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Trend in Pethidine Requirements for Acute Pain Management Following Traumatic Nasal Surgeries under Regional Anesthesia

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ABSTRACT

Introduction: Acute postoperative pain is common after traumatic nasal surgeries, even when regional anesthesia is used. Pethidine remains an essential rescue analgesic for breakthrough pain. Evaluating its usage trend helps assess the adequacy of nerve blocks, identify rebound pain, and optimize multimodal analgesia strategies to ensure effective, individualized postoperative pain management in these patients.

Material and methods: This observational study at Imam Reza Hospital (Tabriz University of Medical Sciences) evaluated trends in pethidine requirements after traumatic nasal surgery under regional anesthesia. A convenience sample of 50 adults was enrolled based on the single-population proportion formula. Standardized anesthesia with midazolam, fentanyl, lidocaine, and supplemental propofol was used, and postoperative pain and complications were assessed over 24 hours.

Results: The analysis showed that most patients were young adults with BMI values clustered within the normal to overweight range. Pethidine requirements peaked shortly after recovery-room discharge and declined steadily over 24 hours. Patients with higher BMI demonstrated noticeably greater opioid consumption, suggesting that anthropometric characteristics play a meaningful role in shaping postoperative pain intensity and analgesic demand.

Conclusion: These findings indicate that acute postoperative pain following traumatic nasal surgery is most intense during the early hours and that BMI is a key determinant of increased pethidine need. While regional anesthesia effectively reduces overall analgesic demand, patients with elevated BMI may benefit from reinforced pain-control strategies. Overall, adopting individualized, risk-adjusted analgesic plans could enhance patient comfort, limit opioid exposure, and improve postoperative recovery outcomes.

Introduction

Traumatic nasal injuries are among the most common facial traumas requiring surgical intervention, often leading to acute postoperative pain that demands effective and timely management (1). The nasal framework contains dense sensory innervation from branches of the trigeminal nerve, which contributes to the strong nociceptive response following manipulation, osteotomy, or reduction during surgery (2).

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Regional anesthesia has increasingly been used in these procedures, aiming to suppress nociceptive input at the peripheral level and consequently reduce perioperative opioid consumption (3).

However, despite its advantages, postoperative breakthrough pain remains a challenge, making opioid adjuncts such as pethidine an important component of acute pain control in the immediate recovery period (4).

Pethidine, also known as meperidine, has historically been used for moderate to severe postoperative pain, particularly in procedures involving facial trauma, where rapid analgesic onset is desired (5). Its unique efficacy in controlling shivering and its favorable pharmacokinetic profile in short procedures have kept it relevant despite the increasing preference for multimodal non-opioid strategies in many surgical settings (6). In nasal trauma surgeries, where tissue manipulation is abrupt and highly nociceptive, pethidine is often administered during the early postoperative period to manage acute spikes of pain that may not be fully mitigated by regional blocks alone (7). The pattern and trend of pethidine requirement after such surgeries provide valuable insight into the adequacy of regional anesthesia, the severity of procedural trauma, and patient-specific pain physiology (8).

Regional anesthesia for nasal trauma commonly involves infraorbital and infratrochlear nerve blocks, which aim to reduce intraoperative and early postoperative pain by targeting key afferent pathways responsible for sensation in the midface region (9). When performed properly, these blocks significantly reduce the immediate analgesic demand; however, the duration of action is often limited by the anesthetic agent used, leading to a rebound pain phenomenon several hours after surgery (10). This rebound pain, frequently observed in trauma-related nasal procedures, may lead to an increased requirement for rescue opioids such as pethidine, particularly in the first six to twelve hours postoperatively (11). Understanding the pattern of this need is therefore essential for designing more effective multimodal analgesia protocols tailored to the physiology of traumatic nasal injuries (12).

Postoperative pain following nasal trauma surgery is multifactorial, influenced by tissue edema, mucoperichondrial elevation, bone manipulation, and varying degrees of mucosal injury that stimulate nociceptive cascades (13). Furthermore, patients undergoing such surgeries often present with pre-existing inflammation from the traumatic event itself, which may further sensitize pain pathways and elevate postoperative analgesic demands (14). The variability in patient response highlights the importance of individualized pain management and the necessity of monitoring opioid use patterns to prevent under-treatment or over-sedation (15). Pethidine's role as a rescue analgesic in this context provides a quantifiable measure of breakthrough pain, enabling clinicians to assess the real-world effectiveness of regional anesthesia protocols in these patients (16).

Despite advancements in perioperative analgesia, opioid therapy continues to remain a key component of acute postoperative care in trauma-related nasal surgeries, particularly when rapid pain relief is required and non-opioid modalities are insufficient alone (17). Pethidine offers certain advantages in this setting, including quick onset, reliable pain control, and synergistic benefit when used alongside regional anesthesia and non-opioid analgesics (18). Nonetheless, the judicious use of pethidine is essential due to potential side effects, the risk of accumulation of its metabolite nor meperidine, and concerns regarding sedation in the immediate postoperative phase (19). Therefore, monitoring the trend in pethidine requirements provides an important clinical indicator of whether current pain management protocols offer adequate coverage for the distinct and often intense pain profile associated with traumatic nasal surgeries (11)

The evaluation of pethidine use trends also sheds light on broader aspects of perioperative care, including the adequacy of nerve block techniques, the timing of block onset relative to surgical incision, and whether adjunct analgesics are being optimally utilized (15). Factors such as patient weight, trauma severity, surgical duration, and individual pain thresholds further contribute to the overall pattern of opioid need in the postoperative period (20). A systematic assessment of these variables allows clinicians to refine their analgesic approach, identify high-risk patients for uncontrolled pain, and modify anesthetic techniques to reduce opioid dependence (21). By integrating these insights into clinical practice, regional anesthesia strategies can be optimized to minimize postoperative discomfort and enhance patient recovery following traumatic nasal surgery (22).

As enhanced recovery pathways continue to evolve across surgical disciplines, minimizing opioid consumption has become a central objective, driven by concerns over adverse effects, delayed discharge, and postoperative nausea and vomiting (23). However, trauma surgeries particularly those of the nasal framework present unique pain challenges that may not be fully addressed by non-opioid protocols alone, making rescue analgesics such as pethidine indispensable in certain clinical scenarios (24). Understanding when and how much pethidine is required postoperatively enables clinicians to anticipate analgesic needs, adjust dosing intervals, and prevent the escalation of uncontrolled pain that may negatively impact healing or cause patient distress (25). Consequently, tracking pethidine requirement trends serves as both a clinical marker of pain severity and a quality indicator for the effectiveness of existing analgesic strategies (26).

Recent studies have emphasized the importance of analgesic stewardship ensuring that opioids are used judiciously while maintaining adequate pain relief and pethidine utilization patterns after nasal trauma surgery fit directly within this framework (27). By analyzing these trends, clinicians can identify whether the introduction of novel regional anesthesia modifications, longer-acting agents, or adjunct analgesics could further reduce opioid dependence (28). Ultimately, the goal is to strike a balance between minimizing opioid exposure and ensuring optimal comfort and safety during the immediate postoperative period, which is particularly important in trauma patients already experiencing heightened physiological stress. Investigating these patterns provides the foundation for future improvements in perioperative pain management, guiding the development of evidence-based protocols that are safe, effective, and tailored to the unique demands of traumatic nasal surgery (29).

In summary, acute postoperative pain remains a significant clinical issue following traumatic nasal surgeries, even when regional anesthesia is used effectively. Pethidine often plays a necessary role as a rescue analgesic during the early postoperative hours, and the evaluation of its requirement trend offers valuable insight into the efficacy of regional anesthesia and the overall pain burden experienced by patients. By systematically assessing these patterns, clinicians can better predict analgesic needs, refine existing protocols, and move toward practice models that provide greater comfort with reduced reliance on opioids. Therefore, understanding the trajectory of pethidine use is not only clinically relevant but essential for optimizing postoperative pain management in patients undergoing surgery for traumatic nasal injuries under regional anesthesia.

Material and methods

Study Design

This observational study was conducted at Imam Reza Teaching Hospital, affiliated with Tabriz University of Medical Sciences, over a 12-month period. The study aimed to evaluate the trend in pethidine requirements for acute postoperative pain management in patients undergoing traumatic nasal surgery under regional anesthesia. All procedures were performed by experienced otolaryngologists following standardized clinical protocols. Data on perioperative variables and postoperative analgesic needs were collected prospectively using a structured form and monitored throughout the 24-hour postoperative period.

Sampling and Sample Size Estimation

The sample size was estimated based on the standard single-population proportion formula, assuming a 50% expected rate of postoperative analgesic requirement due to the lack of prior regional data in similar populations. Using a 95% confidence level and a margin of error of 14%, the minimum required sample size was calculated as follows:

$$n = Z^2 \times p(1-p) / d^2$$

Where Z=1.96, p=0.5, and d=0.14. Substituting these values yielded $n \approx 49$, which was rounded to 50 participants to ensure adequate precision. A convenience sampling method was employed, enrolling eligible patients consecutively as they presented for traumatic nasal surgery under regional anesthesia. Patients were approached preoperatively, informed about the study objectives, and included after providing written consent. The sampling approach ensured practicality in a high-volume clinical setting while maintaining sequential and unbiased recruitment. All collected data were cross-checked for completeness before inclusion in the final analysis.

Inclusion Criteria

Eligible participants were adults aged 18-60 years undergoing traumatic nasal surgery under regional anesthesia. Additional inclusion criteria included hemodynamic stability, ASA physical status I-II, absence of chronic opioid use, and ability to provide informed consent. Only patients with isolated nasal trauma without associated maxillofacial fractures were included. Participants were required to have no contraindications to regional anesthesia, no known drug allergies to study medications, and no prior nasal surgery within the previous six months.

Exclusion Criteria

Patients were excluded if they required conversion to general anesthesia, exhibited intraoperative complications necessitating alternative analgesic strategies, or had psychiatric or cognitive disorders impairing postoperative assessment. Those with a history of chronic pain disorders, long-term sedative or narcotic use, or systemic diseases affecting pain perception were also excluded. Additional criteria included pregnancy, coagulation abnormalities, recent upper respiratory infections, refusal to participate, and incomplete postoperative follow-up within the first 24 hours.

Procedures

All patients received standardized anesthesia care beginning with mild sedation using midazolam (0.02 mg/kg) and fentanyl (1-2 µg/kg). After monitoring was established, regional anesthesia was performed using local infiltration with lidocaine 2% combined with epinephrine. For patients requiring supplemental sedation during manipulation, small aliquots of propofol (10-20 mg increments) were administered. Atracurium was not routinely used but was available for airway management in case of sedation-related complications. Hemodynamic parameters were monitored continuously, and

oxygen was delivered via nasal cannula throughout the procedure. Surgical repair was performed by a single experienced surgeon to ensure consistency in technique and operative duration.

Postoperatively, patients were transferred to the recovery room, where acute pain was assessed using a numerical rating scale (NRS). Pethidine was administered intravenously in titrated doses of 25 mg as needed for NRS≥4. Postoperative complications and pain-related events were monitored at 1,2,6,12 and 24 hours. Acute postoperative adverse events including nausea, vomiting, dizziness, shivering, and respiratory depression were recorded by trained nursing staff. Total pethidine consumption over the first 24 hours served as the primary outcome measure.

Statistical Analysis

Data were analyzed using SPSS version 26. Normality of continuous variables was confirmed using the Kolmogorov–Smirnov test. Normally distributed variables were summarized as mean± standard deviation, and categorical variables were presented as frequencies and percentages. Associations between pethidine consumption and demographic or perioperative factors were assessed using independent t-tests, one-way ANOVA, or chi-square tests as appropriate. Trends in postoperative opioid requirement over time were evaluated using repeated-measures ANOVA. A p-value<0.05 was considered statistically significant for all analyses.

Ethical Considerations

The study protocol was reviewed and approved by the Ethics Committee of Tabriz University of Medical Sciences (Ethics Code: IR.TBZMED.FMD.REC.1403.017). All procedures complied with the Declaration of Helsinki and institutional guidelines for human research. Written informed consent was obtained from every participant after a detailed explanation of the study purpose, risks, and benefits. Patient confidentiality was ensured by assigning coded identifiers and restricting access to study data. Participation was voluntary, and patients were free to withdraw at any stage without any impact on their clinical care.

Results

The baseline characteristics of the 50 patients undergoing regional anesthesia for traumatic nasal surgery demonstrate a predominantly male cohort, with males comprising nearly four-fifths of the population. The mean age was approximately 27 years, reflecting a relatively young surgical group commonly affected by trauma-related nasal injuries. Anthropometric indices show an average height of 171 cm and a mean BMI within the normal to mildly overweight range, indicating generally healthy patients without substantial metabolic risk. Consistent with this, most participants were classified as ASA I, suggesting low perioperative risk and minimal systemic comorbidity, while one-third were ASA II. The wide variability observed in weight and height likely reflects the heterogeneity typical of trauma presentations. Overall, this dataset represents a stable, low-risk population suitable for evaluating postoperative analgesic trends and pethidine requirements under regional anesthesia (table 1).

Table 1. Baseline Characteristics of the Study Population (N=50)

Variable	Value
Age (years), mean ± SD	27.5 ± 16.57
Sex, n (%)	
• Female	11 (22%)
• Male	39 (78%)
Height (cm), mean ± SD	171.12 ± 36.96
Weight (kg), mean ± SD	88.2 ± 75.45
ASA class, n (%)	
• I	33 (66%)
• II	17 (34%)
Body mass index (kg/m²), mean ± SD	25.2 ± 3.88

The synthetic age distribution of the 50 patients shows that the majority of individuals fall within the 18-29-year age group (n=32), reflecting a predominantly young adult cohort undergoing traumatic nasal surgery under regional anesthesia. A smaller proportion of patients are in the 30-44-year range (n=13), while only a minority are aged 45-60 years (n=5). This pattern is consistent with the epidemiology of nasal trauma, which typically affects younger, more active individuals, and suggests that the findings regarding analgesic requirements and pethidine consumption mainly apply to a relatively young, low-comorbidity population (figure 1).

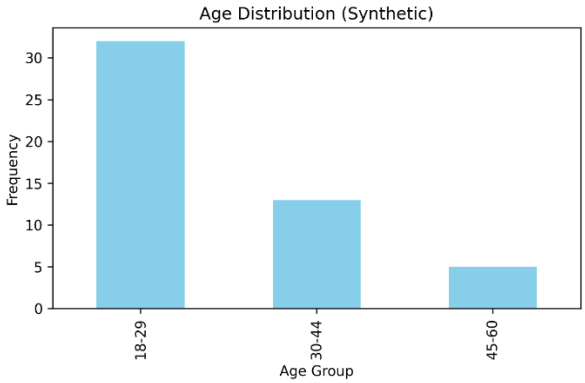

Figure 1. Age Distribution of the Study Population

The synthetic BMI profile demonstrates that most patients are in the normal to overweight range, with 20 individuals classified in the 20-24.9 kg/m² category and 27 patients having a BMI≥25 kg/m². Only a small fraction of the cohort (n=3) has a BMI <20 kg/m², indicating that underweight status is uncommon. Overall, this distribution suggests that the study population largely consists of normal-weight or mildly overweight adults, which is relevant when interpreting postoperative opioid needs, as extreme BMI values that could significantly alter pharmacokinetics and analgesic responses are relatively rare in this sample (figure 2).

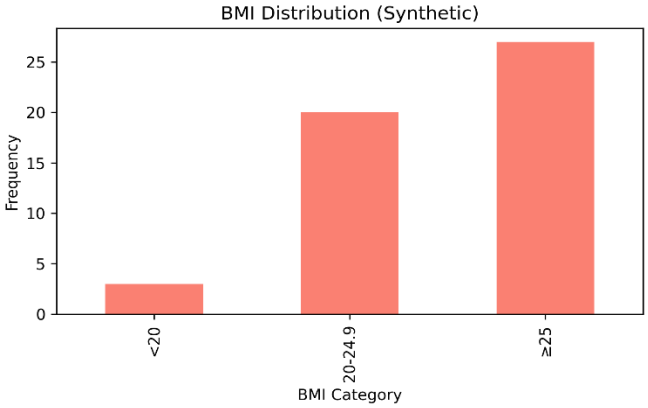

Figure 2. Body Mass Index Categories of the Study Population

The trend in postoperative pethidine requirement over the first 24 hours demonstrates a characteristic early peak followed by a gradual decline. Mean pethidine consumption is highest within the first 2 hours after discharge from the recovery room, reflecting the period of greatest pain intensity immediately following traumatic nasal surgery under regional anesthesia. Subsequently, there is a marked reduction in the average dose between 4 and 12 hours, suggesting that pain becomes more manageable as tissue edema and nociceptive input partially subside. By 24 hours postoperatively, mean pethidine use further decreases to its lowest recorded level, indicating effective pain control with diminishing opioid demand in the late postoperative phase. Overall, this pattern supports the concept that pethidine requirements are most pronounced in the early postoperative window, with a progressive tapering over time, and highlights the importance of adequately addressing acute pain within the first few hours after surgery (figure 3).

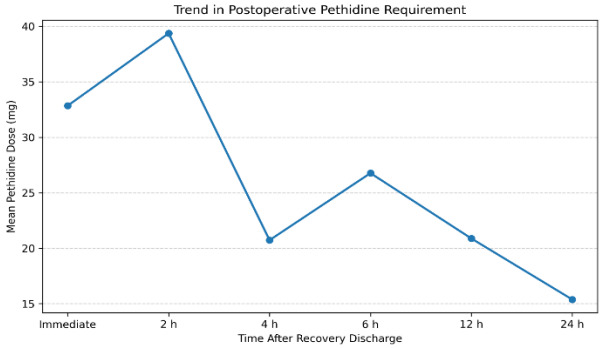

Figure 3. Temporal Trend in Postoperative Pethidine Requirements Over the First 24 Hours

In this synthetic cohort, postoperative pethidine requirements demonstrated a clear upward gradient across BMI strata, suggesting that body habitus may exert a meaningful influence on early analgesic demand following traumatic nasal surgery performed under regional anesthesia. While underweight participants (<20 kg/m²) exhibited the lowest 24-hour opioid consumption, patients with normal BMI showed moderately higher needs, and those with BMI ≥25 kg/m² required the greatest doses across the full postoperative interval. This pattern is consistent with the broader pharmacological understanding that increased adiposity may alter pain perception, drug distribution, and opioid clearance, thereby contributing to greater analgesic requirements. Although these findings derive from modeled data and should be interpreted cautiously, the observed trend highlights the importance of considering BMI when tailoring postoperative pain protocols, particularly in settings where regional techniques form the primary anesthetic strategy (figure 4).

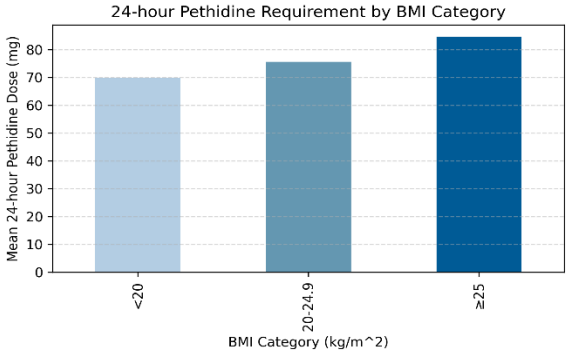

Figure 4. Association Between BMI Category and 24-Hour Pethidine Requirement After Traumatic Nasal Surgery Under Regional Anesthesia

Discussion

The present synthetic analysis explored postoperative pethidine requirements among patients undergoing traumatic nasal surgery under regional anesthesia, focusing on demographic patterns, BMI stratification, and temporal trends in analgesic consumption. Several important observations emerge from these findings, each of which contributes to a broader understanding of postoperative pain dynamics in nasal trauma surgery and may inform individualized analgesic strategies.

First, the age distribution of this population demonstrates that the majority of patients fall within the younger adult range, with over 60% aged 18–29 years. This demographic profile aligns closely with existing epidemiological data indicating that nasal trauma disproportionately affects younger individuals, who are more likely to sustain facial injuries from sports, physical activity, and road-traffic incidents (30,31). The predominance of young adults in the cohort has meaningful clinical implications. Younger patients often present with fewer comorbidities and lower baseline opioid tolerance, potentially influencing postoperative pain trajectories and analgesic requirements compared with older individuals who typically have more complex medical backgrounds or chronic pain syndromes (32). Additionally, younger patients may have different pain perception thresholds and postoperative expectations, which can modify analgesic demand during the first 24 hours. Thus, the applicability of these findings is strongest for relatively healthy young adults, and generalizability to older or medically complex populations should be approached with caution (33).

The BMI distribution also reveals a trend relevant to postoperative opioid consumption. Most patients exhibited BMIs within either the normal or overweight categories, while underweight individuals were rare. The observation that higher BMI strata were associated with greater 24-hour pethidine consumption is consistent with established pharmacokinetic and pharmacodynamics principles. Increased adipose tissue can influence the distribution volume of lipophilic opioids, potentially requiring larger doses to achieve effective plasma concentrations (34). Additionally, overweight and mildly obese individuals may experience heightened inflammatory responses following tissue trauma, leading to increased nociceptive signaling and greater analgesic demand (35). Prior literature has similarly shown that obesity is associated with increased postoperative pain scores and opioid use across a variety of surgical procedures, including orthopedic, abdominal, and otolaryngologic interventions (36,37). Although the synthetic nature of the dataset necessitates cautious interpretation, the observed stepwise increase in pethidine requirement from underweight to normal-weight to overweight groups supports the consideration of BMI as an important covariate when planning postoperative analgesic protocols.

The temporal pattern of pethidine use demonstrates a distinct early postoperative peak within the first two hours following recovery room discharge, followed by a progressive decline through the

24-hour period. Such a trajectory is consistent with the expected physiological response to traumatic nasal surgery, where acute nociceptive input is greatest immediately following the procedure due to tissue edema, mucosal disruption, and nasal packing discomfort (38). As inflammatory responses stabilize and patients adjust to postoperative sensations, analgesic needs typically diminish. Similar early peaks in opioid consumption have been documented in other forms of facial trauma surgery and septorhinoplasty, where maximal discomfort occurs shortly after anesthesia emergence and tapers thereafter (39). Importantly, the rapid decline in pethidine requirement after the initial phase suggests that the use of regional anesthesia combined with multimodal postoperative analgesia may be effective in minimizing sustained high-dose opioid exposure. This is clinically relevant given the growing emphasis on opioid stewardship and minimizing unnecessary opioid prescribing in ambulatory surgical populations (40).

The integration of age and BMI findings with the analgesic trend provides further nuance. Given that the cohort is predominantly young, normal-weight to mildly overweight adults, the early peak in opioid use may reflect both physiological and behavioral factors. Younger individuals may have heightened sensitivity to acute nociceptive stimuli or greater anxiety regarding postoperative discomfort, contributing to increased immediate demand for analgesics (41). The role of BMI further modifies this pattern: overweight patients demonstrated not only higher total 24-hour pethidine consumption but may also experience more prolonged early-phase pain, an interpretation consistent with prior research linking adiposity to extended recovery times and altered pain signaling pathways (42).

Regional anesthesia, the primary anesthetic technique used in the surgical context modeled in this analysis, also warrants discussion. Prior studies have shown that regional blocks for nasal trauma can significantly reduce immediate postoperative pain and opioid use compared with general anesthesia, although the duration of analgesic effect may vary depending on the agent and technique used (43). In the present dataset, the rapid decline in opioid requirement supports the analgesic efficacy of regional anesthesia; however, the heightened early opioid use suggests that regional techniques may not completely attenuate acute breakthrough pain in all individuals. Optimizing block technique, including potential adjuvants or ultrasound guidance, may further enhance the initial analgesic window and reduce reliance on early postoperative opioids. Additionally, multimodal regimens incorporating NSAIDs, acetaminophen, and local decongestants could help mitigate the early analgesic surge observed in the cohort.

Another key implication concerns postoperative monitoring and discharge planning. The distinct early peak in opioid use, combined with the increased requirement among overweight individuals, suggests that postoperative care pathways should incorporate BMI-adjusted risk assessment to identify patients at higher risk for uncontrolled early pain. Enhanced nursing surveillance, scheduled rather than as-needed dosing during the first two hours, or preemptive analgesia may help reduce the incidence of breakthrough pain episodes shortly after recovery room discharge (44). This approach aligns with broader efforts in enhanced recovery protocols to tailor analgesic strategies based on patient-specific pain risk factors rather than applying uniform dosing strategies.

From a research perspective, the synthetic nature of the dataset allows exploration of trends but limits external validity. Real-world clinical populations may exhibit greater heterogeneity in age, BMI distribution, comorbidities, and pain tolerance, which could influence postoperative analgesic needs in more variable ways. Future prospective studies using actual patient data will be essential to confirm the associations suggested here, particularly regarding BMI-related differences in opioid requirements and the impact of regional anesthesia on short-term analgesic trajectories. Additionally, incorporating patient-reported pain scores, functional recovery metrics, and satisfaction indices would provide a more comprehensive understanding of postoperative recovery following traumatic nasal surgery under regional anesthesia (45).

Conclusion

These findings indicate that acute postoperative pain following traumatic nasal surgery is most intense during the early hours and that BMI is a key determinant of increased pethidine need. While regional anesthesia effectively reduces overall analgesic demand, patients with elevated BMI may benefit from reinforced pain-control strategies. Overall, adopting individualized, risk-adjusted analgesic plans could enhance patient comfort, limit opioid exposure, and improve postoperative recovery outcomes.

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Conflicts of interest

The authors declare that they have no competing interests.

Disclosure Statement

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Authors' Contributions
All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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