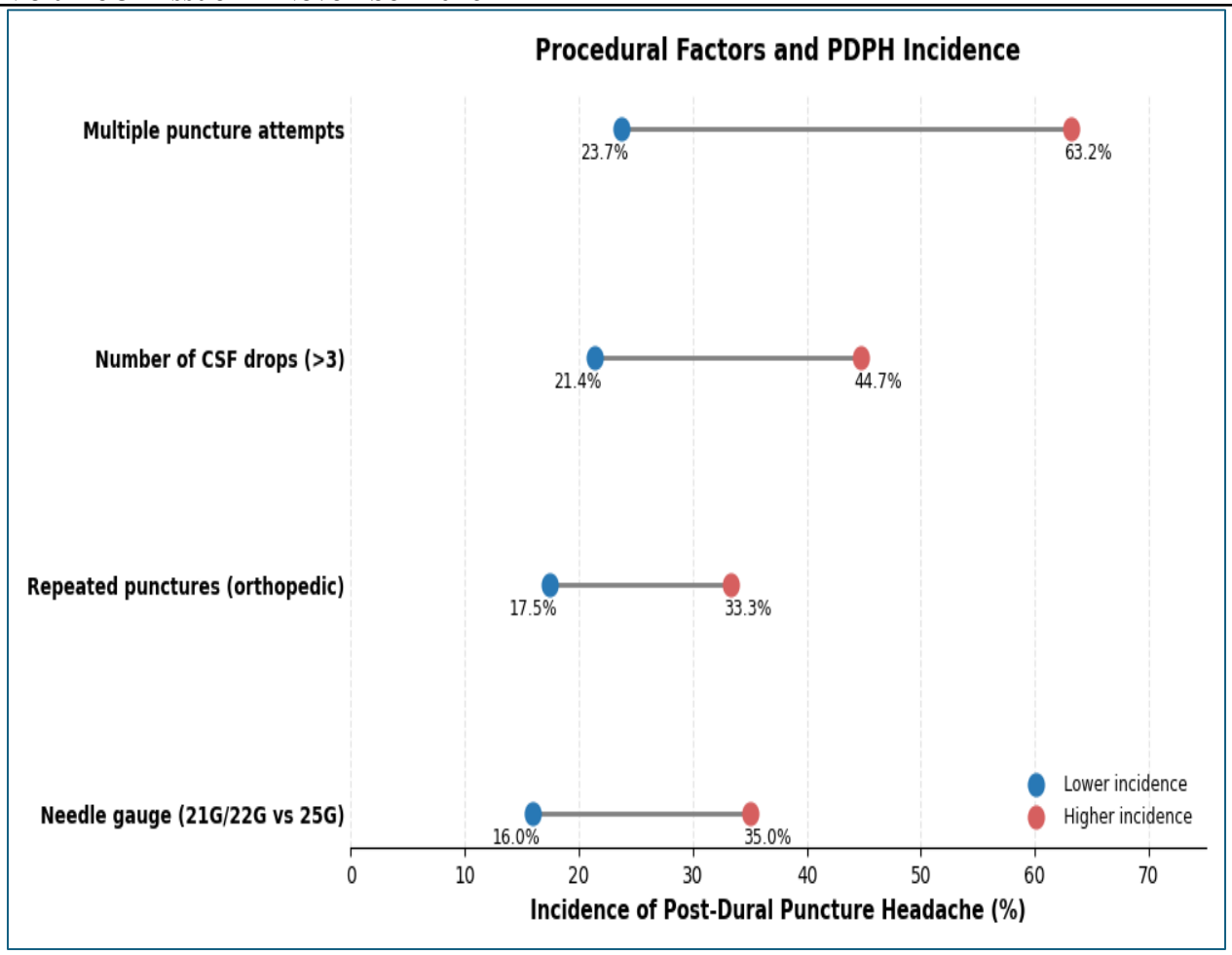

Figure 3: Dumbbell plot illustrating differences in PDPH incidence across procedural factors and spinal needle gauges

PDPH Incidence Across Different Age Groups

Rate of PDPH by age group The incidence of Post-Dural Puncture Headache (PDPH) is shown in Figure 4 by age group. Middle aged adults (30-59 years) had the highest incidence with 31.4% (11/35) of patients suffering from PDPH. In comparison, the incidence was 12.1% (4/33) among younger adults (15-29 years) and 14.8% (4/27) among older adults (≥60 years). This suggests that there is a higher percentage of middle-aged patients with PDPH than in younger patients, or older patients. Notably, the incidence of PDPH was around 2.6 times greater in the middle age group compared to the younger group. This is an unusual pattern when compared to the usual expectation that older adults are more likely to develop PDPH and suggests that age and population may be important factors in influencing the occurrence of PDPH.

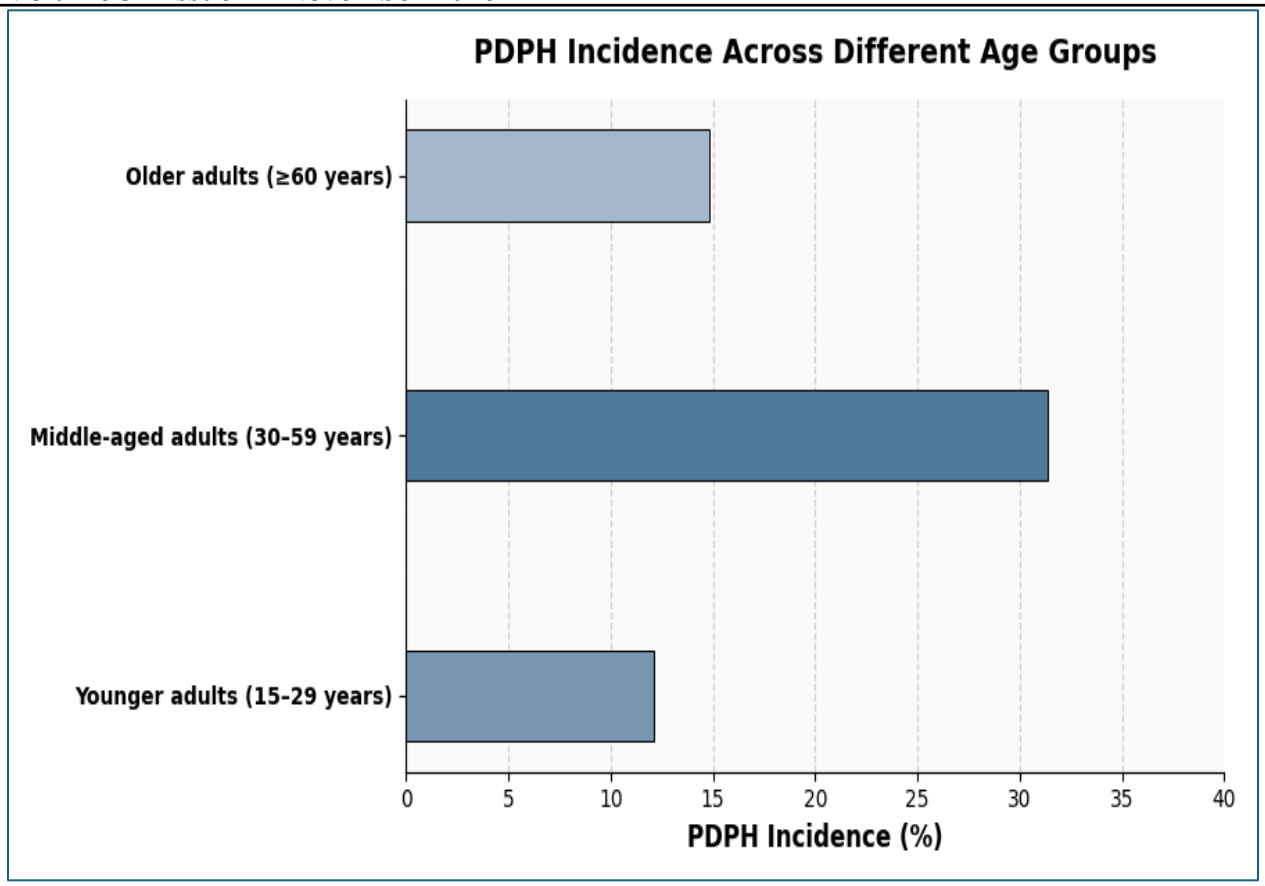

Figure 4: Bar graph showing PDPH Incidence Across Different Age Groups

Discussion

Summary of Included Literature and Key Findings

The studies summarized in Table 1 demonstrate considerable variation in the reported incidence of post-dural puncture headache (PDPH) following spinal anesthesia. The incidence ranged from 2.0% to 38.8%, suggesting substantial differences between clinical populations, procedural practices, and spinal needle characteristics. Higher frequencies were reported in the Ethiopian obstetric and general surgical populations, including 28.7% among cesarean patients (Gedefaw et al., 2020; Taye et al., 2021) and 38.8% in the general surgical population (Kassa et al., 2015, as cited in Weji et al., 2020). Similarly, Oumer et al. (2023) reported an incidence of 20.0% among orthopedic patients. In contrast, lower frequencies were reported in the United States and Germany, where the incidence was 2.0% and 5.9%, respectively, according to the secondary citations presented in the reviewed literature.

These differences may reflect variations in needle diameter, needle-tip configuration, patient characteristics, and procedural experience. Weji et al. (2020) identified needle size and multiple puncture attempts as important predictors of PDPH, whereas Oumer et al. (2023) reported a significant association between middle age and PDPH. The contrasting findings indicate that the risk of PDPH cannot be explained by needle characteristics or demographic factors independently. Instead, the interaction between patient susceptibility and procedural variables should be considered when interpreting differences across studies (Bayram & Dolğun, 2026; Zorrilla-Vaca et al., 2018). Furthermore, because several studies in Table 1 are reported through secondary citations, their findings

should be interpreted cautiously until the original publications have been checked.

Comparison of Overall PDPH Incidence Across Populations

Table 2 highlights differences in PDPH incidence between obstetric and orthopedic populations. The reported overall epidemiological range was 10–40% following spinal anesthesia (Weji et al., 2020). Within the specific cohorts, obstetric patients undergoing cesarean delivery demonstrated a higher incidence of 28.7%, compared with 20.0% among orthopedic patients (Vaajala et al., 2022; Zięt ek et al., 2023). This difference may be associated with variations in age distribution, sex, physiological characteristics, and procedural circumstances.

The relatively high incidence among obstetric patients may partly reflect the demographic characteristics of this population, as younger age and female sex have been associated with increased susceptibility to PDPH. However, the difference between these two cohorts cannot be attributed exclusively to pregnancy-related hormonal changes or dural elasticity because the studies were not direct comparative investigations. Differences in needle selection, operator experience, and postoperative assessment may also have contributed. Therefore, the findings suggest that the clinical population is an important consideration when interpreting PDPH incidence, but they do not establish that obstetric status independently increases risk ((Sohail, 2026; Khan et al., 2026; Khan et al., 2025; Fredrickson et al., 2009).

Symptom Profiles, Associated Clinical Features, and Severity Distribution of PDPH

The findings presented in Table 3 demonstrate that PDPH may involve several associated clinical manifestations beyond the characteristic postural headache. In the orthopedic cohort, tinnitus was reported in 30.2% of affected patients, followed by neck stiffness (28.3%), photophobia (22.6%), and nausea and vomiting (18.9%). These symptoms are consistent with the clinical consequences of reduced CSF volume and altered intracranial pressure following dural puncture (Fredrickson et al., 2009; Poredoš, 2022).

Regarding headache severity, 10.5% of the overall study population experienced mild pain, while 9.5% experienced moderate pain. No severe headache was documented, and 80.0% of the participants were classified as having no headache. These findings indicate that PDPH severity may vary considerably between individuals and that the presence of the complication does not necessarily imply severe clinical impairment. Nevertheless, the absence of severe headache in this relatively small cohort should not be generalized to all patients undergoing spinal anesthesia.

Uppal et al. (2024) emphasize the importance of recognizing PDPH because persistent or severe cases may interfere with mobility, daily activities, and postoperative recovery. In addition, uncommon but potentially serious complications, including subdural hematoma and cerebral venous sinus thrombosis, have been described in association with dural puncture. Therefore, systematic postoperative assessment and timely clinical management remain important, even when initial symptoms appear mild (Kapan et al., 2024; Janvier & Russell, 2022).

Impact of Spinal Needle Gauge and Diameter on PDPH Risk

Table 4 demonstrates the clinical importance of spinal needle diameter in relation to PDPH development. Larger-bore needles, particularly those within the 18G–23G range, may produce greater dural disruption and permit increased CSF leakage compared with finer needles. In the reviewed studies, PDPH incidence was reported as 20.0% in orthopedic patients and 28.7% in obstetric patients using the reported needle ranges (Thyagaraju, 2015; Niemantsverdriet et al., 2015).

Conversely, finer spinal needles, particularly 25G–27G, are generally associated with reduced dural trauma. Weji et al. (2020) identified needle size as a significant predictor of PDPH in their obstetric cohort. These observations are

supported by the meta-analysis of Nath et al. (2018), which demonstrated a lower incidence of PDPH with atraumatic pencil-point needles compared with conventional cutting needles. Similarly, Uppal et al. (2024) recommend appropriate needle selection and the preferential use of non-cutting needles to reduce the risk of PDPH (Stevens, 2003; Omole & Ogunbanjo, 2015).

Needle gauge and needle-tip design should be considered separately. A smaller-gauge needle does not necessarily have the same clinical effect as a pencil-point needle of a different gauge. In addition, very fine needles may present technical challenges in certain circumstances. Consequently, needle selection should balance the reduction of dural injury with procedural feasibility and the experience of the anesthetist.

Temporal Patterns of PDPH Onset and Spontaneous Resolution Following Spinal Anesthesia

Figure 1 illustrates the timing of PDPH development and its subsequent spontaneous resolution. According to Oumer et al. (2023), 52.6% of affected patients developed headache within the first 12 hours following spinal anesthesia, whereas 47.4% experienced symptoms between 12 and 72 hours. This distribution indicates that although PDPH may develop relatively early, a substantial proportion of patients experience delayed symptom onset. These observations support the importance of postoperative monitoring beyond the immediate recovery period (Lybecker et al., 1995; Schyns-van Den Berg et al., 2024).

Regarding spontaneous resolution, approximately 75% of untreated cases recovered within one week, increasing to 88% within six weeks. However, 12% of patients continued to experience symptoms beyond six weeks (Oumer et al., 2023). The recovery pattern suggests that most patients experience gradual improvement without invasive treatment, although persistent cases may require additional clinical assessment. The findings are consistent with the recognized natural history of PDPH, in which symptoms frequently improve over time as the dural defect heals and CSF leakage decreases. Nevertheless, prolonged or severe symptoms should not be ignored because they may interfere with daily activities and postoperative rehabilitation. Uppal et al. (2024) recommend appropriate follow-up and individualized management, including consideration of an epidural blood patch when conservative treatment is insufficient (Wallentin et al., 2000; Cima et al., 2019).

Forest Plot Comparing PDPH Risk Across Different Spinal Needle Designs

Figure 2 presents a comparative assessment of PDPH risk associated with different spinal needle designs. The clinical importance of this comparison lies in the distinction between cutting and non-cutting needle configurations. Conventional cutting needles, such as Quincke needles, penetrate the dura by cutting its fibres, whereas pencil-point needles are designed to separate dural fibres and reduce tissue disruption. The broader evidence supports a lower risk of PDPH with pencil-point needles. Zorrilla-Vaca et al. (2018), in a meta-analysis of 57 randomized controlled trials involving 16,416 participants, reported a significantly reduced risk of PDPH with pencil-point needles compared with cutting needles (RR = 0.41, 95% CI: 0.31–0.54). This represents an approximately 59% relative reduction in risk (Zorrilla-Vaca et al., 2018; Xu et al., 2017). The findings provide strong support for selecting atraumatic spinal needles when clinically appropriate. Similarly, the multisociety guidelines by Uppal et al. (2024) identify non-cutting needle designs as an important preventive measure.

However, the findings of Oumer et al. (2023) did not establish a statistically significant independent association between needle type and PDPH in their orthopedic cohort. This may reflect the limited sample size and the distribution of needle types within that particular study (Ismail et al., 2026). Therefore, the absence of statistical significance in an individual cohort should not outweigh the broader evidence from randomized trials. The choice of needle should

consider both its gauge and tip configuration rather than treating these characteristics as interchangeable.

Differences in PDPH Incidence Across Procedural Factors and Spinal Needle Gauges

Figure 3 demonstrates the relationship between procedural characteristics and the incidence of PDPH, highlighting the importance of minimizing unnecessary dural trauma. The greatest absolute difference was observed in relation to the number of puncture attempts. (Al-Hashel et al., 2022; Islam, 2024) reported that PDPH incidence increased from 23.7% following a single attempt to 63.2% after multiple attempts, representing an absolute increase of 39.5 percentage points. A similar pattern was reported by Oumer et al. (2023), in which the incidence increased from 17.5% following the first attempt to 33.3% following a second attempt.

CSF loss also demonstrated an important association with PDPH occurrence. Weji et al. (2020) reported an incidence of 21.4% among patients experiencing CSF loss of three drops or fewer, compared with 44.7% among patients experiencing greater CSF loss. This finding supports the proposed mechanism that increased CSF leakage may contribute to reduced intracranial CSF volume and subsequent traction on pain-sensitive structures (Purcell & Illing, 2026; Liu et al., 2024).

Needle diameter demonstrated a comparable pattern. The reported incidence was 35.0% with larger-bore 21G/22G needles, compared with 16.0% with 25G needles (Weji et al., 2020). These differences suggest that needle diameter and procedural execution are important considerations in PDPH prevention. Nevertheless, the observed differences are descriptive comparisons and should not automatically be interpreted as independent causal effects because patient characteristics and procedural circumstances may also influence the outcomes.

The overall pattern is consistent with the multisociety guidelines, which identify needle type, needle size, number of attempts, and operator experience as relevant procedural considerations (Uppal et al., 2024). Therefore, minimizing unnecessary punctures, using appropriate needle designs, and improving technical proficiency may collectively reduce the likelihood of PDPH.

PDPH Incidence Across Different Age Groups

Figure 4 shows the results of Oumer et al. (2023) on the variation in PDPH incidence over adult age groups. The highest incidence was seen in middle age adults (31.4%) followed by older age adults (14.8%) and younger adults (12.1%). These proportions were used to estimate the incidence of the middle aged group to be over 2 times greater than that of the younger or older age groups. In contrast, this is not the usual set of epidemiological expectations that would expect younger adults to be most at risk because of their high dural elasticity. Additionally, middle age adults had significantly elevated adjusted odds ratio (AOR = 12.15, 95% CI: 1.77-83.48; p = 0.011) in the multivariable regression analysis of the original study. There is a significant match of the observed frequency and adjusted risk, suggesting a possible effect of the changes in the spinal ligaments with age, technical puncture difficulty or a cohort-specific effect that would change the traditional risk curves. However, more large-scale prospective studies are needed to firmly establish patient age as an independent predictor of the development of PDPH (Dagenais et al., 2020; Song et al., 2023).

Conclusion

Post-dural puncture headache (PDPH) is still a clinically relevant complication after spinal anesthesia, with its epidemiology being highly variable and different factors affecting its occurrence. There is synthesized evidence to suggest that multiple dural puncture attempts, excessive CSF egress (larger-bore needles, 18G-23G) and the use of fine-gauge needles (25G-27G) and atraumatic pencil-point increase the incidence of headache, while atraumatic pencil-point provides strong mechanical protection. Additionally, although obstetric parturients are

known to be at high risk for PDPH because of age- and hormonally-related physiological and hormonal changes, new cohort-based studies suggest that middle-aged adults (30–59 years) may also have higher PDPH adjusted odds, challenging traditional age-risk paradigms. While the majority of cases present in 72 hours or less and heal spontaneously over 6 weeks, proactive prevention, which involves choosing fine-gauge non-cutting needles, limiting dural passes and ensuring structured postoperative follow-up, is essential to ensure optimal surgical recovery and patient safety.

Declarations

Consent for publication

All subjects gave their "informed consent" for the publication of details within the text ("informed consent") to be published in the above Journal and Article. Written "informed consent" was obtained from all authors for the publication of this manuscript.

Availability of data and materials

Data are provided within the manuscript or supplementary information files.

Competing Interest

All authors declare that there are no competing interests.

Conflict of interest

All the authors declare no conflicts of interest.

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