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Effects of Chewing Gum on Postoperative Nausea and Vomiting (PONV): A Systematic Review and Meta-analysis

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Abstract:

Purpose: Postoperative nausea and vomiting (PONV) is a common complication that brings discomfort to patients. Many researchers believe chewing gum can promote the recovery of postoperative gastrointestinal function. However, it is unclear whether chewing gum could reduce the incidence of PONV. This paper conducted a meta-analysis by systematically reviewing all literature to explore the relationship between chewing gum and PONV.

Method: We searched in eight major databases for all clinical trials exploring chewing gum and PONV. Statistical analyses were conducted by Stata and Revman Software.

Results: In all, there are 36 eligible studies for our meta-analysis. We found a significant difference between the chewing gum group and the control group on the incidence of PONV (OR: 0.48; 95%CI: 0.29 to 0.77; I^2:49.0%; p<.001), on the incidence of nausea (OR:0.66; 95%CI: 0.51 to 0.84; I^2: 15.0%; p<.001), on the incidence of vomiting (OR:0.58; 95%CI: 0.43 to 0.80; I^2: 20.0%; p<.001). In subgroup meta-analysis, there is remarkable difference merely in gynecological and obstetrics surgery on the incidence of PONV (OR: 0.43; 95%CI: 0.25 to 0.73; I^2:17.0%; p=.002), on the incidence of nausea (OR: 0.56; 95%CI: 0.37 to 0.84; I^2:34.0%; p=.005), on the incidence of vomiting (OR: 0.47; 95%CI: 0.27 to 0.81; I^2:39.0%; p=.006). No obvious difference between the two groups was found in other surgery. Besides, there is no difference between the two groups in the use of antiemetics.

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Conclusion: Chewing gum could decrease the incidence of PONV, especially in gynecology and obstetrics surgery.
Keywords：Chewing gum, PONV, Meta-analysis

1. INTRODUCTION

Postoperative nausea and vomiting (PONV) is a common complication with a 20%~30% incidence rate. PONV usually occurs after gynecological, gastrointestinal, ophthalmic, otological, and emergency surgery. Currently, there is no effective treatment for nausea and vomiting in PACU, and most measures are just symptomatic treatments. Continuous PONV can increase abdominal pressure and delay wound healing, even making the wound rupture and get an infection, which reduces patient satisfaction, prolongs hospital stay, and increases the burden on patients and physicians(Barnes, 2020; Veiga-Gil, Pueyo, & López-Olaondo, 2017). Ondansetron is commonly used for postoperative nausea and vomiting. A 2017 study in BJA found that chewing gum was as effective as ondansetron in preventing nausea and vomiting after laparoscopic or breast surgery in female patients.(J.N. Darvall, M Handscombe, & K Leslie, 2017). This research indicates chewing gum might help reduce PONV, but controversy exists. Some studies show it aids gastrointestinal recovery, yet its effectiveness in preventing nausea and vomiting is not firmly established. (Hochner, Tenfelde, Abu Ahmad, & Liebergall-Wischnitzer, 2015; Q. Liu, Jiang, Xu, & Jin, 2017; Mei, Wang, Cui, Wen, & Shen, 2017). Could chewing gum before or after an operation help lower the risk of postoperative nausea and vomiting?

THROUGH LITERATURE REVIEW, WE OBSERVED THAT PAST RESEARCH AND META-ANALYSES HAVE HIGHLIGHTED CHEWING GUM'S POTENTIAL TO ENHANCE GASTROINTESTINAL RECOVERY. YET, DEFINITIVE OUTCOMES REGARDING ITS ROLE IN DECREASING PONV REMAIN ELUSIVE. THIS ARTICLE STANDS OUT AS THE INAUGURAL META-ANALYSIS INVESTIGATING THE LINK BETWEEN CHEWING GUM AND PONV, OFFERING SUBSTANTIAL INNOVATION AND CLINICAL RELEVANCE. THE STUDY CONDUCTED AN EXHAUSTIVE META-ANALYSIS BY METICULOUSLY EXAMINING VARIOUS DATABASES' LITERATURE TO ASCERTAIN IF CHEWING GUM EFFECTIVELY MINIMIZES THE FREQUENCY AND SEVERITY OF POSTOPERATIVE NAUSEA AND VOMITING.

2. METHODS

Inclusion and exclusion criteria

This research provides a system-based review-based meta-analysis oriented with Randomized Controlled Trials (RCTs) for comparing the PONV rate when the patients received different care (standard care or chewing gum). The published contents abide by the PRISMA Statement(Moher, Liberati, Tetzlaff, & Altman, 2009).

The review question was structured using the PICO framework. The study focused on adult patients (Population), comparing the intervention of chewing gum with standard care (Intervention vs. Comparator), and assessing outcomes such as the incidence of PONV, emesis rate, and vomiting rate (Outcome). Our main outcomes encompass the incidence of PONV, along with the rates of emesis and vomiting. In several studies, the distinction between nausea and vomiting wasn't precisely recorded. In such cases, we combined the occurrences of nausea and vomiting as instances of PONV. In other instances, studies provided separate data for nausea and vomiting. We defined the sensation of impending vomiting as an occurrence of nausea. Additionally, the act of expelling gastric fluids or water was classified as an occurrence of vomiting. *Search, Selection & Data Extraction*

Our team conducted a comprehensive search across electronic databases, including Pubmed, Embase, Cochrane

Library, Web of Science, ClinicalTrial.gov, CNKI, WanFang Database, and CQVIP. We employed the following search terms: "Chewing Gum," "chew gum," "chew gums," "Chewing Gums," "Gum, Chewing," "Gums, Chewing," "Postoperative Nausea and Vomiting," "PONV," "Nausea and Vomiting, Postoperative," "Vomiting, Postoperative," "Postoperative Emesis," "Postoperative Vomiting," "Emesis, Postoperative," "Emeses, Postoperative," "Postoperative Emeses," "Postoperative Nausea," "Nausea, Postoperative," "randomized controlled trial," "randomized," and "placebo." These terms were combined using the Boolean operators "OR" and "AND." Two experts independently compiled the data using Microsoft Excel, with any disparities resolved by a third expert when necessary.

Risk of Bias (RoB) Assessment

Coupled with crucial methodological points (PH, GV, IP and IT), the Cochrane Risk of Bias Tool was employed to rate the Risk of Bias (Higgins et al., 2011). The results from the Risk of Bias (RoB) assessment were incorporated into the findings as illustrations rather than being directly integrated into the statistical analysis. Any discrepancies identified during the consensus process were subsequently addressed. *Quality of evidence*

The quality of evidence for each outcome was evaluated using methodologies like the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE). *Statistical analysis*

Utilizing Revman and Stata software, a skilled statistician conducted the statistical analysis. Additionally, our study conducted distinct meta-analyses based on varying types of surgeries and different chewing gum formulations to explore potential variations. Furthermore, we assessed the combined relative risks (RRs) along with their corresponding 95% confidence intervals (CIs) across all initial outcomes.

"STATISTICAL ANALYSES WERE CONDUCTED WHEN AT LEAST TWO RANDOMIZED CONTROLLED TRIALS (RCTS) WERE AVAILABLE PER GROUP. DUE TO THE INHERENT VARIANCE IN RESEARCH SETTINGS, THE RANDOM-EFFECTS MODEL, UTILIZING MANTEL-HAENSZEL ESTIMATION, WAS EMPLOYED. HETEROGENEITY WAS ASSESSED THROUGH I^2 AND CHI-SQUARED TESTS, WITH A SIGNIFICANCE LEVEL OF $P < 0.1$ INDICATING SUBSTANTIAL HETEROGENEITY (JPT., 2011). PUBLICATION BIAS WAS EVALUATED USING FUNNEL PLOT AND EGGER'S TEST.

3. RESULTS

Search Flow Chart & Characteristics of Studies

Fig 1 illustrates the search process and reasons for exclusions. Ultimately, a total of 36 studies met the inclusion criteria and were assessed for this meta-analysis. (Abdelkarim, Ciampoli, Zwakman-Hessels, Darvall, & Bellomo, 2020; Bowe et al., 2021; Chan et al., 2017; J. N. Darvall, M. Handscombe, & K. Leslie, 2017; Ertas et al., 2013; B. Ge et al., 2017; Gong et al., 2015; Jernigan, Chen, & Sewell, 2014; Kadirogullari, Seckin, Yalcin Bahat, & Aytufan, 2021; Lim et al., 2013; X. Y. Liu, Fan, & Wang, 2016; Pekin et al., 2015; Vergara-Fernandez, Gonzalez-Vargas, Castellanos-Juarez, Salgado-Nesme, & Ramos, 2016; Yang, Long, & Wei, 2018; Zaghiyan et al., 2013; Zhang, D, Li, L.J,& Yan, J,F., 2018; Gu,W.H., Wang,S.L., Chen, J.M., & Tian, B.B., 2017; Han,Z., Zhao,H.L., Liu,C.R, & Jing,Q., 2011; He,T, Li,H.F., Guo,J., & Luo, J. F., 2019; Hua, T., Zhang, K., Li, T.B., Zhou, X. H., & Yuan, H. B., 2018; Lai, S. R., Lai, X. L., Zhang, S. F., & Zhu, S. N., 2019; Li, K., Han, X. D., & Zhang, P., 2015; Li, W. et al., 2015; Li, W. et al., 2016; Li X. K. et al., 2016; Liang J.H. et al., 2007; Wan, X. D. & Wei, W. X., 2013; Wang, L. J., 2020; Wang, S. Y., Hou, Y. K., Dong, S. P., Liu, B. Y.,& Zhang, K., 2011; Yang, F. D., Li, J., Wei, W. C., Wang, Z. F., & Jiang, C. F., 2017; Yu, D. & Wu, N., 2017; Zhang, J. J., Su, Y. L., Li, S., Wang, Y., & Ruan, Y., 2015; Zhang, W. & Shao, Q., 2015; Zhong, Z. F., Ye, F., & Lin, J.

J., 2009; Zhou, H. & Lv, G. F., 2017; Zhu, C. Y., 2020). Furthermore, Table 1 provides an overview of the study characteristics. Upon review, it became evident that the majority of studies employed postoperative chewing gum intervention, with the exception of the study by TengHe2019. *RoB and Publication Bias*

Some studies exhibited limitations in meeting the criteria for low Risk of Bias (RoB), particularly in aspects such as random sequence generation, allocation concealment, and blinding. The summary of RoB for randomized controlled trials can be found in *Supplementary1*. The presence of publication bias was assessed using Funnel Plot and Egger's Test for the three outcomes, as depicted in *Fig3*. Notably, significant publication bias was observed in the outcome of vomiting incidence (p = .004). However, no significant publication bias was detected in the outcome of nausea incidence (p = .291) and the incidence of PONV (p = .651). *The incidence of PONV*

Among the 36 studies, ten focused specifically on patients experiencing postoperative nausea or vomiting. Consequently, these ten studies were included in our analysis to investigate whether chewing gum could effectively reduce the incidence of PONV. (*Fig 4*). Based on a total of 1110 cases, our analysis revealed a significant difference between the chewing gum group and the control group (OR: 0.48; 95% CI: 0.29 to 0.77; I2: 49.0%; p = .003). This suggests that chewing gum is indeed beneficial in reducing the incidence of PONV. Additionally, we categorized the ten studies into subgroups based on the type of surgery: gastrointestinal surgery, obstetrics and gynecology surgery, and other types of surgery. Subgroup meta-analysis demonstrated a notable distinction in the gastrointestinal and obstetrics/gynecology surgery subgroup (OR: 0.43; 95% CI: 0.25 to 0.73; I2: 17.0%; p = .002), indicating a significant reduction in PONV incidence with chewing gum use in obstetrics and gynecology surgeries. However, no significant differences were observed between the two groups in the other two subgroup meta-analyses. (*Fig 4*).

The incidence of nausea

Given the distinct symptoms of nausea and vomiting, some studies differentiate between these two symptoms in their clinical research. Hence, we incorporated all studies addressing the symptom of nausea into our meta-analysis. In total, 21 studies involving 2342 cases were included to explore the association between chewing gum and the incidence of nausea. A significant distinction emerged between the chewing gum group and the control group (OR: 0.66; 95% CI: 0.51 to 0.84; I2: 15.0%; p < .001), indicating a favorable effect of chewing gum in mitigating postoperative nausea. (*Fig 5*). Similarly, these studies were stratified into various subgroups. Notably, a substantial difference between the two groups (OR: 0.56; 95% CI: 0.37 to 0.84; I2: 34.0%; p = .005) signifies that chewing gum can significantly decrease the incidence of nausea in obstetrics and gynecology surgery. Conversely, no significant differences were observed between the two groups in the other two subgroup meta-analyses. (*Fig 5*).

The incidence of vomiting

We analyzed 21 studies, comprising a total of 2409 cases, to explore the link between chewing gum and the incidence of vomiting. A significant disparity emerged between the chewing gum group and the control group (OR: 0.58; 95% CI: 0.43 to 0.80; I2: 20.0%; p < .001), favoring the chewing gum group. This outcome reinforces the notion that chewing gum is indeed advantageous in alleviating postoperative vomiting. (*Fig 6*). Furthermore, these studies were categorized into three subgroups. A remarkable differentiation between the two groups (OR: 0.47; 95% CI: 0.27 to 0.81; I2: 39.0%; p = .006) suggests that chewing gum can substantially lower the incidence of vomiting in obstetrics and

gynecology surgery. On the other hand, no significant differences were found between the two groups in the other two subgroup meta-analyses. (*Fig 6*).

The use of antiemetics

Among all the studies, only three conducted research on the use of postoperative antiemetics. Our meta-analysis found no significant difference between the chewing gum group and the control group in this regard. (*Fig 7*).

4.DISCUSSION

Our meta-analysis indicates that perioperative chewing gum administration is associated with a reduction in the incidence of PONV, as well as nausea and vomiting. This finding aligns with our initial hypothesis and is consistent with results published in previous literature, such as the study in BJA.(J.N. Darvall et al., 2017). In this study, 94 female patients undergoing laparoscopic or breast surgery were randomly allocated to either an ondansetron group (receiving 4mg ondansetron intravenously during surgery) or a chewing gum group. Patients were treated accordingly when experiencing PONV in the post-anesthesia care unit (PACU). The results revealed no significant difference in PONV incidence between the two groups in the PACU setting. Notably, when patients were treated with chewing gum or intravenous antiemetics for PONV, the remission rate of PONV exhibited no significant distinction between the two groups. This study suggests that chewing gum could have a similar effect in treating nausea and vomiting as intravenous ondansetron 4mg. (J.N. Darvall et al., 2017). Additionally, our analysis indicates that chewing gum's impact on postoperative nausea and vomiting appears to be more pronounced in obstetrics and gynecology surgery. Interestingly, our results show that chewing gum does not seem to reduce the incidence of postoperative nausea and vomiting in gastrointestinal surgery.

Nausea, an unpleasant sensation associated with the urge to vomit, lacks a clear underlying mechanism. Vomiting is a multifaceted reflex process involving the expulsion of stomach contents through the mouth. The vomiting center receives various stimuli and initiates nerve impulses that trigger the vomiting response. Among the five mechanisms leading to PONV, the vagal mucosal pathway within the gastrointestinal system holds particular significance.(Shaikh, Nagarekha, Hegade, & Marutheesh, 2016). Numerous studies have indicated that chewing gum, simulating food intake through sham feeding, can enhance bowel motility recovery.(W. Ge, Chen, & Ding, 2015). It is believed that chewing gum activates the cephalic-vagal pathway, stimulating intestinal myoelectric activity and hastening bowel motility.(Fanning & Valea, 2011). Moreover, chewing gum elevates cortisol levels, alleviating stress, and potentially enhancing cerebral blood flow and cognitive diversion(Gray et al., 2012). The reduction in PONV incidence associated with chewing gum appears to be linked to these mechanisms. Given that gastrointestinal surgery inherently triggers stimulation of the gastrointestinal tract, substantial gastrointestinal dysfunction commonly follows, elevating the risk of PONV. Moreover, during anesthesia, multiple factors exacerbate the inflammatory reaction in the gastrointestinal tract. Consequently, the severity of post-gastrointestinal surgery nausea and vomiting tends to surpass that of other surgeries(Mazzotta, Villalobos-Hernandez, Fiorda-Diaz, Harzman, & Christofi, 2020). This likely explains the absence of a significant difference between the chewing gum group and the control group in gastrointestinal surgery within our study. Furthermore, the majority of studies included in our meta-analysis concentrated on chewing gum's impact on

intestinal function recovery. The chosen outcomes were relatively simplistic, often centering on the incidence of nausea or vomiting. Utilizing more intricate and quantifiable outcomes in future studies might yield different results.

Through this paper, we present the first meta-analysis that investigates the impact of chewing gum on postoperative nausea and vomiting (PONV) by synthesizing a comprehensive range of literature. This study demonstrates strong innovation and holds significant clinical value. However, it's important to note that there exists notable heterogeneity due to variations in intervention methods across different studies (see in *Table 1*). Our meta-analysis has limitations. Most included studies primarily focus on chewing gum's impact on gastrointestinal function, with PONV incidence as a secondary outcome, lacking depth. We included only 2-3 randomized controlled trials specifically addressing chewing gum's effect on PONV, resulting in somewhat simplistic outcomes.

To enhance accuracy, future trials should employ quantifiable measures like vomiting frequency or nausea duration. This approach would provide more robust and convincing insights into chewing gum's impact on postoperative nausea and vomiting.

5.Conclusion

Chewing gum has the potential to reduce PONV occurrence, particularly in gynecology and obstetrics surgeries. For future clinical trials, it's advisable to choose more measurable outcome indicators. This approach will contribute to a more precise and persuasive exploration of the effects of chewing gum on postoperative nausea and vomiting.

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Table

Table1: Characteristics of Included Studies

author	**year**	**randomization**	**allocation concealment**	**blinding**	**surgery type**	**control group measures**	**treatment group measure**	**outcome**
Bowe	2021	unclear	unclear	unclear	caesarean section	intraoperative ondansetron (4mg, iv.)	1. ondansetron (4mg, iv.) 2. chewing gum	the incidence of PONV in POD1
Abdelkarim	2020	computerised random number generator	sequentially numbered envelopes	double-blind	non-oropharyngeal, maxillary or oesophageal surgery	a 20 mL sip of water (q4h, po.)	chewing gum for at least 15 minutes (q4h, Post-op.)	1.the number of patients with nausea in POD1 2.the incidence of

								vomiting or dry retching 3.use doses of rescue antiemetics 4.duration of nausea episodes 5.Worst nausea score
Ertas	2013	computer-generated code using the blocked randomization method	sequentially numbered, opaque, sealed envelopes	double-blind	Total abdominal hysterectomy with systematic pelvic and para-aortic lymphadenectomy	Standardized postoperative feeding regime: 30–60 ml of water (from POD1 until the first passage of flatus)	1. standardized postoperative feeding regime 2. chewing gum for 30min (tid, Post-op. POD1 until the return of bowel function)	1.the number of patients using antiemetics 2.the number of patients with moderate and severe vomit symptoms
Chan	2017	online randomized software	unclear	double-blind	Posterior Spinal Fusion Surgery	standardized postoperative care	1. standardized postoperative care 2. chewing gum for 30min (q4h, from Post-op. 2h to POD3)	1. the number of patients without any nausea during postoperative period 2. nausea score at different timepoints
Jernigan	2014	random number generator	Opaque envelopes	double-blind	laparotomy for benign gynecologic surgery	routine postoperative care	1. routine postoperative care	1. the number of patients using

							2. chewing gum for 15min (every 4 h while awake)	postoperative antiemetics 2. the number of patients with nausea 3. the number of patients with emesis
Gong	2015	computer-generated random numbers table	unclear	unclear	elective laparoscopic gynecologic surgery	standardized postoperative care	1. stadardized postoperative care 2. chewing gum for 30min (tid, from Post-op. 6h to flatus)	the number of patients with nausea and vomiting
Ge	2017	computer-generated randomization sequence	unclear	unclear	laparoscopic surgery for gastric cancer	standardized ward care, ERAS (perioperative warming, patient-controlled analgesia, early removal of urinary catheters and early ambulation on POD 1).	1.standardized ward care, ERAS 2. chewing gum for 15 minutes (tid, from POD1 until the day of exhaust defecation)	nausea/vomiting score
Zaghiyan	2013	computer online program	unclear	nonblinded	major colorectal surgery	Enhanced recovery after surgery	1.Enhanced recovery after surgery protocol	episodes of emesis

						protocol (early enteral feeding of a clear-liquid diet, patient-controlled analgesia, and early ambulation)	2. chewing gum for 45min（tid, from POD1 to POD7）	
Yang	2018	computer-generated randomization software	Sealed opaque envelopes	double-blind	elective open proctectomy	standard care	1. standard care 2. chewing gum	the patients' number of nausea the number of vomit
Pekin	2015	draw	envelope	double-blind	gynecologic surgery	Standardised postoperative dietary regime (100–200 ml of water at the Post-op. 8th h, 1L other liquids per day until the first passage of faltus. Upon passing flatus, a	1. Standardised postoperative dietary regime 2. chewing gum for 30 min (every 4 h, from Post-op. 3rd h to gas discharge)	the number of patients with nausea

						solid diet was permitted)		
Kadirogullari	2021	random number generator	unclear	unclear	total laparoscopic hysterectomy	standard postoperative care	1.standard postoperative care 2. chewing gum for 15 min (every 2h, from Post-op. 4th h to gas discharge)	1. the number of patients with nausea 2. the number of patients with vomiting
Darvall	2017	computerized random number generator	quentially numbered envelopes	double-blind	laparoscopic or breast surgery	ondansetron 4mg i.v.	chewing gum for a period of 15min	1. the number of patients with PONV 2. the number of patients with the first, second, third nausea 3. the number of patients with the first, second, third vomiting
Lim	2013	computer-generated random numbers	numbered opaque envelopes	unclear	Elective Colorectal Resectional Surgery	traditional ERAS program(preoperative immunonutrition, no nasogastric tubes, voidance of urinary	1. traditional ERAS program 2. chewing gum for 15min (qid)	1. the number of patients with nausea 2. the number of patients with vomiting

						catheters, early commencement of diet, early mobilization)		
Vergara-Fernandez	2016	unclear	unclear	unclear	Colorectal Surgery with Primary Anastomosis	standard post-operative recovery.	1. standard post-operative recovery. 2. chewing gum for 15min (every 4 h while awake)	1. the number of patients with nausea 2. the number of patients with vomiting
Chengya Zhu	2020	unclear	unclear	unclear	cesarean section		1.standard post-operative care 2.chewing gum	the number of patients with nausea and vomiting
Teng He	2019	computer-generated random numbers table	unclear	unclear	Gynecologic laparoscopic surgery	1. Not use antiemetics during surgery 2. standard post-operative care (drink water Post-op. 6th h; early urinary catheters removal and early	1. Not use antiemetics during surgery 2. standard post-operative care (drink water Post-op. 6th h; early urinary catheters removal and early ambulation on POD 1) 3. Chewing gum for 30min	1. the number of patients with nausea 2. the number of patients with vomiting

						ambulation on POD 1)	(Pre-op. 30 ~ 60 min)	
Zifeng Zhong	2009	draw	unclear	unclear	rectal cancer resection	standard post-operative care	chewing gum for 5~15 minutes (tid, from Post-op. 12th h)	1. the number of patients with nausea 2. the number of patients with vomiting
Zhi Han	2011	computer-generated random numbers table	Sealed opaque envelopes	double-blind	hysteromyomectomy	standard post-operative care (drink water Post-op. 12th h; early ambulation on POD 1; patient-controlled analgesia)	1. standard post-operative care 2. chewing gum for 15 minutes (tid, from Post-op. 4th h; every 2h per time until flatus)	1. the number of patients with nausea 2. the number of patients with vomiting
Tong Hua	2019	computer-generated randomization software	unclear	unclear	Posterior Spinal Fusion Surgery	standard post-operative care (including patient-controlled analgesia)	1.standard post-operative care 2. chewing gum for 20~30min (tid; POD1~POD3)	nausea score
Shurong Lai	2019	draw	unclear	unclear	Laparoscopic colorectal cancer surgery	ERAS program（early ambulation; medical nutrition	chewing gum for 10~15min(qid; from Post-op. 2th h)	1. the number of patients with nausea 2. the number of patients

						therapy;mental healing ）		with vomiting
Kun Li	2015	draw	unclear	unclear	Laparoscopic gastric bypass surgery	standard post-operative care	1.standard post-operative care 2. chewing gum for 30min (qid; from Post-op.3th h)	1. the number of patients with nausea 2. the number of patients with vomiting
Xingyu Liu	2016	draw	unclear	unclear	Splenectomy	standard post-operative care	1.standard post-operative care 2. chewing gum for 30min (qid; from Post-op.3th h)	1. the number of patients with nausea 2. the number of patients with vomiting
Wei Li	2015	computer-generated randomization software	unclear	unclear	laparotomy for benign gynecologic surgery	standard post-operative care	1. standard post-operative care 2. chewing gum for 20min (every 6 hours per time; from Post-op. 4th h)	1. the number of patients with nausea 2. the number of patients with vomiting
Wei Li	2016	computer-generated randomization software	unclear	double-blind	laparotomy for gynecological malignant tumors	standard post-operative care (drink water Post-op. 12th h; early ambulation on POD 1; patient-	1. Standard post-operative care 2. Chewing gum for 30min (tid; from POD1)	1. the number of patients with nausea 2. the number of patients with vomiting

						controlled analgesia)		
Xiaoke Li	2016	unclear	unclear	unclear	laparoscopic sleeve gastrectomy	standard post-operative care	1. Standard post-operative care 2. Chewing gum for 15min (qid; from Post-op. 4th h)	1. the number of patients with nausea 2. the number of patients with vomiting
Junhua Liang	2007	unclear	unclear	unclear	Cesarean section	standard post-operative care(including patient-controlled analgesia)	1. Standard post-operative care 2. Chewing gum for 15min (qid)	the number of patients with nausea and vomiting
Xidi Wan	2013	unclear	unclear	unclear	Radical hysterectomy for cervical cancer	standard post-operative care(including early ambulation on POD 1)	1. Standard post-operative care 2. Chewing gum for 15min (tid; from Post-op. 6th h)	1. the number of patients with nausea 2. the number of patients with vomiting
Shaoyuan Wang	2011	draw	Sealed opaque envelopes	double-blind	rectal carcinoma radical surgery	standard post-operative care	1. Standard post-operative care 2. Chewing gum for 15min (every 4 hours per time; from Post-op.6th h until flatus)	1. the number of patients with nausea 2. the number of patients with vomiting
Jingjing Zhang	2015	unclear	unclear	unclear	hepatectomy	standard post-	1. standard post-operative care	1. the number of patients with nausea

						operative care	2. Chewing gum for 30min(qid; from POD1 until the first defecating)	2. the number of patients with vomiting
Dan Yu	2017	draw	unclear	unclear	Laparoscopic Choledocholithotomy	standard post-operative care (including arly ambulation on POD 1 and abdominal massage)	1. standard post-operative care 2. Chewing gum for 30min (qid; from Post-op. 6th h)	1. the number of patients with nausea 2. the number of patients with vomiting
Huan Zhou	2017	draw	unclear	unclear	Laparoscopic colorectal cancer surgery	standard post-operative care	1. Standard post-operative care 2. Chewing gum for 5~20min (tid; from POD1)	1. the number of patients with nausea 2. the number of patients with vomiting
Fudi Yang	2017	draw	unclear	unclear	Appendectomy	standard post-operative care	1. Standard post-operative care 2. Chewing gum for 20~30min (qid; from Post-op. 6th h)	the number of patients with vomiting
Weihua Gu	2017	draw	unclear	unclear	laparoscopic gynecologic surgery	standard post-	1. Standard post-operative care	the number of patients with

						operative care	2. Chewing gum for 30min (tid; from POD1)	nausea and vomitting
Lujie Wang	2020	computer-generated randomization software	Sealed opaque envelopes	double-blind	laparoscopic gynecologic surgery	standard post-operative care	1. Standard post-operative care 2. Chewing gum for 15min (every 2 hours per time; from POD1)	the number of patients with nausea and vomitting
Zhang Du	2018	random numbers table	unclear	unclear	Colorectal surgery	standard post-operative care	1. Standard post-operative care 2. Chewing gum for 5~15min (tid; from POD1)	the number of patients with nausea and vomitting
Wei Zhang	2015	unclear	unclear	unclear	Laparoscopic Appendectomy	standard post-operative care	1. Standard post-operative care 2. Chewing gum for 30min (tid; from POD1)	the number of patients with nausea and vomitting

（q4h: once every 4 hours; tid: three times a day; qid: four times a day; 3th: the third; 4th: the fourth; h: hour; po: oral; iv：intravenous intravenously; POD: postoperative day; Post-op: postoperative; Pre-op: preoperative; ）

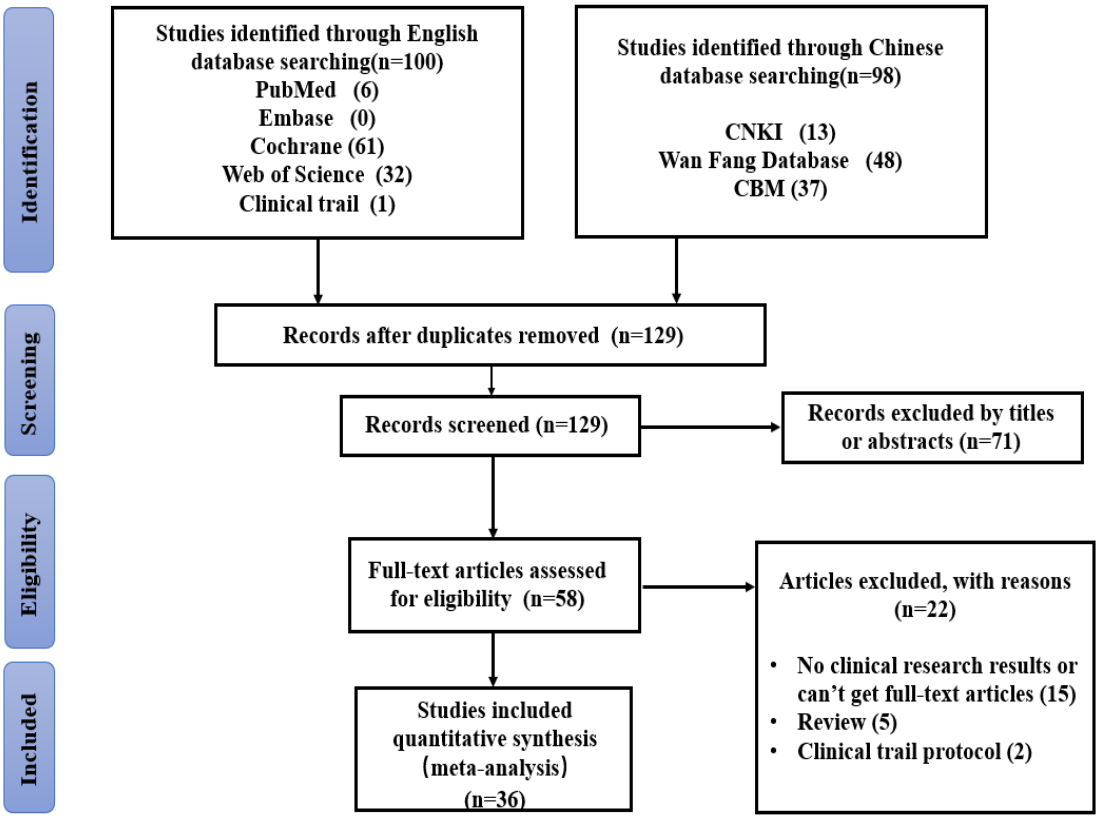

Fig1: The flow Chart of meta-analysis

Fig2: The summarization of RoB ("+": low risk of bias; "?": unclear risk of bias; "−": high risk of bias)

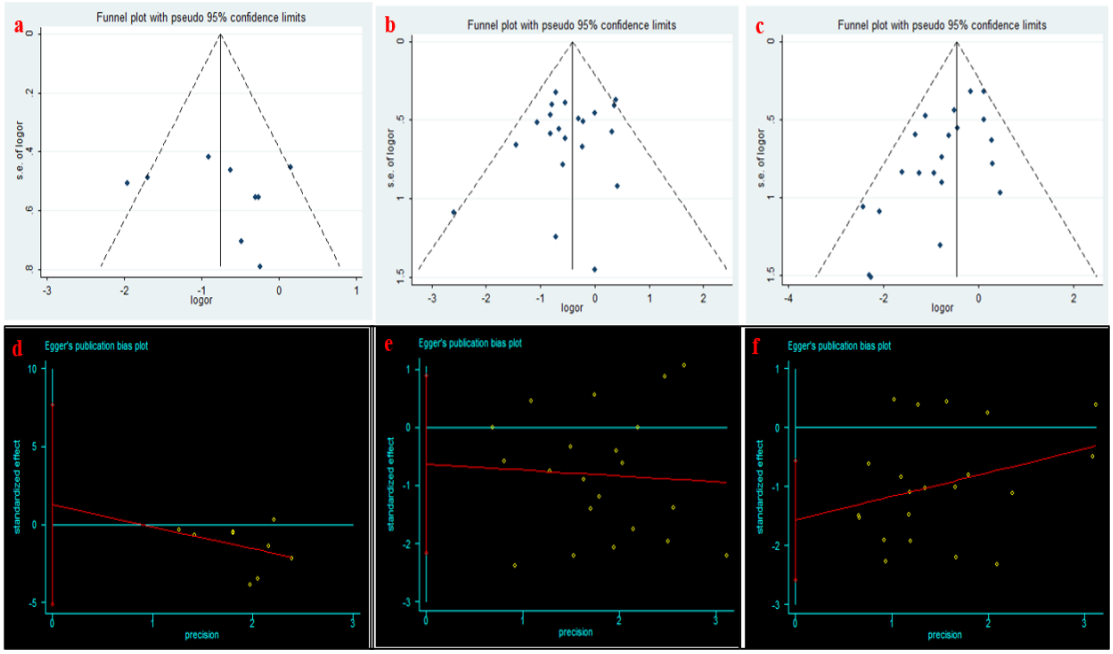

Fig 3: Funnel Plot and Egger's test of outcomes (a: Funnel Plot of the incidence of PONV; b: Funnel Plot of nausea incidence; c: Funnel Plot of vomiting incidence; d: Egger's test of the incidence of PONV P=0.651; e: Egger's test of nausea incidence P=0.391; f: Egger's test of vomiting incidence P=0.004)

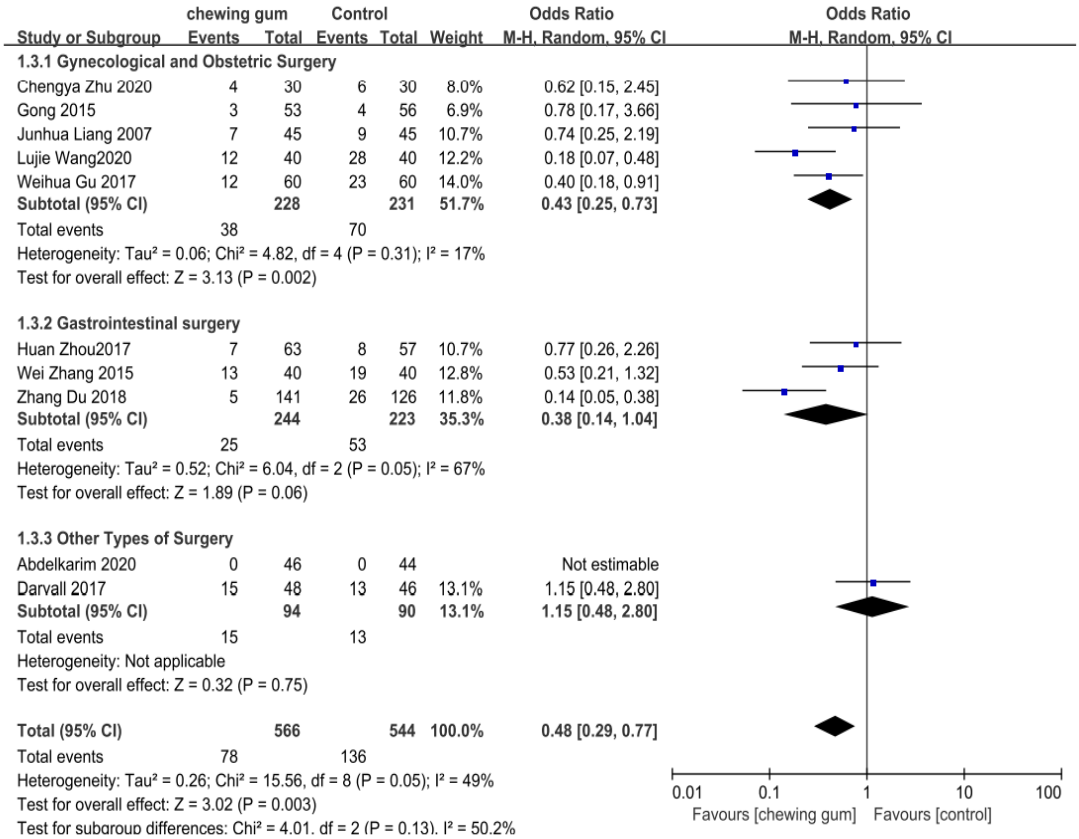

Fig 4: Forest Plot of the incidence of PONV (CI: confidence interval)

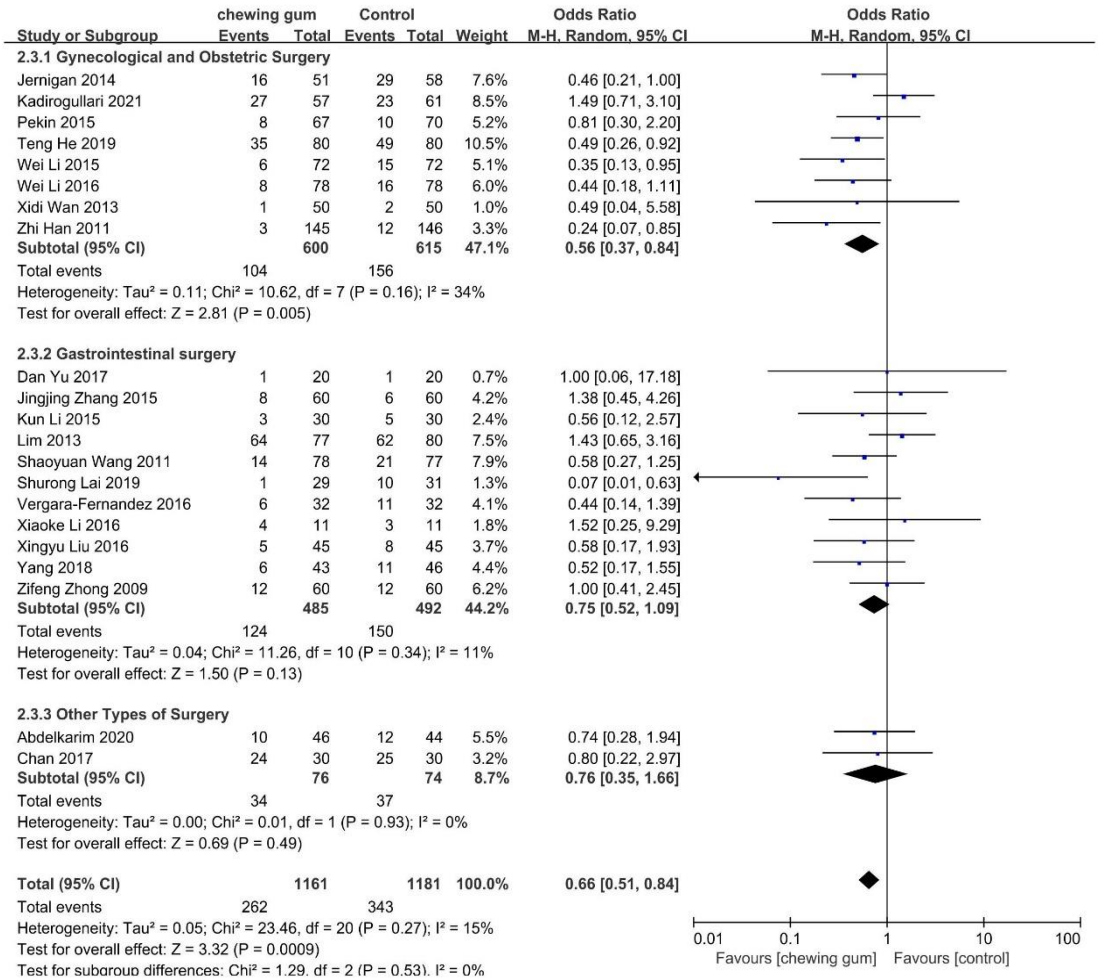

Fig 5: Forest Plot of the incidence of nausea (CI: confidence interval)

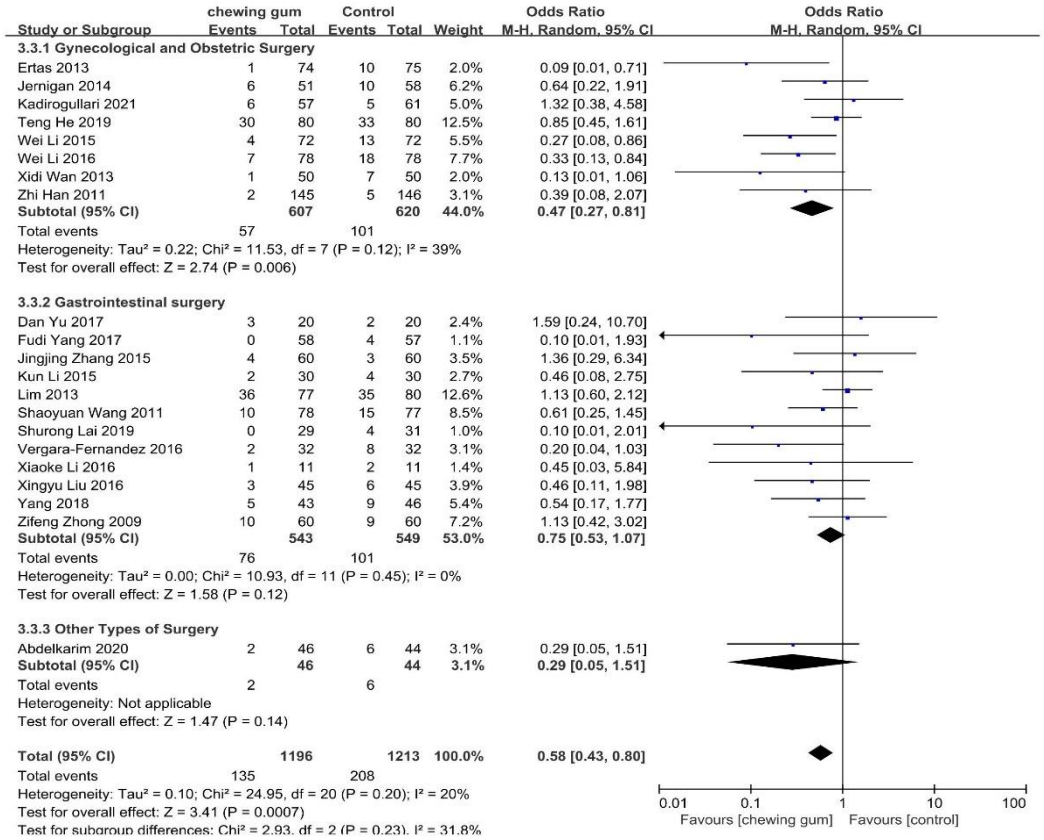

Fig 6: Forest Plot of the incidence of vomiting (CI: confidence interval)

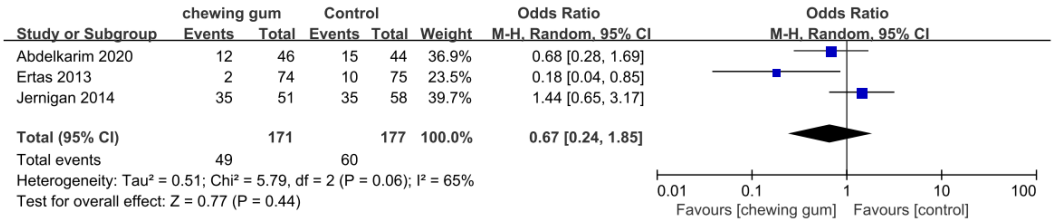

Fig 7: Forest Plot of the use of antiemetics (CI: confidence interval)