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Incidence and Predictors of Postoperative Nausea and Vomiting (PONV) after General Anesthesia in Patients Undergoing Laparoscopic Cholecystectomy

1.Arshad Javaid (Corresponding Author)
Lecturer, Department of Anesthesia Technology, Faculty of Allied Health Sciences, Gomal University, Dera Ismail Khan, Pakistan.
Email: a.javaidkhan06@gmail.com
2.Mishkat Ahmed
Department of Anesthesia Technology , Faculty of Allied Health Science (FAHS) , Gomal university ,Dera Ismail Khan, Pakistan
Email: ahmedmishkat497@gmail.com
3.Muqadas Taj
Department of Anesthesia Technology , Faculty of Allied Health Science (FAHS) , Gomal university ,Dera Ismail Khan, Pakistan
Email : muqadastaj60@gmail.com
4.Muhammad Junaid
Department of Anesthesia Technology, Faculty of Allied Health Sciences (FAHS), Gomal University, Dera Ismail Khan, Pakistan
Email: malikjunaid116264@gmail.com
5.Basit Ali
Department of Anesthesia Technology, Faculty of Allied Health Sciences (FAHS), Gomal University, Dera Ismail Khan, Pakistan
Email: ba067793@gmail.com
6. Zarak Nawaz
Department of Anesthesia Technology, Faculty of Allied Health Sciences (FAHS), Gomal University, Dera Ismail Khan, Pakistan
Email: gandapur17@gmail.com
7.Muhammad Umar Waqas
Department of Anesthesia Technology, Faculty of Allied Health Sciences (FAHS), Gomal University, Dera Ismail Khan, Pakistan
Email: umarwaqas7936@gmail.com
8.Naeem Ullah
Department of Anesthesia Technology, Faculty of Allied Health Sciences (FAHS), Gomal University, Dera Ismail Khan, Pakistan
Email: naeemulla125@gmail.com

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Corresponding E-mails & Authors*:
Arshad Javaid*
Email:a.javaidkhan06@gmail.com

Abstract

Background: Postoperative nausea and vomiting (PONV) remain a common and distressing complication following general anesthesia, particularly in laparoscopic procedures where emetogenic stimuli are pronounced. It adversely affects patient recovery, satisfaction, and healthcare costs. This study aimed to determine the incidence and predictors of PONV in patients undergoing laparoscopic cholecystectomy under general anesthesia.

Methods: This prospective observational study included 195 patients undergoing elective laparoscopic cholecystectomy under general anesthesia at DHQ hospital, Dera Ismail Khan, Pakistan. Data on demographic, clinical, anesthetic, and surgical variables were collected. The primary outcome was the occurrence of PONV within 24 hours postoperatively. Associations were analyzed using chi-square tests, and independent predictors were identified through multivariate binary logistic regression.

Results: The incidence of PONV was 56.9% (111/195) patients. In multivariate analysis, intraoperative opioid use was the strongest independent predictor (AOR = 19.79, p = 0.017). Induction agent selection was also significantly associated with PONV (AOR = 3.08, p = 0.016). Additionally, longer duration of surgery (χ^2 = 12.87, p = 0.005) and pneumoperitoneum (χ^2 = 12.35, p = 0.002) showed significant associations. The model demonstrated excellent performance (Nagelkerke R^2=0.809, classification accuracy=90.3%).

Conclusion: PONV remains highly prevalent following laparoscopic cholecystectomy. Modifiable anesthetic factors, particularly opioid administration and induction agent choice, play a critical role. Strategies such as opioid-sparing multimodal analgesia and propofol-based anesthesia may help reduce PONV incidence and improve postoperative outcomes.

Introduction

Laparoscopic cholecystectomy (LC) is a commonly performed minimally invasive procedure for the removal of a diseased gallbladder, usually due to gallstones or gallbladder inflammation (1). The procedure involves inserting a laparoscope and surgical instruments through small abdominal incisions after insufflation of the abdomen with carbon dioxide (2). Compared with open cholecystectomy, LC offers several advantages, including less postoperative pain, smaller scars, shorter hospital

stay, faster recovery, and reduced blood loss (3–5). However, open surgery may still be required in complex cases, emergencies, or extensive disease conditions (6).

Despite its benefits, postoperative nausea and vomiting (PONV) remain among the most common complications following general anesthesia, affecting approximately 30–50% of surgical patients (7). PONV is characterized by nausea, vomiting, or both during the postoperative period and is associated with patient discomfort, delayed recovery, dehydration, electrolyte imbalance, wound complications, and prolonged hospitalization (17–19). Many patients consider PONV more distressing than postoperative pain itself (11).

Several factors contribute to the development of PONV. Patient-related factors include female gender, younger age, non-smoking status, previous history of PONV or motion sickness, migraines, diabetes, and preoperative opioid use (8,9,13). Anesthetic factors such as volatile anesthetics, nitrous oxide, prolonged anesthesia, opioid administration, and increased intra-abdominal pressure from carbon dioxide insufflation are also associated with a higher risk of PONV (12). Surgical factors, particularly laparoscopic procedures and longer operative durations, further increase the likelihood of PONV (14).

The Apfel Risk Score is widely used to estimate the risk of PONV based on four predictors: female gender, non-smoking status, history of motion sickness or PONV, and postoperative opioid use (15). The risk increases progressively from 10% in patients with no risk factors to 80% in those with all four factors.

Among patients undergoing laparoscopic cholecystectomy, the incidence of PONV may reach up to 75% within the first 24 hours after surgery (10). Evidence suggests that higher intra-abdominal carbon dioxide pressure (>12 mmHg) may increase postoperative pain and PONV, whereas lower pressures (<8 mmHg) may reduce these complications (16). Effective prevention strategies include minimizing the use of inhalational anesthetics and opioids, ensuring adequate hydration, avoiding nitrous oxide when possible, and administering prophylactic antiemetic medications (20–22).

Although considerable research has examined PONV in surgical patients, limited evidence is available regarding its incidence and predictors following laparoscopic cholecystectomy in local healthcare settings. Variations in patient characteristics, anesthetic practices, and perioperative management contribute to inconsistent findings across studies (23–25). Therefore, this study aims to determine the incidence of PONV within the first 24 hours after laparoscopic cholecystectomy and identify patient-related, anesthetic, and surgical factors associated with its occurrence.

Methodology

This prospective observational study was conducted at DHQ Teaching Hospital, Dera Ismail Khan, Pakistan, over a period of six months to determine the incidence and

predictors of postoperative nausea and vomiting (PONV) among patients undergoing laparoscopic cholecystectomy under general anesthesia.

The sample size was calculated using the single population proportion (Cochrane) formula with a 95% confidence level, 5% margin of error, and an expected PONV prevalence of 15%. The required sample size was 195 participants. A non-probability convenience sampling technique was employed for participant recruitment.

Data were collected using a structured and pre-tested proforma developed according to the study objectives and relevant literature. Eligible participants included patients aged 18–65 years of either gender undergoing laparoscopic cholecystectomy under general anesthesia, classified as ASA physical status I–II, able to communicate postoperative symptoms, and willing to provide written informed consent.

Patients were excluded if they underwent to open cholecystectomy, had pre-existing nausea, vomiting, gastrointestinal or vestibular disorders, recent use of antiemetics, steroids, or opioids within 24 hours, ASA status III or above, pregnancy or lactation, significant cardiac disease, gastrointestinal, renal, or liver disease, substance addiction, or inability to communicate reliably.

Following ethical approval and informed consent, data were collected in three phases. Preoperative information included demographic and baseline clinical characteristics. Intraoperative variables were obtained from anesthesia and surgical records. Postoperatively, patients were monitored for 24 hours in the post-anesthesia care unit and surgical ward for the occurrence of nausea and vomiting. PONV assessment was performed through direct patient interviews and clinical observation at predetermined intervals.

Data were entered and analyzed using SPSS version 25. Descriptive statistics were used to summarize study variables, with categorical data presented as frequencies and percentages. The incidence of PONV was calculated as the proportion of patients who developed symptoms within 24 hours after surgery. Associations between variables and PONV were assessed using the chi-square test. Variables with a p-value ≤ 0.20 in univariate analysis were entered into a multivariate binary logistic regression model to identify independent predictors. Results were reported as adjusted odds ratios (AORs) and statistical significance was set at $p \leq 0.05$.

Ethical approval was obtained from the Institutional Review Board of Gomal University in collaboration with DHQ Teaching Hospital, Dera Ismail Khan. Written informed consent was obtained from all participants before enrollment. Confidentiality was ensured through the use of unique identification codes, access to data was restricted to the research team, and participants were free to withdraw from the study at any time without affecting their medical care.

RESULTS

Baseline Demographic and Clinical Characteristics of the Study Participants

The study cohort comprised 195 patients who underwent laparoscopic cholecystectomy under general anesthesia. The baseline demographic and clinical characteristics are presented in Table 4.1, providing a comprehensive overview of the study population's composition across multiple clinically relevant domains.

Age Distribution: The age distribution revealed a predominance of middle-aged adults, with the largest proportion in the 31-45 years age group (32.8%, n=64), followed closely by the 46-60 years group (29.7%, n=58). Young adults aged 18-30 years constituted 26.2% (n=51) of the cohort, while elderly patients (>60 years) represented the smallest subgroup at 11.3% (n=22). This distribution pattern reflects the typical epidemiological profile of patients undergoing cholecystectomy, with the condition being most prevalent in the fourth to sixth decades of life.

Gender Composition: The study demonstrated a slight male predominance, with 52.3% (n=102) male participants compared to 47.7% (n=93) females. This near-balanced gender distribution minimizes potential sex-based confounding in subsequent analyses of PONV occurrence.

BMI Distribution: Anthropometric assessment revealed that 41.5% (n=81) of participants had normal BMI (18.5-24.9 kg/m^2), while overweight and obese categories each comprised 29.2% (n=57) of the population. The substantial proportion of overweight/obese individuals (58.4%) is consistent with established associations between elevated BMI and gallstone disease, reflecting a high-risk surgical population.

ASA Physical Status: Most patients (60.5%, n=118) were classified as ASA II, indicating mild systemic disease. ASA I patients (healthy individuals) comprised 39.5% (n=77) of the cohort. The absence of ASA III or higher classifications suggests that patients with

significant comorbidities were excluded or underrepresented, possibly due to institutional protocols or referral patterns.

Smoking Status: Notably, 75.9% (n=148) of participants were identified as smokers, representing a substantial majority. This high prevalence of smoking may be attributable to the regional population characteristics or the high prevalence of smoking among individuals with biliary pathology.

History of Motion Sickness: The majority (80.0%, n=156) of patients reported no history of motion sickness, while 20.0% (n=39) had a positive history. This finding is relevant as motion sickness history is considered a surrogate marker for susceptibility to nausea and vomiting in various clinical contexts.

Previous History of PONV: Approximately one-fifth (20.5%, n=40) of patients reported a previous history of PONV following prior anesthesia, while 79.5% (n=155) had no such history. This distribution aligns with known population frequencies and underscores the importance of this variable as a potential predictor.

Table 4.1. Baseline Demographic and Clinical Characteristics of the Study Participants (N = 195)

Variables	Category	n (%)
Age (years)	18-30	51 (26.2)
	31-45	64 (32.8)
	46-60	58 (29.7)
	>60	22 (11.3)
Gender	Male	102 (52.3)
	Female	93 (47.7)
BMI Category	Normal (18.5-24.9)	81 (41.5)
	Overweight (25-29.9)	57 (29.2)
	Obese (≥30)	57 (29.2)
ASA Status	ASA I	77 (39.5)
	ASA II	118 (60.5)
Smoking Status	Non-Smoker	47 (24.1)
	Smoker	148 (75.9)
History of Motion Sickness	No	156 (80.0)
	Yes	39 (20.0)
Previous History of PONV	No	155 (79.5)
	Yes	40 (20.5)

Note: ASA = American Society of Anesthesiologist; BMI = Body Mass Index; PONV = Postoperative Nausea and Vomiting

Association Between Patient-Related Factors and PONV

The analysis of age as a potential determinant of PONV revealed interesting patterns across age categories. The highest PONV incidence was observed in the >60 years age group (63.6%), followed by the 46-60 years group (56.9%), the 31-45 years group (56.2%), and the youngest cohort (18-30 years) with 54.9% incidence.

Despite the apparent trend of increasing PONV incidence with advancing age, the chi-square test demonstrated no statistically significant association between age category and PONV occurrence (χ^2 = 0.501, df = 3, p = 0.919). This non-significant finding suggests that while minor variations exist, age does not serve as a reliable predictor of PONV in this population. The relatively homogeneous distribution of PONV across age groups may reflect the multifactorial etiology of PONV, where age-related risk factors may be counterbalanced by other variables.

Table 2 Association between Age and Postoperative Nausea and Vomiting (PONV)

Age category	No PONV *n* (%)	PONV *n* (%)	Total *n* (%)	χ^2	*df*	*p*
18-30 years	23 (45.)	28 (54.9)	51 (26.2)			
31-45 years	28 (43.8)	36 (56.2)	64 (32.8)			
46-60 years	25 (43.1)	33 (56.9)	58 (29.7)			
>60 years	8 (36.4)	14 (63.6)	22 (11.3)			
Total	84 (43.1)	111 (56.9)	195 (100)	0.501	3	.919

Note: PONV= postoperative Nausea and Vomiting

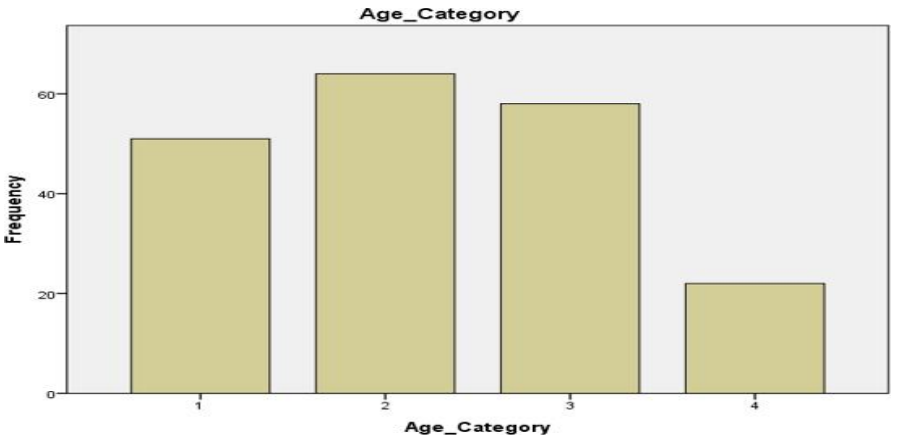


Fig: 1 The bar chart visually depicts the distribution of PONV across age categories.

Association between Gender and Postoperative Nausea and Vomiting (PONV)

Gender-based analysis demonstrated that females exhibited a higher PONV incidence (61.3%, n=57) compared to males (52.9%, n=54). This observation aligns with established literature suggesting that female gender is a well-documented risk factor for PONV, potentially attributable to hormonal influences, differences in pain perception, or variations in pharmacokinetics and pharmacodynamics of anesthetic agents.

However, statistical evaluation via chi-square test revealed that this difference was not statistically significant (χ^2 = 1.383, df = 1, p = 0.240). The lack of significance may be attributable to the relatively balanced gender distribution and sample size constraints. While the observed 8.4% absolute difference in incidence may be clinically relevant, the statistical non-significance warrants cautious interpretation.

Table 4.3 Association between Gender and Postoperative Nausea and Vomiting (PONV)

Gender	No PONV *n* (%)	PONV *n* (%)	Total *n* (%)	χ^2	*df*	*p*
Male	48 (47.1)	54 (52.9)	102 (52.3)			
Female	36 (38.7)	57 (61.3)	93 (47.7)			
Total	84 (43.1)	111 (56.9)	195 (100)	1.383	1	.240

Note:

Fig: 2 The bar chart illustrates the gender-based PONV distribution..

Association Between BMI and Postoperative Nausea and Vomiting (PONV) Analysis of BMI categories revealed notable variations in PONV incidence. Patients with normal BMI demonstrated the highest PONV rate (64.2%), followed by the obese category (54.4%) and overweight category (49.1%). This inverse relationship between BMI and PONV incidence is particularly interesting, suggesting that higher BMI may confer a protective effect against PONV in this population.

Despite these observed differences, the chi-square test yielded a non-significant association ($\chi^2 = 3.312$, df = 2, p = 0.191). The trend toward lower PONV incidence in overweight and obese patients may be attributed to several mechanisms, including alterations in drug distribution volumes, differences in adipose tissue sequestration of lipophilic anesthetic agents, or possibly variations in neurotransmitter receptor sensitivity.

Table 4.4 Association Between BMI and Postoperative Nausea and Vomiting (PONV)

BMI Category	No PONV *n* (%)	PONV *n* (%)	Total *n* (%)	χ^2	*df*	*p*
Normal (18.5-24.9)	29 (35.8)	52 (64.2)	81 (41.5)			
Overweight (25-29.9)	29 (50.9)	28 (49.1)	57 (29.2)			
Obese (≥30)	26 (45.6)	31 (54.4)	57 (29.2)			
Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**3.312**	**2**	**.191**

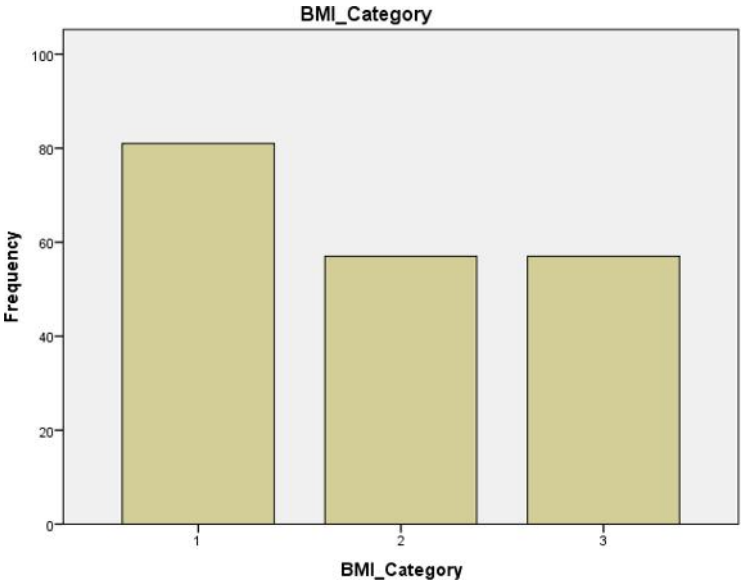


Fig: 3 The bar chart visually represents the BMI-based PONV distribution.

Association Between ASA Physical Status and Postoperative Nausea and Vomiting (PONV)

Comparative analysis of ASA classifications revealed that patients with ASA II status (mild systemic disease) exhibited a slightly higher PONV incidence (58.5%) compared to those with ASA I status (54.5%). This observation suggests that the presence of mild comorbidity may marginally increase PONV susceptibility, potentially through alterations in physiological reserve or drug metabolism.

Statistical evaluation indicated no significant association between ASA classification and PONV (χ^2 = 0.293, df = 1, p = 0.588). The non-significant result may reflect the relatively homogeneous nature of the study population (limited to ASA I and II patients) and the potential confounding effects of other perioperative variables.

Table 4. 5 Association Between ASA Physical Status and Postoperative Nausea and Vomiting (PONV)

ASA Classification	No PONV *n* (%)	PONV *n* (%)	Total *n* (%)	χ^2	*df*	*p*
ASA I	35 (45.5)	42 (54.5)	77 (39.5)			
ASA II	49 (41.5)	69 (58.5)	118 (60.5)			
Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**0.293**	**1**	**.588**

Note:

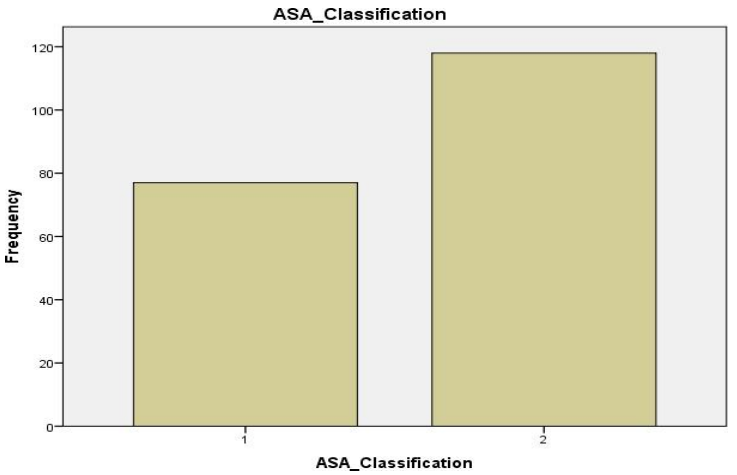


Fig: 4 The bar chart demonstrates the comparable PONV incidence between ASA groups, with minimal absolute difference.

Association Between Smoking Status and Postoperative Nausea and Vomiting (PONV)
Smoking status analysis demonstrated a minimal difference in PONV incidence between smokers (57.4%) and non-smokers (55.3%). This finding contrasts with some previous studies that have suggested a potential protective effect of smoking against PONV, possibly through nicotine-induced dopamine release or alterations in hepatic enzyme activity.
The chi-square test confirmed no significant association (χ^2 = 0.065, df = 1, p = 0.799), indicating that smoking status does not serve as a meaningful predictor of PONV in this cohort. The lack of a protective effect may be attributable to the chronic nature of smoking in this population, potential tachyphylaxis to nicotine effects, or the overall high incidence of PONV overshadowing any modulatory effect of smoking.

Table 4.6 Association Between Smoking Status and Postoperative Nausea and Vomiting (PONV)

Variable	No PONV *n* (%)	PONV *n* (%)	Total *n* (%)	χ^2	*df*	*p*
Smoking Status						
Non-smoker	21 (44.7)	26 (55.3)	47 (24.1)			
Smoker	63 (42.6)	85 (57.4)	148 (75.9)			
Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**0.065**	**1**	**.799**

N=195

Association Between History of Motion Sickness and Postoperative Nausea and Vomiting (PONV)

Patients with a positive history of motion sickness exhibited a markedly higher PONV incidence (64.1%) compared to those without such history (55.1%). This observation aligns with the established physiological link between motion sickness susceptibility and PONV, both involving the vestibular and chemoreceptor trigger zone pathways.

Statistical analysis, however, revealed that this association did not reach significance ($\chi^2 = 1.025$, df = 1, p = 0.311). The non-significant finding may be attributed to the relatively small number of patients with motion sickness history (n=39), potentially limiting the statistical power to detect a meaningful difference.

Table 4.7 Association Between History of Motion Sickness and Postoperative Nausea and Vomiting (PONV)

History of Motion Sickness	PONV Occurrence		Total *n* (%)	χ^2	*df*	*p*
	No PONV *n* (%)	PONV *n* (%)				
No History of Motion Sickness	70 (44.9)	86 (55.1)	156 (80.0)			
History of Motion Sickness Present	14 (35.9)	25 (64.1)	39 (20.0)			
Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**1.025**	**1**	**.311**

N=195

Association Between Previous History of PONV and Postoperative Nausea and Vomiting (PONV)

A strong trend toward increased PONV risk was observed in patients with a previous history of PONV, with 67.5% experiencing PONV compared to 54.2% in those without such history. This substantial 13.3% absolute difference underscores the clinical relevance of history of PONV as a risk factor.

Despite the clinically meaningful difference, the association did not reach statistical significance ($\chi^2 = 2.296$, df = 1, p = 0.130). The lack of significance may be attributable to

the limited sample size in the PONV history group (n=40) and the multifactorial nature of PONV pathogenesis, where previous history represents only one of multiple interacting risk factors.

Table 4.8 Association Between Previous History of PONV and Postoperative Nausea and Vomiting (PONV)

Previous History of PONV	PONV Occurrence		Total *n* (%)	χ^2	*df*	*p*
	No PONV *n* (%)	PONV *n* (%)				
No Previous History of PONV	71 (45.8)	84 (54.2)	155 (79.5)			
Previous History of PONV Present	13 (32.5)	27 (67.5)	40 (20.5)			
Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**2.296**	**1**	**.130**

N=195

Association Between Surgical Factors and PONV

: Association Between Type of Surgery and Postoperative Nausea and Vomiting (PONV)

Analysis of surgical urgency revealed that patients undergoing emergency laparoscopic cholecystectomy experienced substantially higher PONV incidence (69.0%) compared to those undergoing elective procedures (54.8%). This 14.2% absolute difference suggests that emergency surgery may be associated with increased PONV risk, potentially due to the acute inflammatory state, higher preoperative symptom burden, or less time for preoperative optimization.

The chi-square test, however, indicated no statistically significant association (χ^2 = 2.015, df = 1, p = 0.156). The non-significance may be attributed to the relatively small emergency surgery subgroup (n=29), limiting statistical power to detect what may be a clinically meaningful difference.

Table 4.9 Association Between Type of Surgery and Postoperative Nausea and Vomiting (PONV)

	PONV Occurrence

Type of Surgery	No PONV *n* (%)	PONV *n* (%)	Total *n* (%)	χ^2	*df*	*p*
Elective Laparoscopic Cholecystectomy	75 (45.2)	91 (54.8)	166 (85.1)			
Emergency Laparoscopic Cholecystectomy	9 (31.0)	20 (69.0)	29 (14.9)			
Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**2.015**	**1**	**.156**

Association Between Duration of Surgery and Postoperative Nausea and Vomiting (PONV)

Surgical duration demonstrated a striking dose-response relationship with PONV incidence. The lowest PONV rate was observed in the <60 minutes group (42.9%), with progressively increasing rates in the 60-90 minutes group (52.1%), >90-120 minutes group (73.2%), and the highest incidence of 81.3% in the >120 minutes group. This clear gradient suggests that prolonged surgical duration is a significant risk factor for PONV.

Statistical analysis confirmed this association as highly significant (χ^2 = 12.87, df = 3, p = 0.005). The biological plausibility of this finding includes several mechanisms: prolonged exposure to anesthetic agents, increased opioid requirements, greater intraoperative blood loss, more extensive surgical manipulation, and prolonged pneumoperitoneum duration.

Table 4.10 Association Between Duration of Surgery and Postoperative Nausea and Vomiting (PONV)

Duration of Surgery	PONV Occurrence					
	No PONV *n* (%)	PONV *n* (%)	Total *n* (%)	χ^2	df	p
< 60 minutes	24 (28.6)	18 (16.2)	42 (21.5)			
60-90 minutes	46 (54.8)	50 (45.0)	96 (49.2)			
>90-120 minutes	11 (13.1)	30 (27.0)	41 (21.0)			
>120 minutes	3 (3.6)	13 (11.7)	16 (8.2)			

Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**12.87**	**3**	**0.005***

N=195

Association Between Duration of Pneumoperitoneum and Postoperative Nausea and Vomiting (PONV)

Duration of pneumoperitoneum demonstrated a similar dose-response relationship with PONV incidence. Patients with pneumoperitoneum duration <30 minutes had the lowest PONV rate (38.5%), while those with 30-60 minutes had 58.0%, and those with >60 minutes experienced the highest rate (76.7%). This clear gradient supports the role of pneumoperitoneum as a mechanistically important factor in PONV pathogenesis.

The association was statistically significant (χ^2 = 12.35, df = 2, p = 0.002), confirming that prolonged pneumoperitoneum is independently associated with increased PONV risk. The biological mechanisms likely include increased intra-abdominal pressure leading to vagal stimulation, peritoneal stretching, and release of inflammatory mediators, as well as the potential for carbon dioxide absorption causing acidosis and alteration of neurotransmitter levels.

Table 4.11 Association Between Duration of Pneumoperitoneum and Postoperative Nausea and Vomiting (PONV)

Duration of Pneumoperitoneum	**PONV Occurrence**					
	No PONV *n* (%)	**PONV *n* (%)**	**Total *n* (%)**	**χ^2**	**df**	**p**
< 30 minutes	32 (38.1)	20 (18.0)	52 (26.7)			
30-60 minutes	42 (50.0)	58 (52.3)	100 (51.3)			
>60 minutes	10 (11.9)	33 (29.7)	43 (22.0)			
Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**12.35**	**2**	**0.002**

N=195

Association Between Anesthetics Factors and PONV

Association Between Induction Agent and Postoperative Nausea and Vomiting (PONV)

Analysis of induction agents revealed the highest PONV incidence in patients receiving ketamine (68.2%), followed by propofol (53.5%) and other agents (55.6%). The higher incidence with ketamine aligns with the known emetogenic potential of this agent, while propofol is generally considered to have anti-emetic properties at sub-anesthetic doses.

Statistical evaluation indicated no significant association (χ^2 = 2.952, df = 2, p = 0.229). The lack of significance may reflect the relatively small sample sizes in the ketamine and other agents' groups, as well as potential confounding by other perioperative factors. The propofol group's lower PONV incidence, while not statistically significant, is consistent with the agent's favorable antiemetic profile.

Table 4.12 Association Between Induction Agent and Postoperative Nausea and Vomiting (PONV)

Induction Agent	PONV Occurrence					
	No PONV *n* (%)	PONV *n* (%)	Total *n* (%)	χ^2	df	p
Propofol	66 (78.6)	76 (68.5)	142 (72.8)			
Ketamine	14 (16.7)	30 (27.0)	44 (22.6)			
Other	4 (4.8)	5 (4.5)	9 (4.6)			
Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**2.952**	**2**	**0.229**

N=195

Association Between Intraoperative Opioid Use and Postoperative Nausea and Vomiting (PONV)

A marked difference in PONV incidence was observed based on intraoperative opioid use. Patients receiving opioids experienced significantly higher PONV rates (82.9%) compared to those without opioid use (17.1%). The absolute difference of 65.8% is both clinically and statistically meaningful.

The chi-square test confirmed this as a highly significant association (χ^2 = 6.873, df = 1, p= 0.009). This finding underscores the well-established emetogenic effects of opioids

through multiple mechanisms, including stimulation of the chemoreceptor trigger zone, delayed gastric emptying, and inhibition of gastrointestinal motility.

Table 4.13 Association Between Intraoperative Opioid Use and Postoperative Nausea and Vomiting (PONV)

Intraoperative Opioid Use	PONV Occurrence					
	No PONV *n* (%)	PONV *n* (%)	Total *n* (%)	χ^2	df	p
Not used	28 (33.3)	19 (17.1)	47 (24.1)			
Opioid used	56 (66.7)	92 (82.9)	148 (75.9)			
Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**6.873**	**1**	**0.009**

N=195

Association Between Antiemetic Prophylaxis and Postoperative Nausea and Vomiting (PONV)

Patients who received antiemetic prophylaxis had a slightly higher PONV incidence (58.2%) compared to those who did not (54.1%). This counterintuitive finding may reflect confounding by indication, wherein patients identified as being at higher PONV risk were more likely to receive prophylactic antiemetics.

The chi-square test indicated no significant association (χ^2 = 0.289, df = 1, p = 0.591), suggesting that antiemetic administration, as captured in this study, does not appear to have a substantial protective effect against PONV. This may be due to the non-randomized nature of antiemetic administration, lack of standardization in drug choice or timing, or the possibility that standard antiemetic doses are insufficient in this high-risk population.

Table 4.14 Association Between Antiemetic Prophylaxis and Postoperative Nausea and Vomiting (PONV)

Antiemetic Prophylaxis	PONV Occurrence					
	No PONV *n* (%)	PONV *n* (%)	Total *n* (%)	χ^2	df	p
Not Given	28 (45.9)	33 (54.1)	61 (31.3)			

Given	56 (41.8)	78 (58.2)	134 (68.7)			
Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**0.289**	**1**	**0.591**

N=195

Association Between Volatile Anesthetic Used and Postoperative Nausea and Vomiting (PONV)

Comparison of the two volatile anesthetics revealed similar PONV incidence: sevoflurane (57.3%) and isoflurane (56.3%). This minimal 1.0% difference suggests equivalent emetogenic profiles of these agents in the context of laparoscopic cholecystectomy.

Statistical analysis confirmed no significant association (χ^2 = 0.016, df = 1, p = 0.901), indicating that choice between sevoflurane and isoflurane does not significantly influence PONV risk in this surgical population.

Table 4.15 Association Between Volatile Anesthetic Used and Postoperative Nausea and Vomiting (PONV)

Volatile Anesthetic	**PONV Occurrence**					
	No PONV *n* (%)	**PONV *n* (%)**	**Total *n* (%)**	**χ^2**	**df**	**p**
Sevoflurane	53 (42.7%)	71 (57.3%)	124 (63.6%)			
Isoflurane	31 (43.7%)	40 (56.3%)	71 (68.7%)			
Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**0.016**	**1**	**0.901**

N=195

Association Between Nitrous Oxide Use and Postoperative Nausea and Vomiting (PONV)

Patients receiving nitrous oxide had slightly lower PONV incidence (53.0%) compared to those without nitrous oxide use (61.1%). This finding is somewhat counterintuitive, given the widely recognized emetogenic potential of nitrous oxide.

The chi-square test, however, demonstrated no statistically significant association (χ^2 = 1.284, df = 1, p = 0.256). The lack of a clear increase in PONV with nitrous oxide may

reflect the relatively low concentration or duration of exposure in this practice setting, or potential attenuation by concurrent antiemetic administration.

Table 4.16 Association Between Nitrous Oxide Use and Postoperative Nausea and Vomiting (PONV)

Nitrous Oxide	PONV Occurrence		Total *n* (%)	χ^2	df	p
	No PONV *n* (%)	PONV *n* (%)				
Not use of Nitrous Oxide	37 (38.9%)	58 (61.1%)	95 (48.7%)			
Nitrous Oxide used	47 (47.0%)	53 (53.0%)	100 (51.3%)			
Total	**84 (43.1)**	**111 (56.9)**	**195 (100)**	**1.284**	**1**	**0.256**

N=195

Postoperative Outcomes Related to PONV

Distribution of Postoperative Nausea and Vomiting (PONV)-Related Outcomes Among Study Participants

Postoperative Nausea: The overall incidence of postoperative nausea was 44.6% (n=87), indicating that nearly half of the study participants experienced nausea in the first 24 hours postoperatively. This high prevalence underscores the clinical significance of PONV as a major postoperative complication.

Postoperative Vomiting: The incidence of postoperative vomiting was 27.2% (n=53), less than that of nausea but still representing a substantial proportion of patients. The discrepancy between nausea and vomiting rates is clinically meaningful, suggesting that patients may experience nausea without progressing to vomiting, or that vomiting is under-reported.

Number of Vomiting Episodes: Among patients who vomited, the majority experienced a single episode (12.8%), followed by two episodes (9.2%), and three or more episodes (5.1%). The presence of multiple vomiting episodes in 14.3% of the cohort indicates severe PONV in a subset of patients, potentially requiring intensive management.

Rescue Antiemetic Requirement: A substantial majority (56.9%, n=111) of patients required rescue antiemetic therapy within 24 hours postoperatively. This high rate reflects the clinical burden of PONV and the need for effective prevention and treatment strategies.

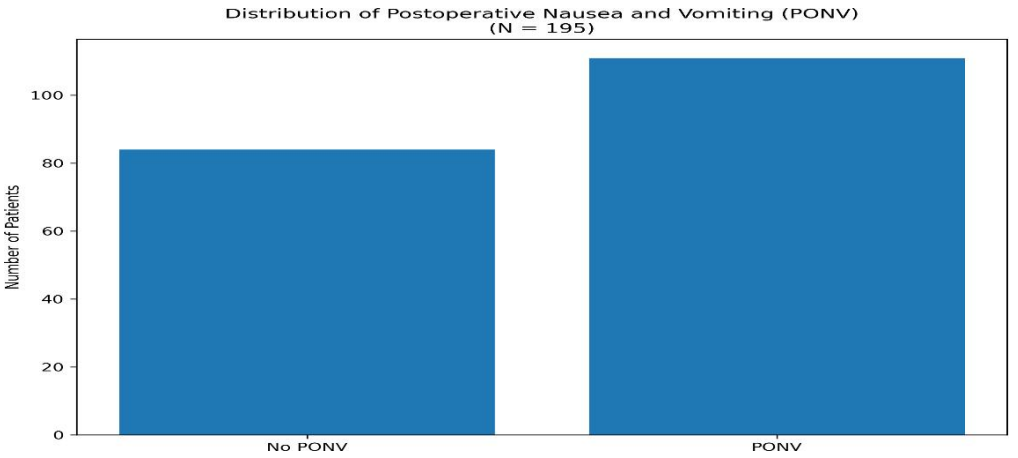
Severity of PONV: The severity distribution reveals that 43.1% (n=84) of patients experienced no PONV, while 29.7% (n=58) had mild PONV, 22.1% (n=43) had moderate PONV, and 5.1% (n=10) had severe PONV. The substantial proportion of moderate-to-severe PONV (27.2%) highlights the clinical relevance of this complication and the need for improved preventive measures.

PONV Occurrence: The overall occurrence of PONV (either nausea or vomiting) was 56.9% (n=111), confirming that PONV remains a major postoperative complication in laparoscopic cholecystectomy despite advances in anesthetic and surgical techniques.

Table 4.17 Distribution of Postoperative Nausea and Vomiting (PONV) – Related Outcomes Among Study Participants (N=195)

Variables	Category	n (%)
Postoperative Nausea	No	108 (55.4%)
	Yes	87 (44.6%)
Postoperative Vomiting	No	142 (72.8%)
	Yes	53 (27.2%)
Number of Vomiting Episodes (24 h)	None	142 (72.8%)
	1 episode	25 (12.8%)
	2 episodes	18 (9.2%)
	≥ 3 episodes	10 (5.1%)
Rescue Antiemetic Required	No	84 (43.1%)
	Yes	111 (56.9%)
Severity of PONV	No PONV	84 (43.1%)
	Mild	58 (29.7%)
	Moderate	43 (22.1%)
	Severe	10 (5.1%)
PONV Occurrence	No	84 (43.1%)
	Yes	111(56.9%)

Note: Data represented as frequency (percentage). PONV= Postoperative Nausea and Vomiting, h=hours



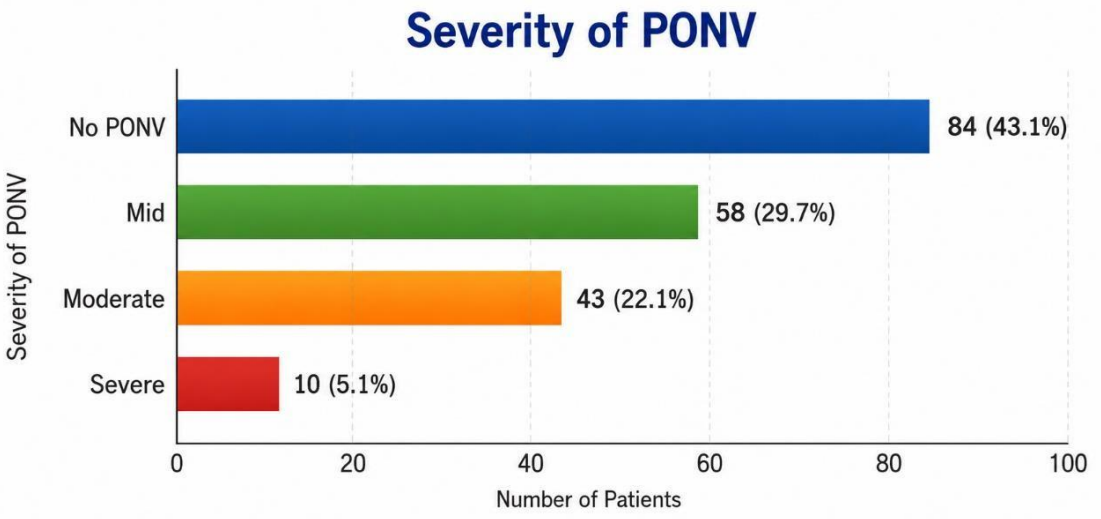


Fig 5 Distribution of postoperative nausea and vomiting (PONV) among study participants.

Multivariable Binary Logistic Regression Analysis of Predictors of Postoperative Nausea and Vomiting (PONV)

Multivariable Binary Logistic Regression Analysis of Independent Factors Associated with Postoperative Nausea and Vomiting (PONV)

The multivariable logistic regression model was developed to identify independent predictors of PONV while simultaneously controlling for potential confounding variables. After adjusting for all 13 predictor variables, only two factors emerged as statistically significant independent predictors of PONV:

Induction Agent: Choice of induction agent demonstrated a significant independent association with PONV (B = 1.126, SE = 0.466, AOR = 3.084, Wald χ^2 = 5.853, p = 0.016). Patients receiving induction agents other than the reference category had approximately three-fold increased odds of developing PONV. This finding supports the selection of appropriate induction agents with favorable emetogenic profiles.

Intraoperative Opioid Use: Intraoperative opioid administration was identified as the strongest independent predictor of PONV (B = 2.985, SE = 1.245, AOR = 19.788, Wald χ^2= 5.747, p = 0.017). The adjusted odds ratio of approximately 20 indicates that patients receiving intraoperative opioids had 20 times the odds of developing PONV compared to those who did not receive opioids. This striking association underscores the critical role of opioid administration in PONV pathogenesis.

Non-Significant Predictors: The remaining 11 variables (age category, gender, BMI category, ASA classification, smoking status, history of motion sickness, previous history of PONV, type of surgery, antiemetic prophylaxis, volatile anesthetic used, and nitrous oxide use) did not reach statistical significance in the multivariable model. This suggests that their apparent associations in univariable analyses may have been confounded by other variables.

Table 4.18 Multivariable Binary Logistic Regression Analysis of Independent Factors Associated with Postoperative Nausea and Vomiting (PONV) (N = 195)

Predictor Variable	B	SE	Adjusted Odd Ratio (AOR)	Wald χ^2	p-value
Age Category	0.524	0.333	1.688	2.471	0.116
Gender	0.711	0.582	2.037	1.493	0.222
BMI Category	-0.112	0.359	0.894	0.098	0.754
ASA Classification	0.785	0.650	2.192	1.458	0.227
Smoking Status	0.250	0.660	1.284	0.144	0.704
History of Motion Sickness	0.704	0.677	2.023	1.083	0.298

Previous History of PONV	1.067	0.784	2.906	1.854	0.173
Type of Surgery	1.082	0.803	2.951	1.816	0.178
Induction Agent*	1.126	0.466	3.084	5.853	0.016*
Intraoperative Opioid Use*	2.985	1.245	19.788	5.747	0.017*
Antiemetic Prophylaxis Given	0.486	0.596	1.626	0.665	0.415
Volatile Anesthetic Used	0.230	0.594	1.259	0.150	0.698
Nitrous Oxide Used	-0.695	0.611	0.499	1.291	0.256

Note: B = Regression Coefficient; OR = Odd Ratio; AOR = Adjusted Odds Ratio; SE = Standard Error; χ^2 = Wald Chi-square statistic; PONV = Postoperative Nausea and Vomiting.
*Statistically significant at $p < 0.05$.

Model Performance and Goodness-of-fit
The multivariable logistic regression model demonstrated excellent overall performance across multiple metrics:

Omnibus Test: The model was highly significant ($\chi^2 = 180.172$, df = 14, $p < 0.001$), indicating that the set of predictor variables collectively provides a better fit to the data than the null model.
Cox & Snell R^2 (0.603): This pseudo-R^2 value indicates that the model explains approximately 60.3% of the variance in PONV occurrence, representing a substantial proportion of the variance.
Nagelkerke R^2 (0.809): This adjusted pseudo-R^2 value of 80.9% indicates that the model explains most of the variance in PONV occurrence. The higher value compared to Cox & Snell R^2 reflects the maximum possible scaling of the R^2.
Classification Accuracy (90.3%): The model correctly classified 90.3% of cases, demonstrating excellent predictive capability. This high accuracy suggests that the model effectively distinguishes between patients who will and will not develop PONV, supporting its potential utility in clinical risk stratification.

Discussion and Conclusion

A total of 195 patients undergoing laparoscopic cholecystectomy under general anesthesia were included in the study. Most participants were aged 31–45 years (32.8%), followed by 46–60 years (29.7%), 18–30 years (26.2%), and >60 years (11.3%).

Males accounted for 52.3% of the sample, while females represented 47.7%. Regarding BMI, 41.5% had normal weight, whereas 29.2% were overweight and 29.2% were obese. Most patients were classified as ASA II (60.5%), and 75.9% were smokers. A history of motion sickness and previous PONV was reported by 20.0% and 20.5% of participants, respectively.

The overall incidence of PONV was 56.9% (111/195). Although higher PONV rates were observed among older patients, females, patients with normal BMI, ASA II status, smokers, those with a history of motion sickness, and those with previous PONV, none of these factors showed a statistically significant association with PONV ($p > 0.05$). Patients with previous PONV had a higher incidence of recurrence (67.5%) compared with those without such history (54.2%), but this association was not significant.

Among surgical factors, emergency procedures showed a higher incidence of PONV (69.0%) compared with elective surgeries (54.8%), although the difference was not statistically significant ($p = 0.156$). In contrast, duration of surgery was significantly associated with PONV ($\chi^2 = 12.87$, $p = 0.005$), with incidence increasing from 42.9% in surgeries lasting less than 60 minutes to 81.3% in procedures exceeding 120 minutes. Similarly, duration of pneumoperitoneum was significantly related to PONV ($\chi^2 = 12.35$, $p = 0.002$), as incidence increased from 38.5% in procedures lasting less than 30 minutes to 76.7% in those exceeding 60 minutes.

Analysis of anesthetic factors showed that ketamine induction was associated with the highest incidence of PONV (68.2%), followed by other agents (55.6%) and propofol (53.5%), but the association was not statistically significant ($p = 0.229$). Intraoperative opioid use demonstrated a significant relationship with PONV ($\chi^2 = 6.873$, $p = 0.009$), with 82.9% of opioid recipients experiencing PONV compared with 17.1% of those who did not receive opioids. No significant associations were found between PONV and antiemetic prophylaxis, volatile anesthetic type, or nitrous oxide use.

Postoperative nausea occurred in 44.6% of patients, while vomiting occurred in 27.2%. Among patients who vomited, 12.8% experienced one episode, 9.2% experienced two episodes, and 5.1% experienced three or more episodes. Rescue antiemetic therapy was required in 56.9% of participants. Regarding severity, 43.1% experienced no PONV, 29.7% had mild PONV, 22.1% had moderate PONV, and 5.1% had severe PONV.

Multivariable logistic regression analysis identified only two independent predictors of PONV. The choice of induction agent significantly increased the likelihood of developing PONV (AOR = 3.084, $p = 0.016$), while intraoperative opioid use emerged as the strongest predictor (AOR = 19.788, $p = 0.017$). Other variables, including age,

gender, BMI, ASA status, smoking, history of motion sickness, previous PONV, type of surgery, antiemetic prophylaxis, volatile anesthetic use, and nitrous oxide use, were not significant after adjustment. The regression model showed excellent performance, with a significant omnibus test (χ^2 = 180.172, $p < 0.001$), Cox and Snell R^2 of 0.603, Nagelkerke R^2 of 0.809, and an overall classification accuracy of 90.3%.

Recommendation

It is recommended that propofol-based anesthesia and opioid-sparing multimodal analgesia be prioritized to reduce the incidence of PONV. Perioperative risk factors, including prolonged surgical duration and elevated pneumoperitoneum pressure, should be carefully optimized. Risk-stratified antiemetic prophylaxis and integration into ERAS protocols are essential to enhance recovery outcomes.

Furthermore, multicenter prospective studies and randomized controlled trials are required to strengthen the evidence base and improve generalizability. Future research should focus on extended PONV monitoring, pharmacogenomic predictors, and external validation of predictive models. Incorporating cost-effectiveness analyses and patient-reported outcomes will facilitate the translation of evidence-based strategies into clinical practice.

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