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Prevalence and associated factors of intraoperative Nausea and Vomiting of mothers who gave birth with cesarean section under regional anesthesia: a systematic review and meta-analysis; 2023

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Abstract

Introduction Cesarean section is one of the most common obstetric procedures performed worldwide under spinal anesthesia which is a commonly practiced rapid, simple, and safe method. Vomiting and nausea are frequent side effects of many surgical procedures. However, with cesarean sections performed under regional anesthesia, this issue occurs even more frequently. The existing evidence regarding the prevalence and associated factors of intraoperative nausea and vomiting is inconsistent. Therefore, this systematic review and meta-analysis aimed to determine the pooled prevalence and associated factors of intraoperative nausea and vomiting.

Methods This is a systematic review and meta-analysis study that was done based on studies published within the last 10 years on the prevalence and associated factors of intraoperative nausea and vomiting during cesarean section under regional anesthesia. After PubMed, Google Scholar, HINAR, Scopus, Science Direct, and grey literature extensive search for primary studies, their quality was assessed with JBI and modified Newcastle Ottawa appraisal assessment tool and data was extracted. STATA^{MP} version 17.0 was used for all possible analyses of the study.

Results Twenty-nine studies were met the inclusion criteria of this systematic review and meta-analysis. However, only 21 studies were included by excluding eight studies due to inappropriate method & outcomes and language other than English. The pooled prevalence of intraoperative nausea and vomiting was 36% (95% CI- 31%, 41%) with heterogeneity (I^2-93.1%). Premedicated with metoclopramide, uterus exteriorization, motion sickness, preeclampsia, and intraoperative propofol were associated with the prevalence of intraoperative nausea and vomiting significantly.

Conclusion The pooled prevalence of intraoperative nausea and vomiting during cesarean section under regional anesthesia was high (36%) which needs more strategies for prevention.

Keywords Anesthesia, Cesarean section, Obstetric, Nausea and vomiting

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Introduction

Cesarean section (CS) is one of the most common obstetric procedures performed worldwide [1]. Spinal anesthesia is a commonly practiced rapid, simple, and safe method of anesthesia for cesarean sections [2]. Intraoperative Nausea and vomiting is the experience of nausea and vomiting during a surgical procedure, often associated with anesthesia and surgical manipulation, which is a common complication of Regional/spinal anesthesia, and procedures like a CS, by which parturient feel discomfort and disturbed.

Due to hormonal changes and elevated intra-abdominal pressure, there is an increased risk of nausea and vomiting during the latter stages of pregnancy [3]. It has been demonstrated that nausea and vomiting are the main side effects of spinal anesthesia, which makes these patients' experiences unpleasant [4].

Nausea and vomiting are frequent side effects of many surgical procedures. However, with CS performed under regional anesthesia, it occurs even more frequently [5]. The patient is at a higher risk of developing IONV due to many factors such as patient related factors like; increased intra-gastric pressure, hypotension, the patient's mental state and procedure related factors like; stretching of the peritoneum (exteriorization of the uterus), excessive surgical manipulation, visceral stimulation, use of opioids, use of uterotonic drugs [5–8]. One significant risk factor for IONV is hypotension linked to spinal, epidural, and spinal-epidural (combined) anesthesia [9–11]. Peritonealization, exteriorizing the uterus for suturing, and peritoneal cleaning are other surgical methods that may also be linked to IONV [7].

The condition known as intraoperative nausea and vomiting (IONV) disturbs the patient and can make surgery more difficult [12]. The anesthesia technique and the preventive and therapeutic measures taken by the anesthetist determine the incidence of IONV during CS under regional anesthesia [5].

When nausea and vomiting start during surgery and continue throughout the recovery phase, it reduces patient comfort, delays hospital leave, and adds expenses [13]. When considering certain potential outcomes, including dehydration, electrolyte imbalance, wound dehiscence, venous hypertension and bleeding, esophageal rupture, airway obstruction, and aspiration pneumonia, this issue merits more investigation [9, 14]. All these complication have their clinical impact on the parturients. Dehydration and electrolyte abnormalities can frequently impair cellular function, resulting in muscular weakness, cardiac arrhythmias, seizures, and altered mental status and even organ failure. Wound dehiscence induces risk of infection, slows recovery and may demand additional surgery. Venous hypertension can cause edema, skin ulceration, and an increased risk of bleeding, particularly in locations with limited venous return. Forceful vomiting can cause esophageal rupture, which is a life-threatening illness that predisposes for rapid surgical intervention. Airway obstruction can be caused by edema, foreign bodies, or decreased consciousness, can quickly lead to hypoxia and cardiac arrest, making prompt detection and management. Finally, aspiration pneumonia is a dangerous infection that can lengthen hospital stays, decrease lung function, and even be fatal [15, 16].

Although IONV has not been thoroughly examined, nausea and vomiting during the postoperative phase of regional anesthesia have been extensively researched [8, 17], and up to 80% of cesarean section cases develop PONV [5].

When the uterus is forced back into the abdominal region, vomiting is one of the most frequent side effects of spinal anesthesia, occurring in 66% of instances [18–20]. This is treated with a range of drugs; the most popular medication is metoclopramide [21–23].

Preoperative and intraoperative use of drugs, including 5-HT3 antagonists (e.g. ondansetron), dopamine antagonists (e.g. metoclopramide, droperidol), and sedatives (midazolam & propofol), can reduce nausea and vomiting during and after surgery under regional anesthesia. Corticosteroids (e.g., dexamethasone), antihistamines (e.g., cyclizine), and anticholinergics (e.g., scopolamine), careful hypotension monitoring, obtaining a good anesthetic block, gentle surgical technique, and prudent use of uterotonic drugs were also effective interventions for nausea and vomiting. In addition, acupressure was useful in lowering nausea but not vomiting [5, 7, 9, 24]. But all these medications could have their own side effects and contraindications. So, it is better to weight the risk benefit comparisons of each interventions. For instance Metoclopramide, can cause extrapyramidal symptoms (EPS) such as tardive dyskinesia, restlessness, and muscle spasms, particularly with prolonged use or high doses. Other side effects include drowsiness, fatigue, and diarrhea. It's contraindicated in patients with pheochromocytoma, mechanical bowel obstruction, and a history of EPS. In addition, Ondansetron can cause headache, constipation, and rarely, cardiac arrhythmias like QT prolongation. Its use should be cautious in patients with congenital long QT syndrome or those taking other QT-prolonging medications [25, 26].

Enhanced recovery after cesarean delivery (ERAC) is an existing guideline/protocol aimed to fasten postoperative recovery, optimizing maternal recovery, improve feto-maternal bonding, and perioperative outcomes after cesarean delivery. These aims can be achieved through different multidisciplinary approaches like preoperative patient education, limited fasting, carbohydrate load, limiting opioids intra- and postoperatively, using scheduled

non-opioid analgesics and supplementing with advanced therapies for women at higher risk for pain [27–29].

Thus, the presence of inconsistent data among the existing studies was our primary problem that needs to be investigated with systematic review and meta-analysis. The evidences of existing literatures on prevalence and associated factors of IONV are vary. Therefore, this systematic review and meta-analysis aimed to generate the aggregated prevalence and associated factors of IONV in mothers who gave birth with cesarean section under regional types of anesthesia by which possible complications and clinical negative impact of IONV will decreased.

Methods

Study setting, data source, and search strategies

This systematic review and meta-analysis was conducted to assess the pooled prevalence and associated factors of IONV among mothers who gave birth with CS under regional anesthesia. Potential studies were identified with three phases. Initially searching with major databases like PubMed/MEDLINE, Hinari, Google Scholar, Scopus, and EMBASE/Science Direct was done with searching terms of "(Magnitude) OR (Prevalence) OR (Incidence) AND (associated factors) OR (predictors) OR (determinants) OR (risk factors) AND (intraoperative nausea and vomiting) AND (cesarean section) OR (Cesarean delivery) OR (Parturients) OR (Mothers) AND (spinal anesthesia) OR (regional anesthesia) OR (neuraxial anesthesia)." In the second phase, searching with these databases was done with another searching phrase like "Intraoperative nausea and vomiting during cesarean section under spinal anesthesia." In the third phase of the search process, cross references of all included studies with full text after appraisal was done with Google Scholar and google search. A grey literature search was done to identify Research and Trial registers, theses/dissertations, organizations/websites, data – statistics, circulars, and reports. The search result was filtered with free full text, human species, English language, and published within 10 years. In addition, grey literature was searched with the search phrases "Magnitude/prevalence/incidence of intraoperative nausea and vomiting during cesarean section under spinal anesthesia" so as not to miss important articles. The search was done on 10–12/12/2023. The topic was checked for duplication in the PROSPERO and it is registered in the PROSPERO with the registration number of CRD42023495124. This systematic review and meta-analysis was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist [30].

Research questions

The research questions that this systematic review and meta-analysis answered are;

1. What is the pooled prevalence of intraoperative nausea and vomiting for mothers who gave birth with cesarean section under regional anesthesia?
2. What is/are the determinant factors that affect the prevalence of intraoperative nausea and vomiting during cesarean section?

We used the **PEO** (**Population**: All parturient; **Exposures**- Surgery/cesarean section, spinal Anesthesia; and **Outcomes**- intraoperative nausea and vomiting, determinant factors) approach to include and exclude studies to answer the research questions.

Question: what is the prevalence & associated factors of intraoperative nausea and vomiting during cesarean section under regional anesthesia

Population	Exposure	Outcomes
Parturient Mothers Pregnant mothers Childbearing age groups	Cesarean sections, Surgery, Spinal anesthesia, Epidural anesthesia Regional anesthesia, Neuraxial anesthesia, Combined spinal-epidural anesthesia	Intraoperative nausea, vomiting, retching Intraoperative nausea and vomiting Determinant factors

Eligibility criteria

Inclusion criteria

Studies conducted on and reporting the prevalence and/or associated factors of intraoperative nausea and vomiting for mothers who gave birth with cesarean section under regional anesthesia were included in this systematic review and meta-analysis. Furthermore, the following criteria were considered as an inclusion criterion.

Study design All types of studies (cross-sectional, case controls, and cohort, RCTs, etc.).

Language The articles were published only in the English language.

Population Parturient who gave birth with cesarean section under regional anesthesia.

Publication condition Both published and unpublished articles from different universities' repositories.

Publication year All publications reported up to December 12, 2023, within the last 10 years.

Exposure Cesarean section, operation, spinal anesthesia, and also there were studies done on different premedication and prophylaxis exposure.

Outcome Prevalence and associated factors or determinants of Intraoperative nausea and vomiting,

Exclusion criteria

Studies lacking appropriate data were excluded. There were studies done to compare the effects of different medications on the prevalence of IONV without a placebo. These studies were excluded from prevalence and factor analysis. Also, studies that haven't full text and failure to reply from the corresponding authors to get the full text were excluded from this meta-analysis.

Study identification and selection

After reading the title and abstracts, all studies with full text were exported to the Endnote X7 reference manager software. All five authors (BCD, NZ, NG, GM, and DTL) assessed and screened the full text of the studies based on aims, methodology, participants, and their findings. The quality of the studies was assessed by all authors independently and any disagreements were resolved through discussion and consensus. For issues not resolved with discussion majority vote was done to make a decision.

Outcome measurement

The primary outcome of interest for this systematic review and meta-analysis was to assess the prevalence of intraoperative nausea and vomiting during cesarean section under regional anesthesia. The events from all studies were taken if they report with prevalence of IONV. For comparative studies, we took the counts of participants who had IONV from all the groups and divided them by the total sample size to get the overall prevalence of IONV. The pooled prevalence of IONV was summarized and reported by using effect size in terms of prevalence with a 95% confidence interval. The secondary outcome of the study was the factors that had significant association with the primary outcome were analyzed and reported with odds ratio and 95% confidence interval.

Quality assessment

The quality of the studies was critically appraised by the JBI and modified Newcastle Ottawa appraisal assessment tool established for cross-sectional, RCT, and cohort studies [31, 32]. The qualities of each study were weighted by all authors (BCD, NZ, NG, GM, and DTL) independently using the quality assessment tool criteria. Those primary studies with a medium score (satisfying 50% quality evaluation criteria) and high quality (≥7 out of 10) were included in this study. The investigators' differences were managed by taking the average score of their quality evaluation outcomes.

Data extraction

Data were extracted from 21 included studies by all the authors of the study. The Microsoft Excel spreadsheet data extraction tool incorporates Authors' names with a year of publication, study country, study design, sample size, and outcome variables. In addition, an information extraction format was prepared for each specific associated factor which was significantly associated with the primary outcome of the included studies. The titles and abstracts of all identified literature in the searches were screened by the authors. Screened studies were appraised by all authors independently, and decisions were made regarding selection/rejection. The disagreements arising were resolved by the discussion of all the authors. Data from the included studies was extracted from all the authors of this study after a critical appraisal of all studies.

Statistical analysis

The necessary information from each study was extracted by using a Microsoft Excel spreadsheet. The extracted data was imported to STATA^{MP} version 17.0 software for analysis. After checking the heterogeneity of included studies, the pooled prevalence of IONV and associated factors were determined by the random-effects model using the DerSimonian-Laird method [33]. The results were presented using texts, tables, and different plots with measures of effect and a 95% confidence interval. Meta-regression, Subgroup analysis, Egger's test, trim, and fill test were done.

Heterogeneity and publication bias

To reduce the risk of bias, extensive searches were done. The authors' collaborative work was crucial in selecting articles based on clear objectives and eligibility criteria, determining study quality, and extracting and obtaining information to minimize bias. We investigate publication bias qualitatively by visually inspecting the funnel plot [34]. Furthermore, Egger's and Begg's correlation tests were performed at a 5% significant level to determine the presence of significant publication bias [35]. The heterogeneity of included studies was detected by using the I^2 statistic, which is a quantitative measure of lack of consistency across studies. If an I^2 statistic of studies is between 0 and 50%, it is considered as low heterogeneity, an I^2 statistic of 50–75% is considered to have moderate heterogeneity, and if the I^2 statistic is larger than 75%, a high degree of heterogeneity are considered in these trials. Usually, it is considered that there is no important heterogeneity if the value of I^2 across the studies is less than 50% [33, 36–38]. Meta-regression was done by

taking sample size, study country, study design, and year of publication as a moderator. Subgroup analysis was also performed by sample size, study country, study design, and year of publication to decrease the random variations among the primary study's point estimates. A sensitivity analysis was also performed to ascertain the possible cause of heterogeneity. If significant heterogeneity was detected, a random-effects model with the DerSimonian-Laird method was used for analysis.

Significant heterogeneity among included studies in a meta-analysis influences the method to meta-regression, subgroup analysis, and sensitivity analysis. Meta-regression is used to determine whether specific factor can account for the observed heterogeneity and how these factors influence effect size. Subgroup analysis, on the other hand, requires categorizing studies based on a specific characteristic and determining whether the effect size differs significantly between these subgroups, implying that the grouping variable is a source of heterogeneity. Finally, sensitivity analysis is critical for assessing the strength of meta-analysis conclusions in the presence of heterogeneity. This can include removing studies with extreme effect sizes, a high risk of bias, or those that contribute the most to heterogeneity in order to determine whether the overall conclusions are consistent.

Results

Search strategy

In this systemic review and meta-analysis, searching for potential studies was done in three phases. During the initial searching phase from major databases around 30,807 studies were identified. In the second phase of the search process around 107 studies were identified. Also after screening of studies identified with the two phases, cross reference searching of the included full texts was done and around 13 studies were identified. After duplication removal, removal of ineligible articles, and screening with other reasons 4,376 articles were found. Sixty-three articles were left with title and abstract screening. Twenty-nine studies that met the inclusion criteria were left for appraisal with full text. During the critical appraisal of the full texts, around eight studies were excluded for different reasons [39–46], and then 21 articles were left to be included in the qualitative and quantitative synthesis of this systematic review and meta-analysis (Fig. 1) [47].

Excluded studies

Studies done to compare effect of different medications on IONV without a placebo were excluded from this study. Because these studies were unable to reveal the overall prevalence of IONV. Also, studies with inappropriate data in terms of method and results were excluded (Table 1).

Characteristics of included studies

In this systematic review and meta-analysis, a total of 21 studies with an overall sample size of 4684 participants were included. The sample size of the included studies ranged from 80 [48, 49] to 1028 [50]. Eight of the included studies were done in the African context. The prevalence of IONV ranged from 11.96% [51] to 58% [52]. The included studies were done with variable study objectives, methods, and exposures. There are studies done to assess the effects of different medications on the prevalence of IONV during CS. Around 13 studies were done with RCT methods. For instance, studies were done on the effects of metoclopramide [53–57], ginger extracts [51], midazolam [49, 53, 58, 59], fentanyl [49, 59], dexamethasone [57, 60], ketamine [60], propofol [48, 55, 58]. Since all of the included studies were assessed to have moderate and above quality based on the JBI and New Castel Ottawa assessment tool, we included them (Table 2).

Outcome interests

A total of 21 primary studies were included to assess the pooled prevalence of IONV during cesarean section under regional anesthesia. For factor analysis, 12 studies were included to extract data on factors that had significant association with the primary outcome of interest.

Prevalence of intraoperative nausea and vomiting during Cesarean section

To assess the pooled prevalence of IONV 21 studies were included. The pooled prevalence of IONV during CS under regional anesthesia in this systematic review and meta-analysis was 36% (95% CI- 31%, 41%) by using the random effect model with the DerSimonian-Laird method since there was significant heterogeneity (I^2-93.1%) among the included studies (Fig. 2).

Publication bias

Publication bias was assessed with funnel plot visualization, Egger's and Begg's regression test, and trim and fill analysis. Although the funnel plot seems asymmetric (Fig. 3), Egger's and Begg's test declared that there was no significant bias as explained with a p-value of 0.5715 and 0.7398, respectively. In addition, the Duval and Tweedie nonparametric trim and fill analysis with the Run estimator revealed that there was no imputed study (Fig. 4). Therefore, there was no significant publication bias among the included studies.

Heterogeneity

There was a significant variability among the included studies as explained by I^2 statistics of 93.1%. This substantial heterogeneity indicates that the variation in prevalence estimates across the included studies is far greater

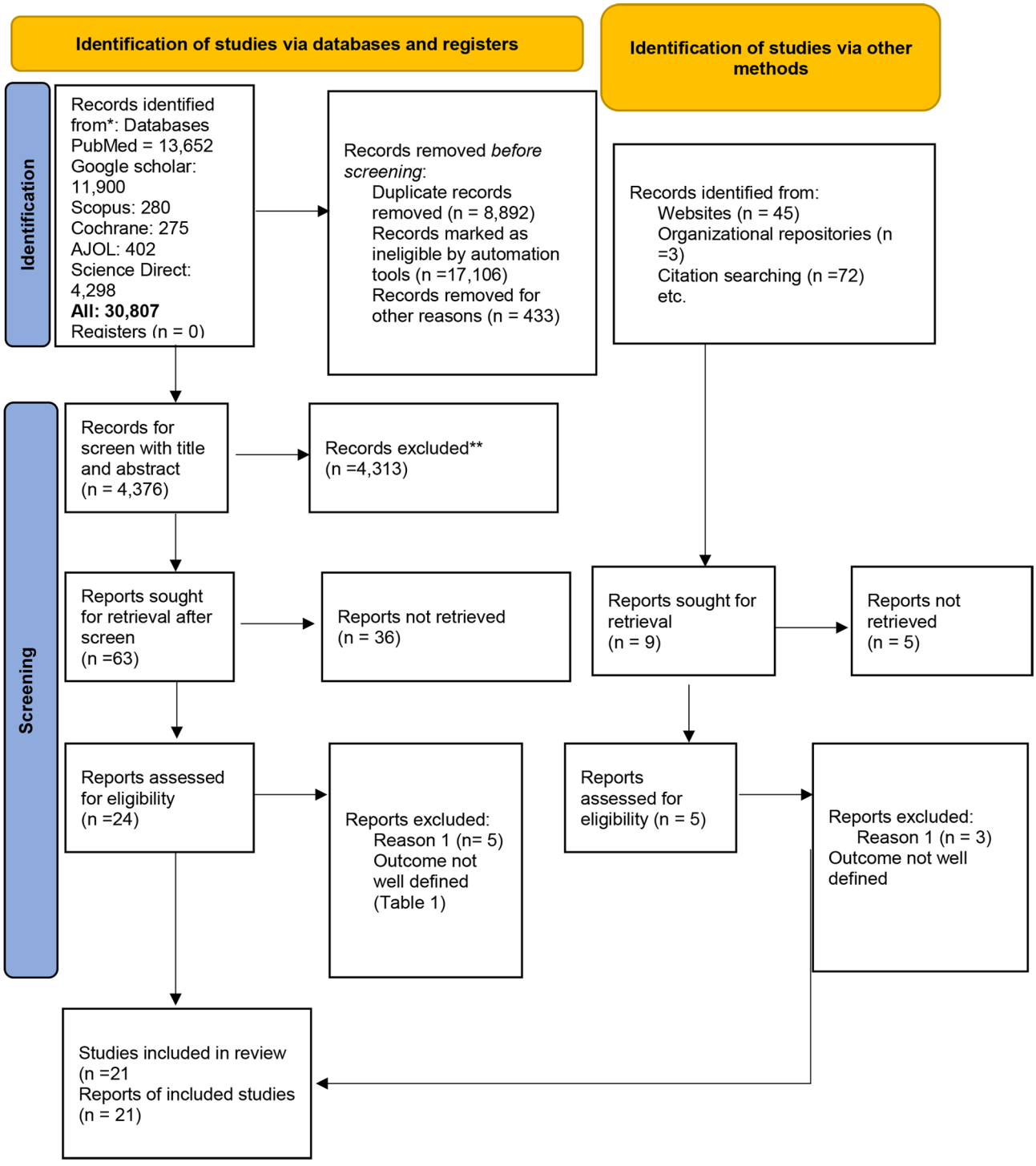

Fig. 1 PRISMA flow diagram showing search strategies and results

Table 1 Studies excluded from this systematic review and meta-analysis due to different reasons

S/no	Author (Year)	Reasons for exclusion
1.	Dr Debjani et al., 2019 [39]	Inappropriate methods and outcomes
2.	Myasar et al., 2023 [41]	Inappropriate outcomes and methods
3.	Navid Kalani et al., 2016 [45]	Inappropriate methods and outcomes
4.	Jelting, Y. et al., 2016 [40]	Inappropriate outcomes
5.	Griffiths et al., 2021 [42]	Since it is a review article
6.	Mojgan et al., 2023 [43]	Inappropriate outcomes and comparisons
7.	Pogodin et al., 2017 [44]	Language other than English
8.	Yanmei Bi et al., 2022 [46]	Inappropriate outcomes and comparisons

than what would be expected by chance alone, suggesting significant differences in populations, methodologies, or contexts between the included studies. Therefore, meta-regression was done to identify the possible sources of the variability by using sample size, publication year, study region, and study design as a moderator. Accordingly, the meta-regression revealed that none of the moderators were the possible sources of the variability among the included studies (Table 3).

Subgroup analysis

Subgroup analysis was done with different factors. Studies were grouped with different factors and groups. Prevalence of IONV by sample size was higher with a sample size of >100 participants at 40.9% (34.3 – 47.6%) as compared with a sample size of <100 participants at 32.2% (23.9%, 40.5%). When we compare the prevalence of IONV with publication year after 2020 and before 2020

Table 2 Characteristics of the included studies to assess the pooled prevalence of intraoperative nausea and vomiting

S/No	Author [year]	study area/region	study design	Exposures	Types of Anesthesia	Sample size	Prevalence	Study quality
1.	Abdallah et al., 2018 [50]	Egypt	RCT	Uterus extrerioziation	SA	1028	31.3	High
2.	Abere et al., 2020 [61]	Ethiopia	Cross-sectional	None	SA	140	54.3	High
3.	Amucheazi et al., 2021 [62]	Nigeria	RCT	Prophylactic Cyclizine, Metoclopramide	SA	116	18.1	High
4.	Arun et al., 2013 [63]	USA	RCT	Ginger extracts	CSE	239	56.9	High
5.	Ashagire et al., 2020 [64]	Ethiopia	Cross sectional	None	SA	373	40.8	High
6.	Magni et al., 2016 [65]	South Africa	Observational	None	SA	258	33	High
7.	Chekol et al., 2021 [66]	Ethiopia	Cross-sectional	None	SA	246	40.2	High
8.	Shin et al., 2019 [49]	Republic of Korea	RCT	Midazolam and fentanyl	SA	80	15	Moderate
9.	Hassanein et al., 2014 [60]	Egypt	RCT	Dexamethasone ketamine	SA	135	34	High
10.	Moshari et al., 2020 [52]	Iran	Cross-sectional	None	SA	200	58	High
11.	Rasooli et al., 2014 [58]	Iran	RCT	Propofol and Midazolam	SA	90	24.4	High
12.	Semiz et al., 2017 [67]	Turk	Observational	None	CSE	209	36.8	High
13.	Simeneh et al., 2018 [56]	Ethiopia	Observational	Metoclopramide	SA	132	37.1	High
14.	Voigt et al., 2013 [57]	German	RCT	Tropisetron, metoclopramide, dimenhydrinate, dexamethasone	SA	308	45.8	High
15.	Mokini et al., 2022 [55]	Italy	RCT	Metoclopramide and Propofol	SA	110	19.1	High
16.	Kazem et al., 2020 [68]	Iran	Cross-sectional	None	SA	500	27.6	High
17.	Safiya et al., 2015 [59]	India	RCT	intrathecal fentanyl and midazolam	SA	90	48.9	Moderate
18.	Kun Niu et al. 2018 [48]	China	RCT	Propofol	CSE	80	42.5	High
19.	Daniellie et al., 2019 [54]	USA	RCT	P6 stimulation (via a peripheral nerve stimulator), IV metoclopramide and ondansetron	CSE	180	44.44	High
20.	Amoll et al., 2017 ([53]	India	RCT	Intrathecal midazolam	SA	120	39.17	High
21.	Zeraati et al., 2016 [51]	Iran	RCT	Ginger extracts	SA	92	11.96	High

Key: SA- Spinal Anesthesia; CSE- Combined spinal epidural; RCT- randomized control trial

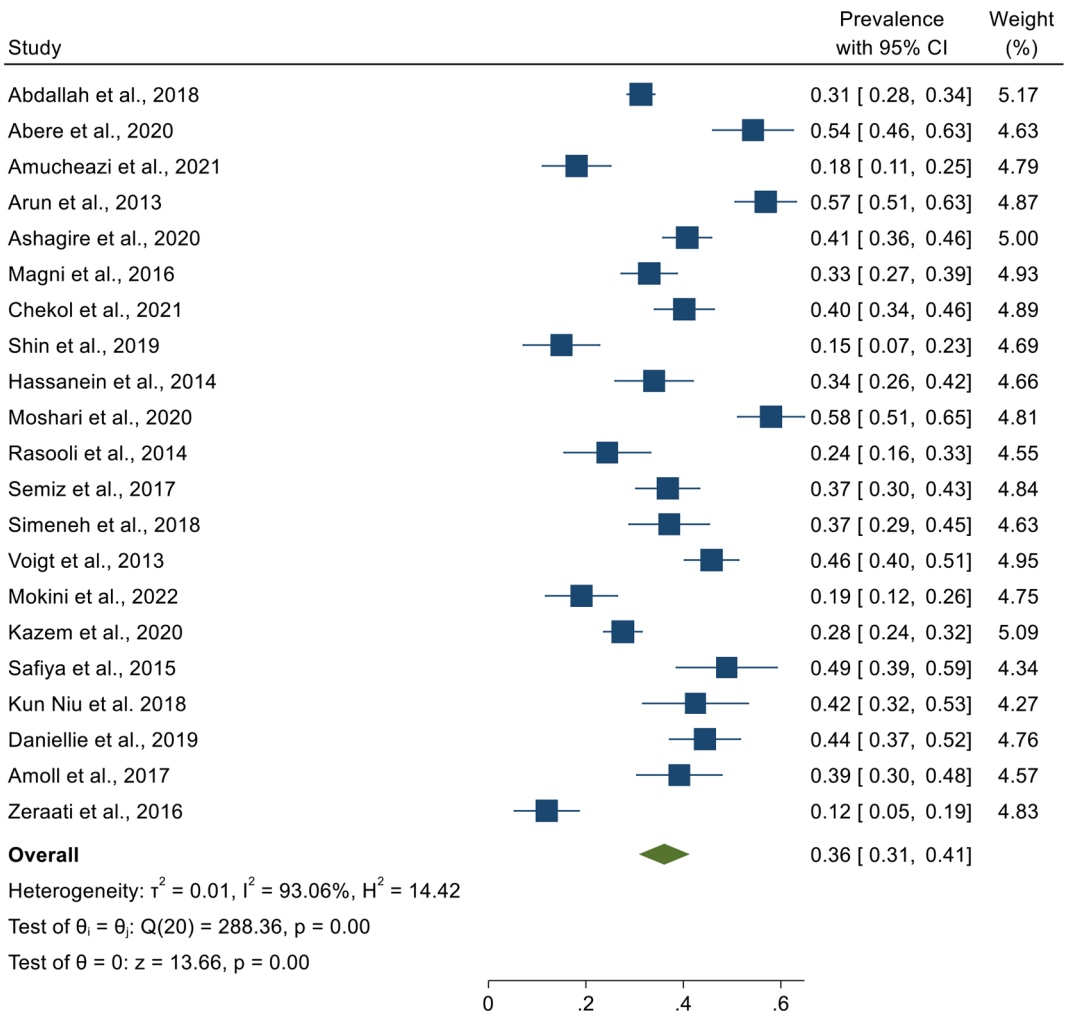

Fig. 2 The pooled prevalence of IONV during cesarean section under regional anesthesia

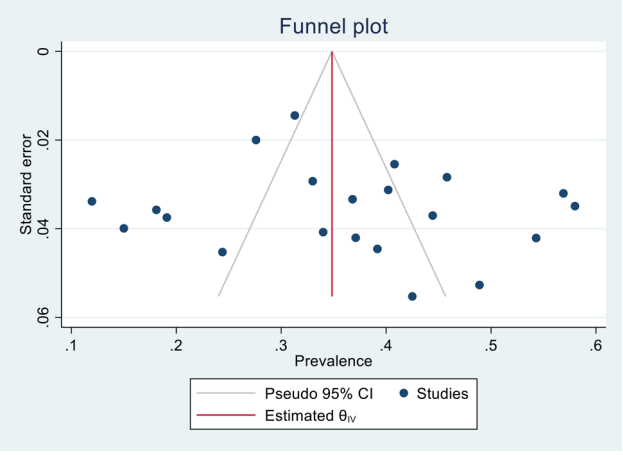

Fig. 3 A funnel plot describes the publication bias of the included studies

it was high after 2020 (36.8%) as compared with before 2020 (35.7%). Although subgroup analysis is performed to minimize level of heterogeneity, still there is significant variability among the included studies.

he existing heterogeneity could be occurred due to other different factors of the included primary studies (Table 4).

Sensitivity analysis

To identify the potential source of heterogeneity observed in the pooled prevalence of IONV, a leave-one-out sensitivity analysis was done. Accordingly, the pooled prevalence of IONV did not rely on a particular study. The pooled prevalence of IONV during cesarean section in this study did not vary significantly and ranged from 35% (95% CI- 30, 40%) to 37% (95% CI- 32, 42%) (Fig. 4).

Factors associated with the prevalence of IONV

Data regarding different factors associated with IONV prevalence was extracted from 12 primary studies. Seven

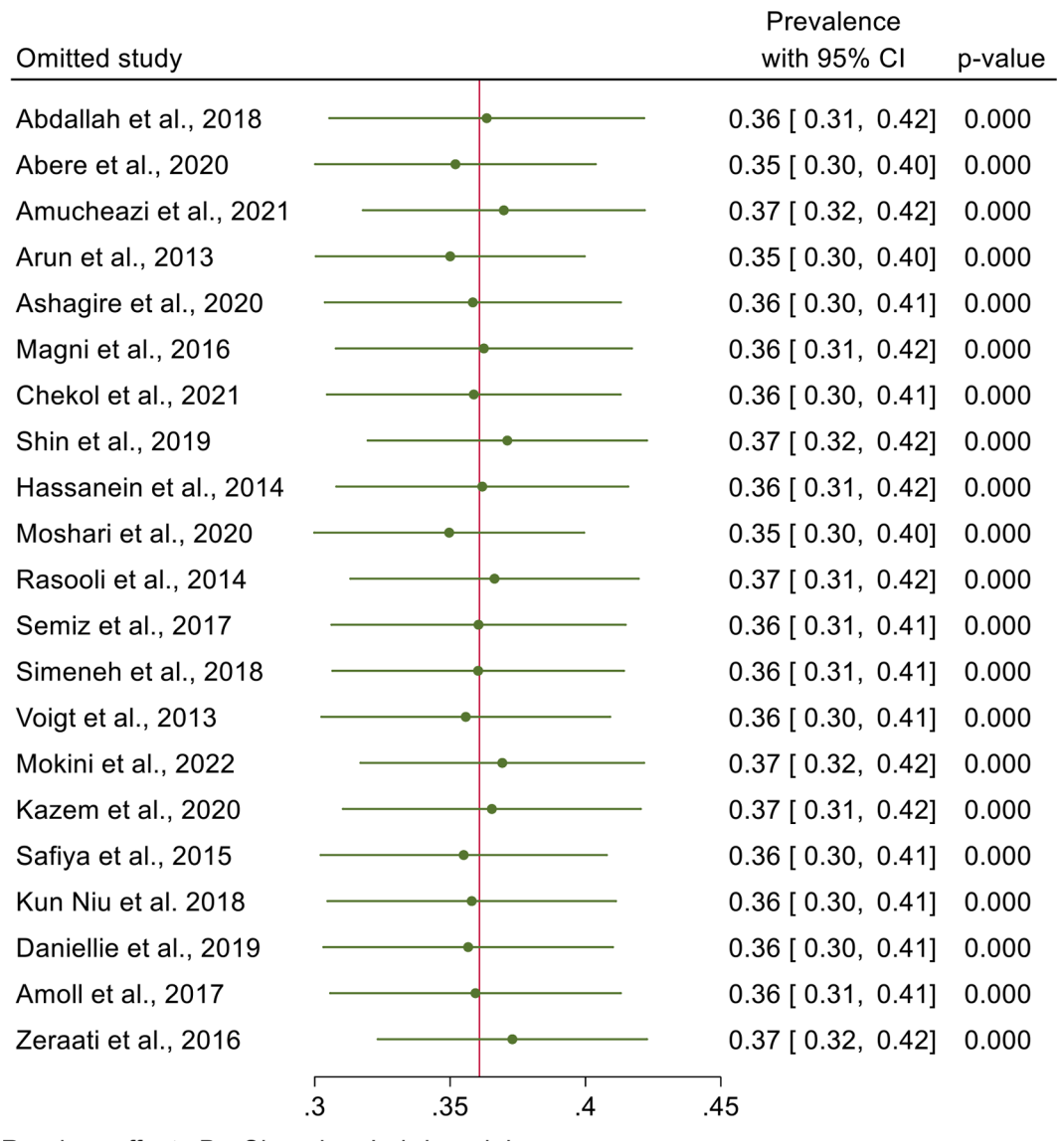

Fig. 4 Sensitivity analysis with a leave-one-out test to detect the effects of each study on the overall effect size

Table 3 Meta-regression results of the included studies to identify the sources of heterogeneity

Regression Moderators	Coefficient	Std. err.	Z-value	*P*-value	95% CI
Publication Year	-0.03	0.07	-0.41	0.68	-0.171, 0.111
Sample size	0.063	0.07	0.90	0.369	-0.074, 0.199
Study region	0.03	0.07	0.41	0.682	-0.103, 0.158
Study Design	-0.07	0.08	-0.83	0.404	-0.233, 0.094

factors were identified to have a significant association with IONV prevalence. AOR with 95% CI of significantly associated factors of the primary studies were extracted. Those factors are the presence of intraoperative hypotension, not premedicated with metoclopramide, motion sickness, uterus exteriorization, having pre-eclampsia, intraoperative vasopressor used, and taking propofol immediately after cord clamp. From these factors, vasopressor used and intraoperative hypotension were not significantly associated in this meta-analysis with OR-3.25 (95% CI- 0.32, 6.17) and 2.9 (0.95, 4.84) respectively.

Association of Metoclopramide premedication and IONV

Four studies revealed a significant association between metoclopramide premedication on the prevalence of IONV. As per this meta-analysis, mothers who were not premedicated with metoclopramide were five times more likely to have IONV as compared to premedicated parturient OR- 5.00 (95% CI- 2.03, 7.96) (Fig. 5).

Table 4 Subgroup analysis results of included studies across different factors and groups

Factors	Groups	No of studies	Prevalence	95% CI	I^2 (%)
Sample size	< 100	12	32.2	23.9, 40.5	92.04
	> 100	9	40.9	34.3, 47.6	93.71
Publication Year	< 2020	14	35.7	29.5, 41.9	91.97
	≥ 2020	7	36.8	26.4, 47.2	95.25
Study design	Observational	8	40.7	33.6, 47.9	91.21
	RCT	13	33.1	25.7, 40.5	93.83
Study region	African	8	35.9	30.0, 41.8	87.96
	Non-African	13	36.2	27.8, 44.5	94.77
Overall		21	36.1	30.9, 41.3	93.06

Motion sickness and IONV

Mothers who had motion sickness were ten times more likely to develop IONV as compared to the counterpart OR- 10.17 (95% CI- 4.07, 16.26) (Fig. 6).

Uterus exteriorization and IONV

Mothers whose uterus were repaired while exteriorized were 1.5 times more likely to have IONV as compared with the uterine repair without exteriorization OR- 1.52 (95% CI- 1.02, 2.02) (Fig. 7).

Preeclampsia and IONV

Parturients who had preeclampsia were twice as likely to have IONV as compared with preoperative normotensive mothers OR- 2.12 (955 CI- 1.47, 2.76) (Fig. 8).

Intraoperative Propofol administration effect on the IONV prevalence

Mothers for whom propofol was administered immediately after cord clamp were less likely to have IONV as compared with parturients who didn't take propofol OR- 0.16 (95% CI- -0.08, 0.41) (Fig. 9).

Discussion

Regional anesthesia is an effective, safe, and anesthetic choice for elective and emergency cesarean sections. Despite major advances in spinal, epidural, and combined spinal-epidural anesthesia techniques, intraoperative nausea and vomiting (IONV) are still present in a significant number of patients. These symptoms can be distressing and uncomfortable for patients, and they may have a negative impact on surgical procedures. It reduces patient comfort, delays hospital leave, and adds expenses [13]. When considering certain potential outcomes, including dehydration, electrolyte imbalance, wound dehiscence, venous hypertension and bleeding, esophageal rupture, airway obstruction, and aspiration pneumonia, this issue merits more investigation [9, 14].

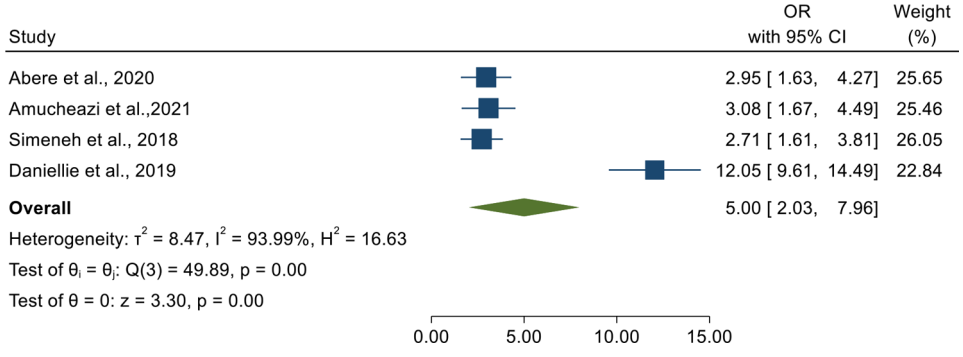

Fig. 5 Effects of metoclopramide premedication on IONV prevalence

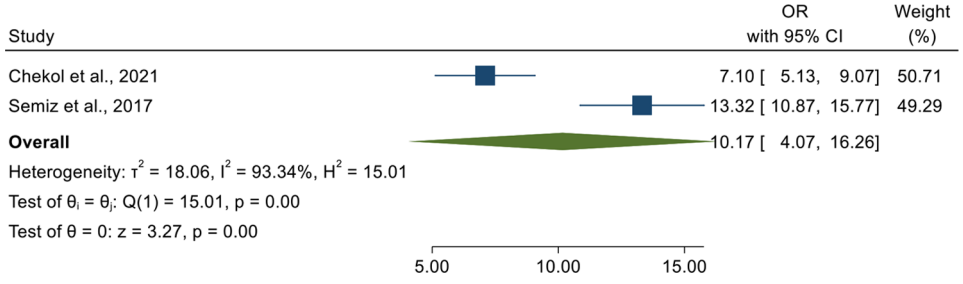

Fig. 6 The association of motion sickness and IONV during cesarean section

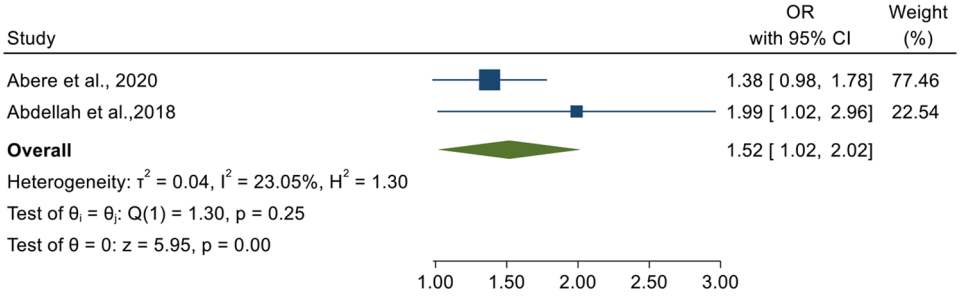

Fig. 7 Effects of uterus exteriorization on the prevalence of IONV during cesarean section

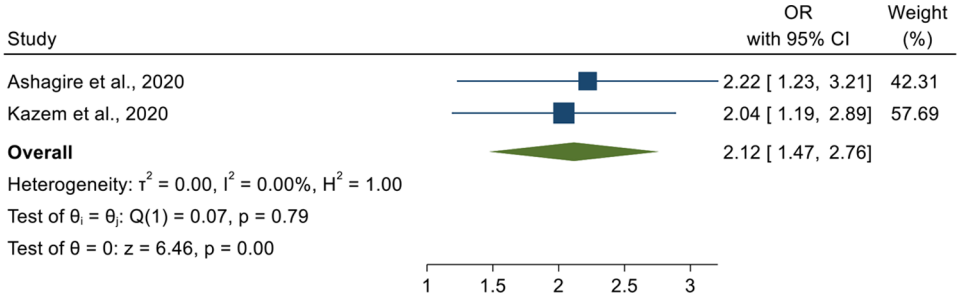

Fig. 8 The association of preeclampsia and IONV prevalence during cesarean section

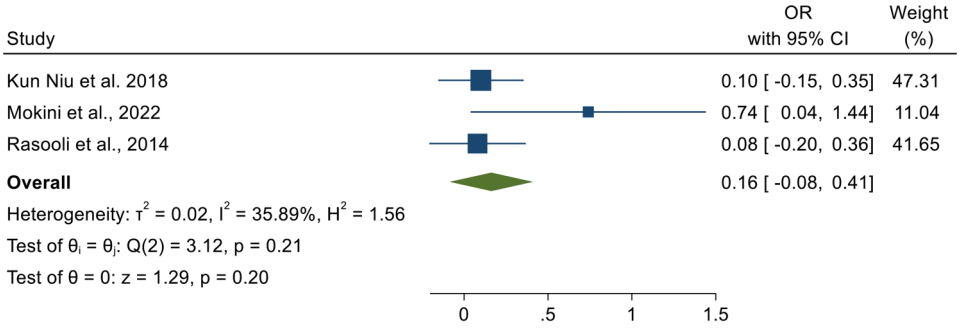

Fig. 9 Effects of intraoperative propofol administration on the prevalence of IONV

The pooled prevalence of intraoperative nausea and vomiting (IONV) during CS under spinal anesthesia of this study was 36% (95% CI: 31–41%). This high prevalence greatly affects the patients for distress, interferes with surgical procedures, causes aspiration of vomitus, and will precipitate intraoperative bleeding. This result was in line with a prospective observational study conducted at two Cape Town Level hospitals on 258 pregnant patients who were undergoing cesarean sections [69].

The findings of this review was high as compared to the findings of other similar independent studies conducted at the University of Gondar that reported IONV during CS under spinal anesthesia was developed in 18.5% of parturients [64]; in the same area 25.8% reported also develop intraoperative nausea and vomiting in 2018 [70]. The possible reason for this variation could be the antiemetic prophylaxis protocols adopted by different health professions in different times and areas.

In this review, the prevalence of IONV during CS under spinal anesthesia was found to be lower when compared to the study that was conducted in South Gondar zone specialized governmental hospitals in 2021 [71]. This variation might be because the majority of the participants in the current study took anti-emetic prophylaxis; with methodological differences.

The reported variations in the prevalence of IONV are mostly due to variations in clinical practice and study methodologies. In clinical practice; Anesthesia practice is greatly different due to availability of resources and protocols and the administration of prophylactic antiemetic; skill of obstetrician with different approaches, all significantly affect the incidence of IONV. Additionally, variations in pain management techniques, especially the use of opioids, which are known to cause nausea,

may complicate intraoperative evaluations if they persist during the initial phase of recovery. Regarding methodology, variations in patient selection criteria, timing and method of IONV assessment, duration of observations, and criteria for diagnosing IONV can be other contributing factors for the variation of IONV prevalence [64].

In this meta-analysis, different factors were identified to have a significant association with the prevalence of IONV. Parturients who are not premedicated with metoclopramide are five times (OR = 5.0; 95% CI: 1.40, 3.45) more likely to develop intraoperative nausea and vomiting as compared to those parturients who are premedicated with metoclopramide. Metoclopramide is a strong dopamine receptor antagonist and blocks the D2 receptor in the chemo-trigger zone and vomiting center. In addition, metoclopramide blocks histamine (H1) and serotonin (5 HT3) receptors; increases bowel motility and shortens bowel transit time; and increases gastroesophageal sphincter tone which helps to reduce the risk of nausea and vomiting [72, 73]. According to different guidelines (ASA, ASOP, ASOG), the use of metoclopramide is guided with risk stratification by considering contraindications and side effects of the medication. The medication may need to combine with other prophylactic drugs and techniques based on the risk [57, 74].

Moreover, those parturients who had a history of motion sickness were ten times (OR = 10.17; 95% CI: 4.07, 16.26) more likely to develop intraoperative nausea and vomiting as compared to their counterparts. Similar to our finding previous studies also revealed that patients who have a history of motion sickness are at increased risk of intraoperative and postoperative nausea and vomiting [75, 76]. Therefore, parturients with motion sickness needs to premedicate wit nausea and vomiting prophylactic medications. This prophylaxis is better to guide according to different risk assessment tools like Apfel criteria [77, 78].

In this systematic review uterine exteriorization increases the risk of intraoperative nausea and vomiting 1.5 times (OR = 1.52; 95% CI: 1.02, 2.02) higher as compared to the repair of the uterus in situ. Uterine exteriorization may induce intraoperative nausea and vomiting by stimulating the vagus nerve which innervates the uterine wall and inducing visceral pain which is mediated by C fibers. Visceral pain which is poorly localized and deep pain induces strong autonomic reflexes which increases the risk of intraoperative nausea and vomiting [79–81].

This meta-analysis also revealed that the incidence of intraoperative nausea and vomiting in preeclamptic parturients was two times (OR = 2.12; 95% CI: 1.47, 2.76) higher as compared to non-preeclamptic mothers. The intense cerebral vasoconstriction in preeclamptic patients will cause cerebral hypo perfusion and stimulate the vomiting center and chemo trigger zone. The risk of cerebral hypo perfusion will be pronounced by spinal anesthesia-induced hypotension which increases the risk of intraoperative nausea and vomiting [82, 83]. Therefore, it is better to prevent spinal anesthesia induced hypotension with different techniques to decrease prevalence of IONV for preeclamptic parturients. The possible techniques might be, balanced preload and co-loading, proactive vasopressors to maintain blood pressure, minimize level of spinal anesthesia block with dose adjustment and positioning, and consider multimodal antiemetic prophilaxis through effective collaboration and monitoring of the parturient.

In addition, this meta-analysis evidenced that intraoperative administration of sub hypnotic dose of propofol reduces the risk of intraoperative nausea and vomiting in parturients undergoing cesarean delivery. The antiemetic activity of propofol is due to the activation of the GABA-A receptor which inhibits serotonin (5 HT3) in the chemoreceptor trigger zone and gastrointestinal tract [84, 85]. This technique better to apply based on specific parturients condition with an appropriate monitoring. The dose adjustment can be done by considering the administration approaches. It is recommended to give 0.25-0.5 mg/kg as loading dose followed by 10-20mcg/kg/min of infusion or 10-20 mg of intermittent dose as needed. It is better to administer the medication after fetal delivery to decrease neonatal depression [86–88].

Strength and limitation

According to our extensive search and best knowledge, this is the first study that assesses the pooled prevalence and associated factors of IONV during CS with systematic review and meta-analysis. The data extraction and critical appraisal conducted by the authors in our study improved the reliability of the overall quality of the study. But, there was a high level of heterogeneity among the included studies. We used a random effect model which is fitted for heterogeneous studies. Also, this study used studies published only in the English language. There might be a selection bias because we included studies with different methodology, sample size, and study area.

Abbreviations

CS	Cesarean Section
OR	Odd Ratio
IONV	Intraoperative nausea and vomiting
CI	confidence Interval

Supplementary Information

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Supplementary Material 1

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Author contributions
B.C.D: contributed to the Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, and Writing – review & editing N.Z.: contributed to the Methodology, Resources, Software, Visualization, Writing – original draft, and Writing – review & editing G.M.: contributed to the Methodology, Resources, Supervision, Validation, Visualization, Writing – original draft, and Writing– review & editing N.G.: contributed to the Supervision, Validation, Visualization, Writing – original draft, and Writing – review & editing D.T.: contributed to the Conceptualization, Data curation, Methodology, Resources, Software, Visualization, Writing – original draft, and Writing – review & editing.

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Data availability
The data that were used for and support the review findings of this study are available upon a reasonable request to the corresponding author.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
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Review registration
This systematic review and meta-analysis was submitted for PROSPERO registration.

Competing interests
The authors declare no competing interests.

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