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Host, Agent, and Environmental Determinants of Postoperative Nausea and Vomiting Following Spinal Anesthesia: A Systematic Review Using the Epidemiological Triad Framework

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Abstract
Introduction: *Postoperative nausea and vomiting (PONV) remains one of the most common complications following spinal anesthesia and may adversely affect patient recovery, satisfaction, and healthcare outcomes.* ***Objective:*** *This study aimed to identify and synthesize host, agent, and environmental determinants associated with PONV following spinal anesthesia using the Epidemiological Triad Framework.* ***Method:*** *A systematic review was conducted according to the PRISMA 2020 guidelines. Literature searches were performed in PubMed, Scopus, ScienceDirect, and Google Scholar for studies published between 2023 and 2025. Eligible studies included randomized controlled trials, cohort studies, observational studies, and quasi-experimental studies involving patients undergoing spinal anesthesia. Data were extracted, critically appraised using Joanna Briggs Institute tools, and synthesized narratively.* ***Results and Discussion:*** *Twelve studies met the inclusion criteria. The most frequently reported host determinants were previous history of PONV, motion sickness, female sex, younger age, and elevated body mass index. Agent-related determinants included opioid exposure, intrathecal morphine, and intrathecal fentanyl, whereas dexamethasone, propofol, clonidine, and opioid-sparing analgesic techniques demonstrated protective effects. Environmental determinants included cesarean section, prolonged fasting, inadequate perioperative hydration, and intraoperative nausea and vomiting.* ***Conclusion:*** *PONV following spinal anesthesia is a multifactorial condition resulting from interactions among host, agent, and environmental factors. Early risk assessment and comprehensive preventive strategies are essential to reduce PONV incidence and improve postoperative outcomes.*

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Introduction

Postoperative nausea and vomiting (PONV) remains one of the most common and distressing complications following surgical procedures and anesthesia. Despite advances in anesthetic techniques and antiemetic therapies, the incidence of PONV remains relatively high, affecting approximately 20–30% of all surgical patients and up to 70–80% of high-risk patients (Gan et al., 2020). PONV is frequently reported by patients as one of the most unpleasant postoperative experiences and may lead to delayed recovery, prolonged hospital stay, increased healthcare costs, dehydration, electrolyte imbalance, wound dehiscence, and reduced patient satisfaction (Gan et al., 2020).

Although spinal anesthesia is generally associated with a lower incidence of PONV than general anesthesia, postoperative nausea and vomiting continue to occur in patients undergoing procedures under spinal anesthesia. Several studies have reported that the incidence of PONV following spinal anesthesia ranges from 15% to 40%, depending on patient characteristics, surgical procedures, anesthetic agents, and perioperative management (Ju et al., 2023; Ogunjiofor et al., 2023). The occurrence of PONV in spinal anesthesia is multifactorial and involves interactions between patient-related characteristics, anesthetic agents, and procedural factors. Recent studies have identified female sex, previous history of PONV, motion sickness, opioid administration, prolonged fasting, inadequate perioperative hydration, and gastrointestinal comorbidities as important contributors to PONV development. Emerging evidence also suggests that enhanced recovery protocols and opioid-sparing analgesic strategies may reduce the incidence of PONV following spinal anesthesia (De La Peña et al., 2023; Schumacher et al., 2025; Jovanovska-Kirovakova et al., 2025).

The pathophysiology of PONV following spinal anesthesia differs somewhat from that observed after general anesthesia. Sympathetic blockade induced by spinal anesthesia may lead to hypotension and reduced cerebral perfusion, including decreased blood flow to the chemoreceptor trigger zone (CTZ), thereby stimulating the vomiting center. In addition, perioperative serotonin release from the gastrointestinal tract secondary to surgical manipulation and hemodynamic changes activates vagal afferent pathways that contribute to nausea and vomiting. The administration of intrathecal opioids, particularly morphine and fentanyl, further increases the risk of PONV through direct activation of opioid receptors within the CTZ and delayed gastric emptying. These physiological mechanisms provide a biological basis for the interaction between patient susceptibility, anesthetic agents, and perioperative conditions in the development of PONV.

From an epidemiological perspective, the occurrence of PONV can be explained through the Epidemiological Triad Framework, which describes disease occurrence as the interaction among host, agent, and environmental factors. Host factors include demographic and clinical characteristics such as age, sex, body mass index, smoking status, anxiety, gastrointestinal history, and previous history of PONV. Agent factors encompass anesthetic medications, opioids, intrathecal adjuvants, antiemetic prophylaxis, and physiological responses induced by anesthesia. Environmental factors refer to surgical and perioperative conditions, including type of surgery, duration of fasting, intraoperative management, hydration status, and enhanced recovery protocols. This framework provides a comprehensive approach for understanding the multifactorial nature of PONV and identifying modifiable determinants that may be targeted for prevention strategies.

Several primary studies have investigated individual risk factors and preventive interventions associated with PONV following spinal anesthesia. Recent evidence has also explored the effectiveness of opioid-sparing regional anesthesia techniques, enhanced recovery after surgery (ERAS) protocols, and prediction models for identifying patients at high risk of developing PONV. However, existing evidence remains fragmented, with most studies focusing on specific populations such as orthopedic surgery patients or parturients undergoing cesarean section. Furthermore, previous studies have predominantly evaluated isolated determinants rather than comprehensively synthesizing host, agent, and environmental factors within an epidemiological framework. To date, no systematic review has comprehensively summarized host, agent, and environmental determinants of PONV following spinal anesthesia using the Epidemiological Triad Framework. Consequently, healthcare professionals may have limited evidence to support risk stratification and evidence-based preventive interventions in clinical practice.

Therefore, this systematic review aimed to identify and synthesize the available evidence regarding host, agent, and environmental determinants associated with postoperative nausea and vomiting among patients undergoing spinal anesthesia. By applying the Epidemiological Triad Framework, this review is expected to provide a comprehensive understanding of PONV determinants and support the development of effective preventive strategies for improving perioperative patient outcomes.

Methods

This study employed a systematic review design based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The review aimed to identify and synthesize evidence regarding host, agent, and environmental determinants associated with postoperative nausea and vomiting (PONV) among patients undergoing spinal anesthesia using the Epidemiological Triad Framework. This review was not registered in PROSPERO and no review protocol was published before study selection.

The PICOS framework was used to formulate the research question and eligibility criteria. The population (P) consisted of patients undergoing surgical procedures under spinal anesthesia. The exposure (I/E) included host-related factors (e.g., age, sex, smoking status, body mass index, and history of PONV), agent-related factors (e.g., opioids, anesthetic agents, antiemetic prophylaxis, and intrathecal adjuvants), and environmental factors (e.g., type of surgery, fasting duration, perioperative management, and enhanced recovery protocols). The outcome (O) was the occurrence of postoperative nausea and vomiting (PONV). Eligible study designs (S) included randomized controlled trials, cohort studies, case-control studies, cross-sectional studies, quasi-experimental studies, and prospective observational studies.

Search Strategy

A comprehensive literature search was conducted in PubMed, Scopus, ScienceDirect, and Google Scholar for studies published between 2023 and 2025. The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords related to postoperative nausea and vomiting and spinal anesthesia. The primary search string was:

(“postoperative nausea and vomiting” OR PONV) AND (“spinal anesthesia” OR “spinal anaesthesia”) AND (“risk factor” OR determinant OR predictor OR prevention)

Additional searches were conducted using related terms, including “cesarean section”, “orthopedic surgery”, “opioid”, “intrathecal morphine”, “antiemetic prophylaxis”, and “enhanced recovery after surgery”. Reference lists of relevant studies were manually screened to identify additional eligible articles. All retrieved records were exported into reference management software, and duplicate records were removed before the screening process.

Eligibility Criteria

Studies were included if they: (1) were original research articles published in English; (2) involved patients undergoing spinal anesthesia; (3) reported determinants, predictors, risk factors, or preventive interventions related to PONV; and (4) were published between 2023 and 2025. Studies were excluded if they were review articles, editorials, conference abstracts, letters to the editor, case reports, guidelines, or studies with insufficient outcome data.

Study Selection and Data Extraction

The study selection process consisted of identification, screening, eligibility assessment, and inclusion stages according to the PRISMA 2020 flow diagram. Titles and abstracts were screened against the eligibility criteria, followed by full-text assessment of potentially relevant articles. Data extraction was performed using a standardized extraction form that included author, publication year, country, study design, sample size, host factors, agent factors, environmental factors, and significant findings related to PONV.

Quality Assessment and Data Synthesis

The methodological quality of the included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools according to the respective study designs. Studies were categorized as high, moderate, or low quality based on their appraisal scores. The findings were synthesized narratively and grouped according to the Epidemiological Triad Framework, consisting of host, agent, and environmental determinants of postoperative nausea and vomiting following spinal anesthesia.

Result and Discussion

1. Result

Study Selection

The literature search identified articles from PubMed, Scopus, ScienceDirect, and Google Scholar databases. After removing duplicates and screening titles, abstracts, and full texts according to the eligibility criteria, 12 studies were included in the final review.

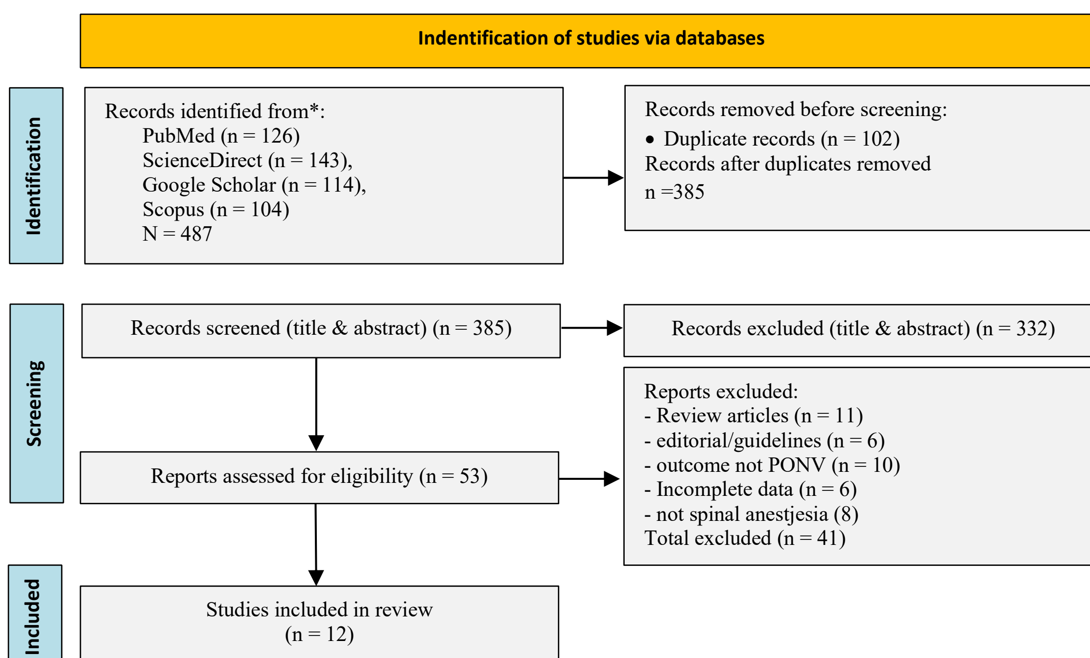

Figure 1 illustrates the study selection process according to the PRISMA 2020 guidelines.

Figure 1 presents the study selection process based on the PRISMA 2020 guidelines. A total of 487 records were identified through database searching. After duplicate removal and screening, 53 full-text articles were assessed for eligibility, and 12 studies met the inclusion criteria and were included in the final synthesis.

Characteristics of Included Studies

A total of 12 studies published between 2023 and 2025 met the inclusion criteria. The included studies consisted of randomized controlled trials, cohort studies, quasi-experimental studies, and observational studies conducted across various countries, including South Korea, Sweden, Brazil, Colombia, South Africa, India, Bulgaria, Indonesia, Iraq, North Macedonia, and the United States.

Table 1
Characteristics of Studies Included in the Systematic Review

No	Author (Year)	Country	Study Design	Sample Size	Population	Main Findings
1	Yustina Ni Putu Yusniawati et al. (2023)	Indonesia	Quantitative Descriptive Study	60	Parturients undergoing cesarean section with subarachnoid block (SAB) and ERAS protocol	Implementation of the ERAS protocol was associated with a low incidence of PONV, with 83.3% of patients reporting no nausea or vomiting.
2	Christopher Schumacher et al. (2025)	United States	Retrospective Secondary Analysis	115	Patients undergoing lower extremity arthroplasty under regional anesthesia	Race, anxiety, gastrointestinal history, and postoperative opioid exposure were identified as significant predictors of PONV.
3	Ayse Menekse Cakir et al. (2025)	Turkey	Prospective Clinical Study	94	Patients undergoing gynecologic cancer surgery	Combined fascial plane blocks significantly reduced opioid consumption and decreased the incidence of postoperative nausea and vomiting.
4	Jae-Woo Ju et al. (2023)	South Korea	Retrospective Observational Study	5,691	Orthopedic surgery patients under spinal anesthesia	Female sex, non-smoking status, opioid use, and baseline heart rate ≥60 bpm increased PONV risk.
5	C. Ogunjiofor et al. (2023)	South Africa	Prospective Observational Study	308	Parturients undergoing cesarean section under spinal anesthesia	Motion sickness history was associated with a significantly higher risk of PONV.
6	De La Peña et al. (2023)	Colombia	Prospective Cohort Study	703	Women undergoing cesarean delivery under spinal anesthesia	Younger age, high BMI, previous PONV, and intraoperative nausea predicted PONV.
7	Khaleel & Mohammed (2024)	Iraq	Randomized Controlled Trial	90	Parturients undergoing elective cesarean section under spinal anesthesia	Propofol infusion significantly reduced postoperative nausea and vomiting.
8	Firaol Niftalem Temsgen et al. (2024)	Ethiopia	Prospective Cross-sectional Analytic Study	273	Patients receiving intrathecal morphine during spinal anesthesia	ASA II status (AOR 3.49), history of motion sickness (AOR 10.83), and previous postoperative nausea/vomiting (AOR 6.83) were significant predictors of PONV.
9	Jovanovska-Kirovakova et al. (2025)	Bulgaria	Observational Study	100	Women undergoing cesarean section	Preoperative fasting duration greater than 8 hours increased PONV risk.

No	Author (Year)	Country	Study Design	Sample Size	Population	Main Findings
10	Churlinov et al. (2025)	North Macedonia	Prospective Randomized Study	100	Parturients undergoing cesarean section under spinal anesthesia	Intrathecal clonidine was associated with lower PONV incidence compared with fentanyl.
11	Fauziyyah Hubabillah et al. (2025)	Indonesia	Quasi-Experimental Study	36	Patients receiving spinal anesthesia	Coloading fluid administration significantly reduced nausea and vomiting scores.
12	Sojitra Seema Jagdishbhai et al. (2025)	India	Prospective Randomized Placebo-Controlled Trial	60	Patients undergoing surgery under spinal anesthesia	Intravenous dexamethasone significantly reduced PONV incidence during the first 24 hours postoperatively.

As shown in Table 1, the included studies investigated various determinants of postoperative nausea and vomiting (PONV) following spinal anesthesia. The determinants were subsequently classified according to the Epidemiological Triad Framework, consisting of host, agent, and environmental factors.

Quality Assessment of Included Studies

Table 2

Quality Assessment of Included Studies Using JBI Critical Appraisal Tools

No	Author (Year)	Study Design	JBI Items	Score	Percentage (%)	Quality Category
1	Yusniawati et al. (2023)	Descriptive Cross-Sectional Study	8	7	87.5	High
2	Schumacher et al. (2025)	Retrospective Observational Study	8	7	87.5	High
3	Ayse Menekse Cakir et al. (2025)	Prospective Clinical Study	11	10	90.9	High
4	Jae-Woo Ju et al. (2023)	Retrospective Observational Study	8	7	87.5	High
5	Ogunjiofor et al. (2023)	Prospective Observational Study	8	7	87.5	High
6	De La Peña et al. (2023)	Cohort Study	11	10	90.9	High
7	Khaleel & Mohammed (2024)	Randomized Controlled Trial	13	11	84.6	High
8	Firaol Niftalem Temsgen et al. (2024)	Analitycal Cross-Sectional Study	8	7	87.5	High
9	Jovanovska-Kirovakova et al. (2025)	Observational Study	8	7	87.5	High
10	Churlinov et al. (2025)	Randomized Controlled Trial	13	11	84.6	High
11	Fauziyyah Hubabillah et al. (2025)	Quasi-Experimental Study	9	8	88.9	High
12	Sojitra Seema Jagdishbhai et al. (2025)	Randomized Controlled Trial	13	12	92.3	High

The methodological quality of the included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools according to the respective study designs. As shown in Table 2, all included studies were categorized as high quality, with appraisal

scores ranging from 84.6% to 92.3%. The overall findings indicate that the included studies demonstrated adequate methodological rigor, thereby supporting the reliability of the evidence synthesized in this review.

Host Determinants of Postoperative Nausea and Vomiting

Host-related determinants were the most frequently reported factors associated with postoperative nausea and vomiting (PONV). Female sex, younger age, previous history of PONV, motion sickness, non-smoking status, elevated body mass index (BMI), anxiety, gastrointestinal history, race/ethnicity, and ASA physical status II were identified across the included studies.

Table 3

Synthesis of Host Determinants Associated with PONV Following Spinal Anesthesia

Host Factor	Number of Studies Reporting Significance
Previous history of PONV	5
Motion sickness history	4
Female sex	3
Younger age	3
Elevated BMI	2
Race/Ethnicity	2
Non-smoker	1
Anxiety	1
Gastrointestinal history	1
ASA II status	1

Table 3 demonstrates that a previous history of PONV was the most consistently reported host determinant, followed by motion sickness history and female sex. Studies by Ju et al. (2023), De La Peña et al. (2023), and Ogunjiofor et al. (2023) reported significantly higher PONV incidence among female patients. This phenomenon may be explained by hormonal influences, particularly estrogen and progesterone, which affect the chemoreceptor trigger zone and vomiting center.

Similarly, previous history of PONV and motion sickness were strongly associated with an increased risk of postoperative nausea and vomiting. Temsgen et al. (2024), Ogunjiofor et al. (2023), and De La Peña et al. (2023) consistently identified these factors as important predictors of PONV, suggesting an intrinsic predisposition toward emetic responses that may be influenced by genetic and neurophysiological mechanisms.

Younger age and elevated BMI were also reported as significant predictors in several studies. De La Peña et al. (2023) found that younger maternal age and higher BMI increased the likelihood of PONV among women undergoing cesarean delivery under spinal anesthesia. In addition, Schumacher et al. (2025) identified gastrointestinal history, anxiety, and race/ethnicity as significant host-related predictors of PONV. Furthermore, Temsgen et al. (2024) reported that patients with ASA physical status II were at greater risk of developing PONV than those with lower perioperative risk profiles. These findings highlight the importance of individualized preoperative risk assessment to identify patients who may benefit from targeted preventive interventions.

Agent Determinants of Postoperative Nausea and Vomiting

Agent-related determinants included opioid administration, intrathecal adjuvants, antiemetic prophylaxis, and perioperative pharmacological interventions.

Table 4

Synthesis of Agent Determinants Associated with PONV Following Spinal Anesthesia

Agent Factor	Number of Studies Reporting Significance
Opioid use	5
Intrathecal morphine	1
Intrathecal fentanyl	2
Dexamethasone prophylaxis	1
Propofol infusion	1
Clonidine intrathecal	1
Regional nerve blocks	1
Opioid-sparing analgesia	1

The findings indicate that opioid exposure remains the most important pharmacological determinant of PONV. Ju et al. (2023) demonstrated that postoperative opioid administration significantly increased the risk of PONV. Similarly, Temsgen et al. (2024) reported that patients receiving intrathecal morphine experienced a higher risk of postoperative nausea and vomiting, particularly among those with a history of motion sickness and previous postoperative nausea and vomiting. Opioids stimulate receptors within the chemoreceptor trigger zone and delay gastric emptying, thereby increasing the likelihood of nausea and vomiting. Several pharmacological and anesthetic interventions demonstrated protective effects against PONV. Khaleel and Mohammed (2024) reported that propofol infusion significantly reduced postoperative nausea and vomiting among parturients undergoing cesarean section under spinal anesthesia. Similarly, Sojitra Seema Jagdishbhai et al. (2025) found that intravenous dexamethasone effectively reduced PONV incidence during the first 24 hours after surgery.

In addition, Churlinov et al. (2025) reported that intrathecal clonidine was associated with lower PONV incidence compared with fentanyl. Recent evidence also suggests that opioid-sparing analgesic strategies may reduce PONV occurrence. Ayse Menekse Cakir et al. (2025) demonstrated that combined fascial plane block techniques significantly reduced opioid consumption and subsequently lowered the incidence of postoperative nausea and vomiting. These findings support the implementation of multimodal antiemetic and opioid-sparing strategies to minimize PONV among patients undergoing spinal anesthesia.

Environmental Determinants of Postoperative Nausea and Vomiting

Environmental determinants included surgical procedures, fasting duration, perioperative hydration, enhanced recovery protocols, and intraoperative conditions that may influence the occurrence of postoperative nausea and vomiting.

Table 5
Synthesis of Environmental Determinants Associated with PONV Following Spinal Anesthesia

Environmental Factor	Number of Studies Reporting Significance
Cesarean section	6
Orthopedic surgery	2
Fasting duration > 8 hours	1
Inadequate hydration	2
ERAS protocol	1
Intraoperative nausea and vomiting (IONV)	1

Table 5 shows that prolonged fasting and inadequate perioperative hydration were associated with a higher incidence of PONV. Jovanovska-Kirovakova et al. (2025) reported that fasting durations exceeding eight hours significantly increased the risk of postoperative nausea and vomiting. Prolonged fasting may contribute to dehydration and hemodynamic instability, which are recognized triggers of nausea and vomiting following spinal anesthesia.

Furthermore, Fauziyyah Hubabillah et al. (2025) demonstrated that perioperative coloading fluid administration significantly reduced PONV scores. Adequate hydration may improve circulatory stability and prevent spinal anesthesia-induced hypotension, thereby reducing the likelihood of nausea and vomiting. Environmental factors related to surgical procedures were also frequently reported. Cesarean section was the most commonly investigated surgical setting associated with PONV, followed by orthopedic surgery. In addition, De La Peña et al. (2023) identified intraoperative nausea and vomiting (IONV) as a significant predictor of postoperative symptoms.

Recent evidence also highlights the importance of enhanced recovery protocols. Yusniawati et al. (2023) reported that implementation of the Enhanced Recovery After Surgery (ERAS) protocol was associated with a low incidence of PONV, with most patients remaining symptom-free during the postoperative period. Overall, these findings suggest that perioperative environmental factors play an important role in the development of PONV and should be considered alongside host-related and agent-related determinants when developing preventive strategies for PONV management.

Summary of Epidemiological Triad Determinants

To provide a comprehensive overview, the identified determinants were categorized according to the Epidemiological Triad Framework.

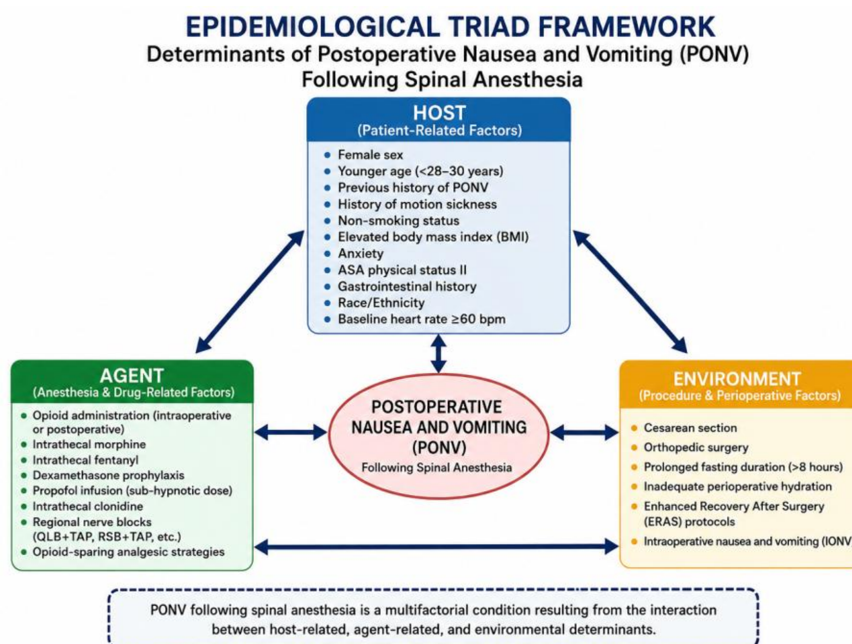

Figure 2. Epidemiological Triad Framework of Determinants Associated with Postoperative Nausea and Vomiting Following Spinal Anesthesia

Figure 2 illustrates the Epidemiological Triad Framework of postoperative nausea and vomiting following spinal anesthesia. The occurrence of PONV results from the interaction between host-related, agent-related, and environmental determinants. Host-related determinants included female sex, younger age, previous history of PONV, motion sickness, non-smoking status, elevated body mass index, anxiety, ASA physical status II, gastrointestinal history, race/ethnicity, and baseline heart rate ≥60 bpm. Agent-related determinants comprised opioid administration, intrathecal morphine, intrathecal fentanyl, dexamethasone prophylaxis, propofol infusion, intrathecal clonidine, regional nerve blocks, and opioid-sparing analgesic strategies.

Environmental determinants included cesarean section, orthopedic surgery, prolonged fasting duration, inadequate perioperative hydration, Enhanced Recovery After Surgery (ERAS) protocols, and intraoperative nausea and vomiting. The synthesis revealed that previous history of PONV, motion sickness, opioid exposure, female sex, and prolonged fasting were the most consistently reported determinants across the included studies. In contrast, dexamethasone prophylaxis, propofol infusion, intrathecal clonidine, adequate perioperative hydration, ERAS protocols, and opioid-sparing analgesic techniques demonstrated protective effects against PONV.

These findings support the hypothesis that PONV following spinal anesthesia is a multifactorial condition resulting from complex interactions among host, agent, and environmental factors. Therefore, comprehensive preventive strategies should address all components of the Epidemiological Triad Framework to reduce the incidence of PONV and improve postoperative outcomes.

2. Discussion

This systematic review synthesized evidence regarding host, agent, and environmental determinants of postoperative nausea and vomiting (PONV) among patients undergoing spinal anesthesia using the Epidemiological Triad Framework. The findings demonstrated that PONV is a multifactorial condition resulting from the interaction of patient-related characteristics, anesthetic and pharmacological factors, and perioperative environmental conditions. Female sex, previous history of PONV, motion sickness, opioid exposure, prolonged fasting, and inadequate hydration emerged as the most consistently reported determinants.

Among host-related determinants, female sex was the most frequently reported predictor of PONV. Several included studies demonstrated that women were significantly more likely to experience postoperative nausea and vomiting than men. This finding is consistent with the Fourth Consensus Guidelines for the Management of PONV, which identify female sex as one of the strongest independent predictors of PONV (Gan et al., 2020). Hormonal influences, particularly fluctuations in estrogen and progesterone levels, may increase the sensitivity of the chemoreceptor trigger zone and vomiting center, thereby predisposing women to nausea and vomiting. Previous history of PONV and motion sickness were also consistently associated with increased risk, suggesting an underlying individual susceptibility to emetic stimuli. Furthermore, Schumacher et al. (2025) identified gastrointestinal history and race/ethnicity as additional host-related predictors, highlighting the importance of individualized risk assessment during the preoperative period.

Regarding agent-related determinants, opioid administration remained the most consistently identified pharmacological risk factor. Ju et al. (2023) reported that postoperative opioid exposure significantly increased the likelihood of PONV among patients undergoing orthopedic surgery under spinal anesthesia. Opioids stimulate μ-receptors within the chemoreceptor trigger zone and delay gastric emptying, thereby promoting nausea and vomiting. Conversely, several interventions demonstrated protective effects. Khaleel and Mohammed (2024) found that propofol infusion significantly reduced postoperative nausea and vomiting in parturients undergoing cesarean section. Similarly, Sojitra Seema Jagdishbhai et al. (2025) reported that dexamethasone effectively reduced PONV incidence during the first 24 hours after surgery. Churlinov et al. (2025) further demonstrated that intrathecal clonidine was associated with lower PONV incidence compared with fentanyl. These findings support the effectiveness of multimodal antiemetic strategies in patients receiving spinal anesthesia.

Recent evidence also highlights the role of opioid-sparing analgesic techniques in reducing PONV. Studies conducted by Ayse Menekse Cakir et al. (2025) demonstrated that regional nerve block techniques significantly reduced postoperative opioid requirements and subsequently decreased the incidence of nausea and vomiting. These findings are consistent with current perioperative recommendations that advocate minimizing opioid exposure whenever possible to improve recovery outcomes and reduce opioid-related adverse effects.

Environmental determinants also played a substantial role in the development of PONV. Prolonged fasting duration, inadequate perioperative hydration, cesarean section, orthopedic surgery, and intraoperative nausea and vomiting were identified as important contributors. Jovanovska-Kirovakova et al. (2025) reported that fasting durations

exceeding eight hours significantly increased the risk of PONV. Extended fasting may contribute to dehydration, hypovolemia, and hemodynamic instability, all of which can trigger nausea and vomiting following spinal anesthesia. Similarly, Fauziyyah Hubabillah et al. (2025) demonstrated that perioperative coloading fluid administration significantly reduced PONV scores, emphasizing the importance of adequate fluid management.

In addition, recent studies have highlighted the potential benefits of Enhanced Recovery After Surgery (ERAS) protocols in reducing postoperative complications, including PONV. Yusniawati et al. (2023) reported that the implementation of ERAS principles in cesarean section patients resulted in a low incidence of PONV, with the majority of patients remaining symptom-free during the postoperative period. These findings suggest that comprehensive perioperative management strategies, including optimized fasting practices, adequate hydration, and early postoperative recovery measures, may contribute to improved patient outcomes.

The findings of this review support the applicability of the Epidemiological Triad Framework in understanding PONV following spinal anesthesia. Unlike previous studies that primarily focused on isolated risk factors, this review integrated determinants into host, agent, and environmental categories, thereby providing a more comprehensive understanding of the multifactorial nature of PONV. This approach may facilitate risk stratification and support the development of targeted preventive interventions in perioperative care.

From a clinical perspective, the application of the Epidemiological Triad Framework enables clinicians to identify patients at high risk of developing PONV before surgery and implement individualized preventive strategies. Patients presenting with multiple host-related risk factors, particularly women with a history of PONV or motion sickness, should be identified during preoperative assessment. Evidence from this review suggests that multimodal antiemetic prophylaxis, opioid-sparing analgesia, adequate perioperative hydration, optimized fasting protocols, and enhanced recovery strategies may substantially reduce the burden of PONV. Integrating these evidence-based interventions into routine perioperative care has the potential to improve patient satisfaction, accelerate postoperative recovery, shorten hospital stay, and reduce healthcare costs associated with PONV.

This review has several limitations. First, heterogeneity in study designs, patient populations, and outcome measurements limited direct comparison across studies. Second, most included studies were observational in nature and therefore may be susceptible to confounding factors. Third, only studies published in English were included, which may have introduced language bias. Nevertheless, the inclusion of studies from multiple countries and diverse surgical settings enhances the generalizability of the findings.

Overall, the evidence indicates that PONV following spinal anesthesia is influenced by a complex interaction between host, agent, and environmental factors. Effective prevention strategies should therefore adopt a multifactorial approach that addresses all components of the Epidemiological Triad Framework.

Conclusion

This systematic review demonstrated that postoperative nausea and vomiting (PONV) following spinal anesthesia is a multifactorial condition influenced by the interaction of host, agent, and environmental determinants. Host-related factors most

consistently associated with PONV included female sex, younger age, previous history of PONV, motion sickness, non-smoking status, elevated body mass index, gastrointestinal history, and race/ethnicity. Agent-related factors, particularly opioid administration and intrathecal fentanyl, were identified as important contributors to increased PONV risk, whereas preventive interventions such as dexamethasone, propofol, clonidine, regional nerve blocks, and opioid-sparing analgesic strategies were associated with reduced PONV incidence. Environmental determinants including cesarean section, orthopedic surgery, prolonged fasting duration exceeding eight hours, inadequate perioperative hydration, and intraoperative nausea and vomiting also significantly influenced the occurrence of PONV.

Among the identified determinants, female sex, previous history of PONV, opioid exposure, and prolonged fasting were the most consistently reported risk factors across the included studies. In contrast, enhanced recovery after surgery (ERAS) protocols, adequate perioperative hydration, multimodal antiemetic prophylaxis, and opioid-sparing approaches demonstrated potential protective effects against PONV. These findings support the application of the Epidemiological Triad Framework as a comprehensive approach for understanding and preventing PONV following spinal anesthesia. Therefore, effective prevention strategies should focus on early identification of high-risk patients, optimization of perioperative antiemetic prophylaxis, reduction of opioid exposure, implementation of opioid-sparing analgesic techniques, appropriate fasting management, and adequate perioperative hydration to improve postoperative outcomes and patient satisfaction. However, the findings should be interpreted cautiously due to heterogeneity among study designs and populations.

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