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Systematic Review

Effect of Postoperative Coffee Consumption on Postoperative Ileus after Abdominal Surgery: An Updated Systematic Review and Meta-Analysis

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Abstract: Background: Previous systematic reviews have not clarified the effect of postoperative coffee consumption on the incidence of postoperative ileus (POI) and the length of hospital stay (LOS). We aimed to assess its effect on these postoperative outcomes. Methods: Studies evaluating postoperative coffee consumption were searched using electronic databases until September 2021 to perform random-effect meta-analysis. The quality of evidence was assessed using the Cochrane risk-of-bias tool. Caffeinated and decaffeinated coffee were also compared. Results: Thirteen trials (1246 patients) and nine ongoing trials were included. Of the 13 trials, 6 were on colorectal surgery, 5 on caesarean section, and 2 on gynecological surgery. Coffee reduced the time to first defecation (mean difference (MD) −10.1 min; 95% confidence interval (CI) = −14.5 to −5.6), POI (risk ratio 0.42; 95% CI = 0.26 to 0.69); and LOS (MD −1.5; 95% CI = −2.7 to −0.3). This trend was similar in colorectal and gynecological surgeries. Coffee had no adverse effects. There was no difference in POI or LOS between caffeinated and decaffeinated coffee ($p > 0.05$). The certainty of evidence was low to moderate. Conclusion: This review showed that postoperative coffee consumption, regardless of caffeine content, likely reduces POI and LOS after colorectal and gynecological surgery.

Keywords: abdominal surgery; caffeine; coffee; ileus; length of stay; meta-analysis; systematic review

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1. Introduction

Postoperative ileus (POI), defined as the transient cessation of coordinated bowel motility, is a common cause of delayed return to normal bowel function after abdominal surgery (e.g., colorectal and gynecologic surgery), occurring in 10–15% of cases [1,2]. Delayed defecation associated with POI causes vomiting, bloating, and intolerance to food, and POI often leads to invasive interventions, such as nasogastric tube insertion [3]. POI increases postoperative length of hospital stay (LOS) and treatment-related costs [4,5]. POI and LOS are important postoperative outcomes because prolonged LOS and increased risk of morbidity due to POI have been shown to reduce patients' quality of life and increase hospital expenditures [4–6].

Coffee is the most widely consumed pharmacological substance worldwide [7]. Caffeine exerts anti-inflammatory effects on the gastrointestinal and cardiovascular systems, mediated by its antagonistic effects on A2A receptors on immune cells, such as T and B cells and macrophages [8,9]. Since the implementation of enhanced recovery protocols (ERPs), multimodal strategies have been used to improve the postoperative return of gastrointestinal function [10,11]. Recommendations regarding the use of postoperative coffee

vary in various international ERPs [10,11]. Previous systematic reviews did not demonstrate that LOS and POI were statistically significantly reduced, because of the small number of trials [12–15]. In addition, it is unclear whether coffee or decaffeinated coffee is effective in treating POI [12].

Coffee, a popular and easily available beverage worldwide, could also be clinically significant if shown to prevent POI incidence in addition to shortening LOS. In terms of ERPs, colorectal and gynecological surgeries are treated similarly because of the manipulation of the bowel [10,11]. Therefore, the present updated systematic review and meta-analysis aimed to assess the effect of postoperative coffee consumption on POI after abdominal surgery, including colorectal surgery, cesarean section, and gynecological surgery.

2. Material and Methods

2.1. Protocol

We followed the Preferred Reporting Items for Systematic Review and Meta-Analysis 2020 (PRISMA 2020) (Appendix A) [16]. This protocol was registered on protocols.io (https://doi.org/10.17504/protocols.io.bymmpu46).

2.2. Inclusion Criteria

Randomized controlled trials (RCTs) that assessed the effect of postoperative coffee consumption after abdominal surgery were included. No language, country, observation period, or publication year restrictions were applied. Review articles, case series, and case reports were excluded. The intervention of interest was postoperative 100–150 mL coffee consumption, three times per day, for 10–20 min. The control group consumed water, tea, or a placebo. The primary outcomes were time to first defecation (hours), LOS (days), and POI. The secondary outcomes were the time to first flatus (hours), the time to first bowel movement (hours), the time to tolerance of solid food (hours), and adverse events.

2.3. Search Method

The following electronic databases and trial registries were searched: MEDLINE (PubMed), Cochrane Central Register of Controlled Trials (Cochrane Library), EMBASE (Dialog) (Appendix B), the World Health Organization International Clinical Trials Platform Search Portal (ICTRP), and ClinicalTrials.gov (Appendix C). The reference lists were checked for studies, including international guidelines [10,11], as well as reference lists of eligible studies and articles citing eligible studies. The authors of the original studies were asked for unpublished or additional data if necessary.

2.4. Data Collection and Analysis

Two independent reviewers (J.W. and A.M.) performed screening, data extraction, and assessment of the risk of bias using the Risk of Bias 2 tool [17] and assessed the quality of evidence based on the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach [18]. Disagreements between the two reviewers were discussed, and if necessary, a third reviewer (K.K.) was consulted.

The relative risk ratios (RRs) and the 95% confidence intervals (CIs) were calculated for the binary variables, POI, and adverse events. The mean differences (MDs) and 95% CIs were calculated for the continuous variables, LOS (days), the time to first defecation (hours), the time to first flatus (hours), the time to first bowel movement (hours), and time to tolerance of solid food (hours). Intention-to-treat analysis was performed for dichotomous data as far as possible. For continuous data, missing data were not imputed based on the recommendations of the Cochrane handbook [19]. In cases where missing data were not known after contacting the original authors, the standard deviation was calculated using the method provided in the Cochrane handbook [19] or a previously validated

method [20]. A random-effects meta-analysis was performed using Review Manager software (RevMan 5.4.2).

2.5. Assessment of Heterogeneity and Reporting Bias

Statistical heterogeneity was evaluated by visual inspection of the forest plots and calculating the I^2 statistic (I^2 = 0–40%, might not be important; 30–60%, moderate heterogeneity; 50–90%, substantial heterogeneity; and 75–100%, considerable heterogeneity) [19]. When there was substantial heterogeneity (I^2 > 50%), we assessed the reason for the heterogeneity. Cochrane's chi^2 test (Q-test) was performed on the I^2 statistic, and a *p*-value less than 0.10 was defined as statistically significant. We searched the clinical trial registry system (ClinicalTrials.gov and ICTRP) to assess any reporting bias. Potential publication bias was evaluated through visual inspection of the funnel plots.

2.6. Additional Analysis

The following subgroup analyses were performed: surgery types (colorectal resection, cesarean section, or gynecological resection) and coffee types (caffeinated or decaffeinated coffee). The following sensitivity analysis was performed: exclusion of studies using imputed statistics.

3. Results

Figure 1 shows the study search process. After the removal of duplicates, 1005 records were screened, of which 31 underwent full-text review and 1 article was added after reviewing reference lists. Finally, 27 studies were included in the qualitative synthesis. The 27 studies comprised 9 ongoing trials (NCT 02510911, NCT02639728, NCT03143621, NCT03191877, NCT03712891, NCT04205058, NCT04547868, IRCT20200116046153N1, and CTRI/2021/04/033141), 5 protocols without results (NCT00130026, NCT01130675, NCT02250924, NCT03660267, and NCT03815877), and 13 clinical trials (1246 patients) [21–33].

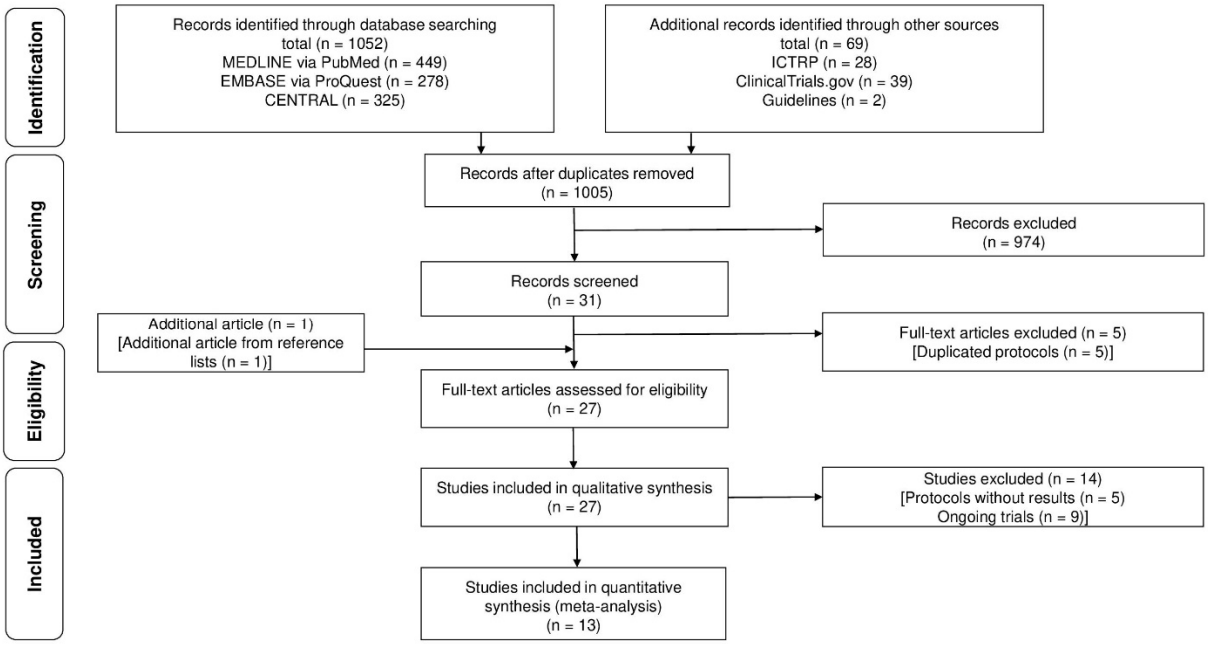

Figure 1. Flow of the study search process.

Table 1 shows the characteristics of the included clinical trials. Of the 13 trials [21–33], 6 were on colorectal surgery, 5 on cesarean section, and 2 on gynecological surgery. The intervention was caffeinated coffee in 10 trials and decaffeinated coffee in 3 trials.

Table 1. The characteristics of the included studies.

Authors [ref. no.]	Year	Country	No.	Age, Year	Male, %	Surgical	Coffee	Volume, mL	Frequency	Control
Müller [21]	2012	Germany	79	61	56	CRS	Caffeine	100	TDS	Water
Dulskas [22]	2015	Lithuania	90	65	53	CRS	Caffeine, Decaf	100	TDS	Water
Piric [23]	2015	Bosnia and Herzegovina	58	63	59	CRS	Caffeine	100	TDS	Tea
Göymen [24]	2016	Turkey	75	50	0	CS	Decaf	100	TDS	Water, no intervention
Güngördük [25]	2017	Turkey	114	55	0	GS	Caffeine	100	TDS	No intervention
Mohamed [26]	2018	Egypt	210	NR	0	CS	NR	NR	NR	No intervention
Rabiepoor [27]	2018	Iran	100	28	0	CS	Caffeine	100	TDS	Water
Hasler-Gehrer [28]	2019	Switzerland	115	66	51	CRS	Caffeine	150	TDS	Tea
Hayashi [29]	2019	Japan	46	77	26	CRS	Caffeine	100	TDS	Water
Bozkurt Koseoglu [30]	2020	Turkey	113	29	0	CS	Caffeine	100	TDS	No intervention
Güngördük [31]	2020	Turkey	96	60	0	GS	Caffeine	150	TDS	Water
Kanza Gül [32]	2021	Turkey	80	28	0	CS	Decaf	NR	TDS	No intervention
Parnasa [33]	2021	Israel	70	56	50	CRS	Caffeine	50 *	TDS	Placebo

CRS, colorectal surgery; CS, caesarean section; GS, gynecological surgery; No., number; NR, not reported; TDS, three times per day. * 100 mg of caffeine citrate.

The risk of bias is shown in Table 2 and Appendixes D and E. In terms of the overall risk of bias for the time to first defecation, there were concerns about the risk of bias for most studies (11/13), with two of these assessed as having a high risk of bias [25,26].

Table 2. Risk of bias for the eligibility studies for the time to first defecation.

Authors [ref. no.]	Risk of Bias 2 Tool Assessment					
	Bias Arising from the Randomization Process	Bias Due to Deviations from Intended Interventions	Bias Due to Missing Outcome Data	Bias in the Measurement of the Outcome	Bias in the Selection of the Reported Results	Overall Risk of Bias
Müller [21]	Low	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
Dulskas [22]	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
Piric [23]	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
Göymen [24]	Some concerns	Low	Low	Some concerns	Some concerns	Some concerns
Güngördük [25]	Some concerns	Low	Low	Some concerns	High	High
Mohamed [26]	Some concerns	High	High	Some concerns	Some concerns	High
Rabiepoor [27]	Some concerns	Low	Low	Some concerns	Some concerns	Some concerns
Hasler-Gehrer [28]	Low	Some concerns	Some concerns	Some concerns	Low	Some concerns
Hayashi [29]	Low	Low	Low	Some concerns	Low	Some concerns

Bozkurt Koseoglu [30]	Low	Some concerns	Some concerns	Some concerns	Low	Some concerns
Güngördük [31]	Low	Some concerns	Some concerns	Some concerns	Low	Some concerns
Kanza Gül [32]	Low	Low	Low	Some concerns	Some concerns	Some concerns
Parnasa [33]	Low	Some concerns	Some concerns	Some concerns	Low	Some concerns

Table 3 summarizes the findings of the GRADE approach. The certainty of the evidence was low to moderate due to the high risk of bias and inconsistency.

Table 3. Summary of findings.

Effect of Postoperative Coffee Consumption after Abdominal Surgery						
Patient: Adults after Abdominal Surgery; Setting: In-Patients; Intervention: Coffee; Comparison: Control						
Outcomes	**Anticipated Absolute Effects * (95% CI)**		**Relative Effect (95% CI)**	**Patient Number (Studies)**	**Certainty of the Evidence (GRADE)**	**Comments**
	Risk with control	**Risk with coffee**				
Time to first defecation	The median time was 42 h.	MD −10 h (−14 to −5.6)	-	1209 (13 RCTs)	Moderate [a]	Coffee reduced the time to first defecation.
Length of hospital stay	The median stay was 6 days.	MD −1.5 days (−2.7 to −0.3)	-	905 (9 RCTs)	Low [a,b]	Coffee reduced the length of hospital stay.
Postoperative ileus	165 per 1000.	69 per 1000 (43 to 114)	RR 0.42 (0.26 to 0.69)	913 (8 RCTs)	Low [a,b]	Coffee reduced postoperative ileus.
Time to first flatus	The median time was 30 h.	MD −4.3 h (−8.5 to −0.07)	-	1113 (12 RCT)	Low [a,b]	Coffee reduced the time to first flatus.
Time to first bowel sound	The median time was 10 h.	MD −4.3 h (−7.1 to −1.5)	-	683 (6 RCTs)	Very low [a,b,c]	Coffee reduced the time to first bowel sound.
Time to tolerance of solid food	The median time was 48 h.	MD −9.9 h (−14 to −5.9)	-	833 (8 RCTs)	Low [a,b]	Coffee reduced the time to first tolerance of solid food.

CI, confidence interval; MD, mean difference; RR, risk ratio. * The risk in the intervention group (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI). GRADE Working Group grades of evidence; High certainty: We are very confident that the true effect lies close to that of the estimated effect. Moderate certainty: We are moderately confident in the estimated effect. The true effect is likely to be close to the estimated effect, but there is a possibility that it is substantially different. Low certainty: Our confidence in the estimated effect is limited: The true effect may be substantially different from the estimated effect. Very low certainty: We have very little confidence in the estimated effect. The true effect is likely to be substantially different from the estimated effect. [a] Downgraded because of a high risk of bias. [b] Downgraded because of inconsistency due to substantial heterogeneity. [c] Downgraded because of imprecision due to the small sample size.

3.1. Primary Outcomes

3.1.1. Time to First Defecation (Hours)

Coffee reduced the time to first defecation after colorectal surgery (MD −15.37 h; 95% CI = −18.0 to −12.75; I^2 = 0%) and gynecological surgery (MD −12.83 h; 95% CI = −22.44 to −3.23; I^2 = 92%) but not after cesarean section (MD −4.79 h, 95% CI = −10.32 to 0.74; I^2 = 94%) (Figure 2).

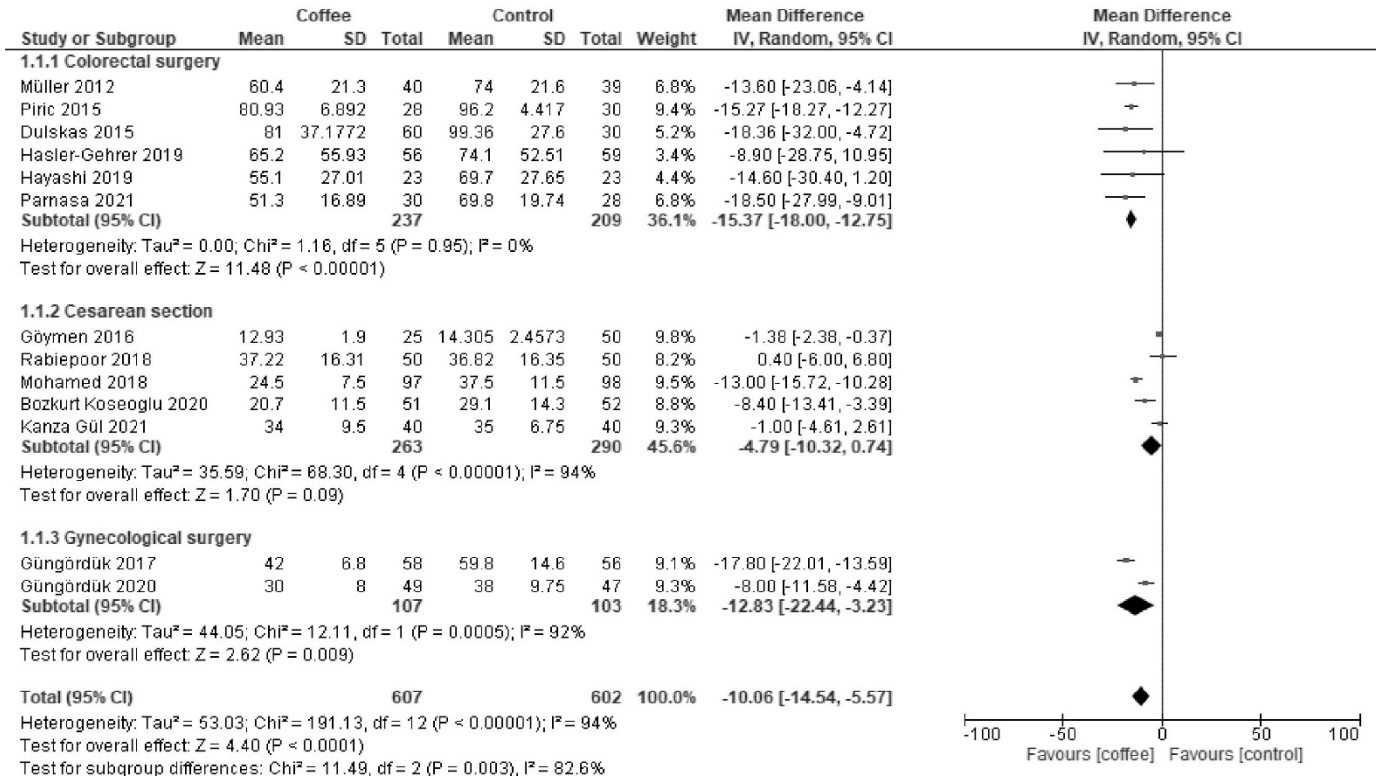

Figure 2. Forest plot of the time to first defecation.

3.1.2. LOS (Days)

Coffee reduced LOS after gynecological surgery (MD −1.08 d; 95% CI = −1.63 to −0.54; I^2 = 0%) but not after colorectal surgery (MD −1.78 d; 95% CI = −4.31 to 0.75; I^2 = 99%) and cesarean section (MD −0.30 d; 95% CI = −0.70 to 0.10; I^2 = 93%) (Figure 3).

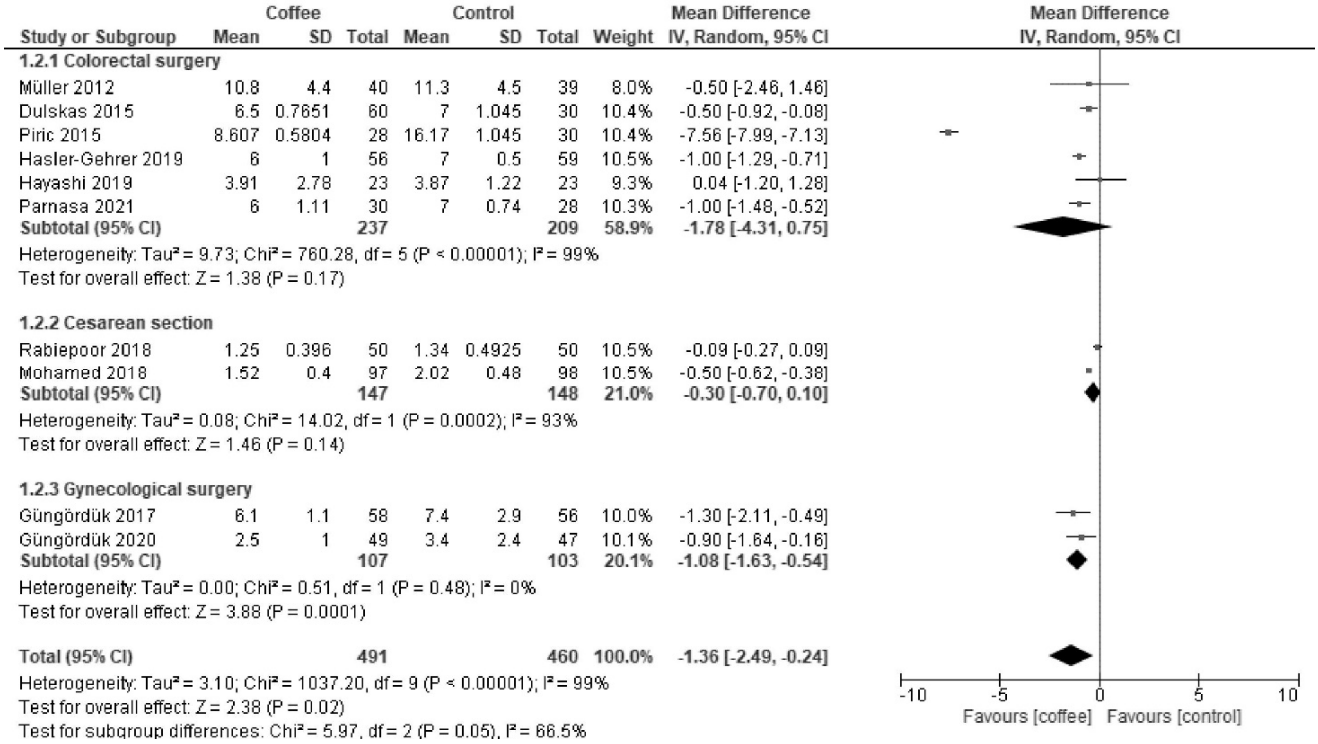

Figure 3. Forest plot of the length of hospital stay.

3.1.3. POI

Coffee reduced POI incidence after cesarean section (RR 0.32; 95% CI = 0.14 to 0.72) and gynecological surgery (RR 0.25; 95% CI = 0.13 to 0.48; I^2 = 0%) but not after colorectal surgery (RR 0.81; 95% CI = 0.40 to 1.63; I^2 = 0%) (Figure 4).

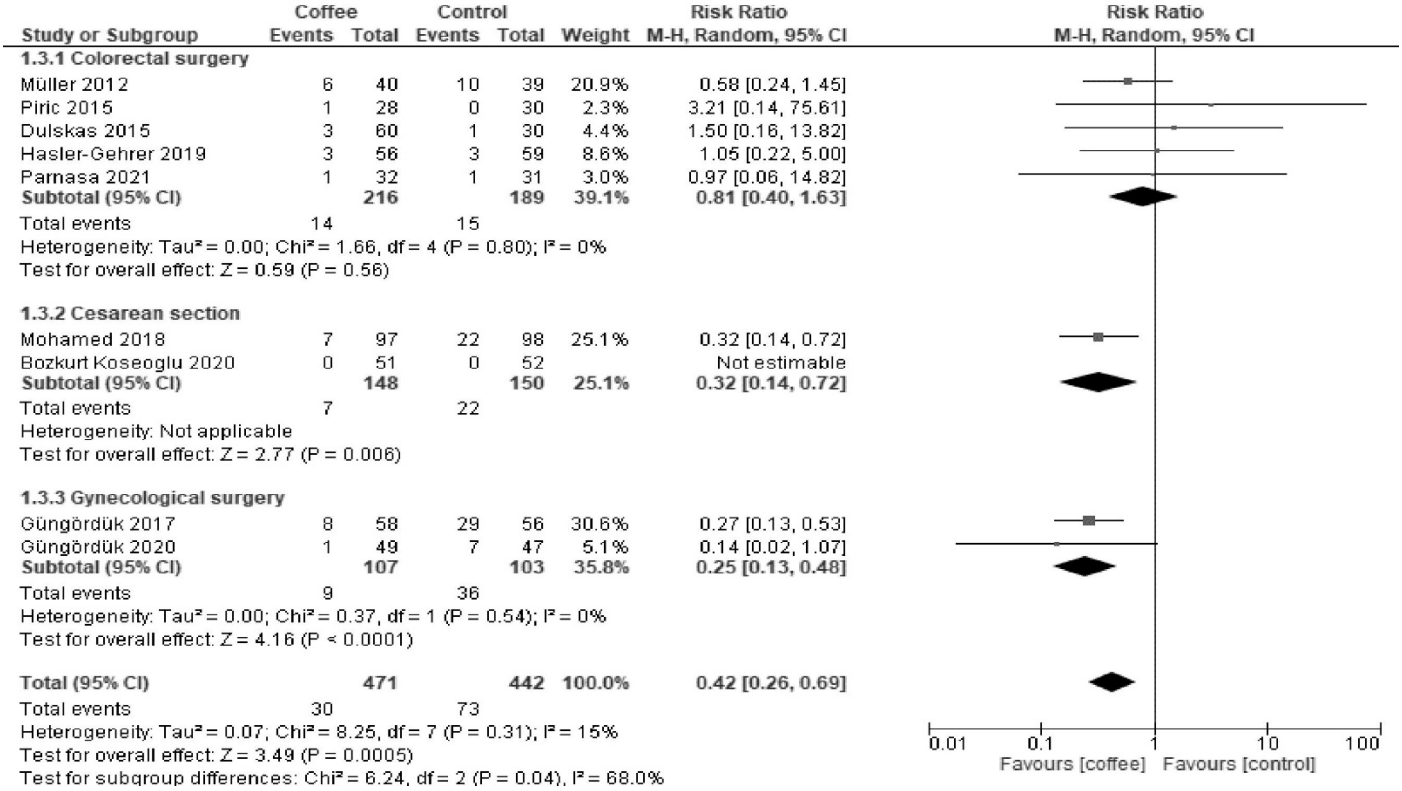

Figure 4. Forest plot of postoperative ileus.

3.2. Secondary Outcomes

3.2.1. Time to First Flatus (Hours)

Coffee reduced the time to first flatus after abdominal surgery (MD −4.27 h; 95% CI = −8.28 to −0.26; I^2 = 96%) (Figure A1). There was no statistically significant difference between colorectal surgery, cesarean section, or gynecological surgery in the subgroup test (p = 0.36).

3.2.2. Time to First Bowel Sound (Hours)

Coffee reduced the time to first flatus after gynecological surgery (MD −8.87 h; 95% CI = −14.65 to −3.09; I^2 = 86%) but not after cesarean section (MD −1.87 h; 95% CI = −4.40 to 0.66; I^2 = 93%) (Figure A2).

3.2.3. Time to Tolerance of Solid Food (Hours)

Coffee reduced the time to tolerance of solid food after colorectal surgery, cesarean section, and gynecological surgery (MD −10.11 h; 95% CI = −14.26 to −5.95; I^2 = 95%) (Figure A3).

3.2.4. Complications/Adverse Events

There have been no reports of adverse events related to postoperative coffee consumption. Coffee did not increase the risk of complications or adverse events after colorectal surgery (RR 0.85; 95% CI = 0.48 to 1.51; I^2 = 40%) and cesarean section (RR 0.80; 95% CI = 0.23 to 2.81). Coffee decreases complications after gynecological surgery (RR 0.27; 95% CI = 0.13 to 0.53) (Figure A4).

3.3. Additional Analyses

In subgroup analyses of caffeinated vs. decaffeinated coffee (Figures A5–A11), there were statistically significant differences between caffeinated and decaffeinated coffee for the time to first defecation ($p = 0.02$) and the time to tolerance of solid food ($p = 0.04$). However, when analyzed by surgery type, there were no statistically significant differences between caffeinated and decaffeinated coffee for the time to first defecation after colorectal surgery ($p = 0.14$) or cesarean section ($p = 0.51$) (Figure A12) or for the time to tolerance of solid food after cesarean section ($p = 0.35$) (Figure A13). The results of the sensitivity analysis, excluding studies using imputed statistics, were consistent with the original results except for the time to first flatus (Figures A14–A16).

Regarding publication bias, the funnel plots were symmetric, suggesting a no-potential-no-publication bias (Figure A17).

4. Discussion

This systematic review and meta-analysis demonstrated that postoperative coffee consumption likely reduces the time to first defecation, LOS, and POI after abdominal surgery. This trend is similar to the trends after colorectal and gynecological surgeries. Additionally, there was no difference in LOS and POI between caffeinated and decaffeinated coffee intake. This updated evidence is beneficial to both patients and surgeons regarding the practical endpoints of LOS and POI.

In previous systematic reviews [12–15], coffee accelerated the postoperative recovery of gastrointestinal function but did not reduce POI and LOS. The present review in 13 RCTs with 1246 patients extends the findings of previous reviews, showing a novel benefit of coffee for POI and LOS, in addition to standard ERPs. Preventing POI and shortening LOS can potentially affect the quality of life of patients and reduce their social costs by approximately 40–50% per patient [4–6]. In addition, preventing POI and shortening LOS has the potential to reduce hospital expenditures by US$750 million per year [4,5]. On average, the incidence of POI was 60% lower in the coffee group (POI: 6.9%) than in the non-coffee control group (16.5%). With postoperative coffee consumption, LOS was reduced by 1.5 days. Given that other consensus data show that ERPs reduce morbidity (RR 0.78) and LOS (−3.1 days) and opioid antagonists, which are frequently used to improve the postoperative course, reduce POI (32%) and LOS (−0.3 days) [34,35], the improved POI and LOS following coffee intake appear to be meaningful in the clinical setting.

The mechanism underlying the effect of coffee on POI is not fully understood. The factors may be caffeine and other substances in coffee, mainly phenolic antioxidants of chlorogenic acid [36]. Caffeine acts positively on inflammation, activating ryanodine-sensitive Ca^{2+} channels by releasing Ca^{2+} from the sarcoplasmic reticulum and inhibiting cyclic guanosine monophosphate degradation, thereby promoting nitric oxide synthesis in the endothelium and enhancing caffeine-induced endothelium-dependent vasodilation [37–39]. Caffeine promotes postoperative recovery of gastrointestinal function through vasodilation [32,40]. Chlorogenic acid has beneficial effects on inflammation and pain [41]. Chlorogenic acid has an anti-inflammatory effect by potently inhibiting the production of tumor necrosis factor-α and interleukin-6 by peripheral blood mononuclear cells [42,43]. In addition, chlorogenic acid inhibits edema formation leading to pain and improves pain following inflammatory responses [42]. These effects may prevent POI and/or lead to shorter LOS.

There were no differences in the recovery of postoperative gastrointestinal function between caffeinated and decaffeinated coffee. These results suggest that caffeine and non-caffeine substances may have a positive effect on POI. In previous studies, both caffeinated and decaffeinated coffee similarly reduced the risk of various cancers and death from all causes [44,45]. The results of our study were in accordance with those of previous studies. However, caution should be exercised when interpreting the results due to the small number of studies involving decaffeinated coffee.

In the present review, there were no reports of adverse events related to coffee, although the caffeine group had a higher postoperative systolic blood pressure (mean 120 mmHg) than that of the control group (mean 100 mmHg) [32,46]. The amount of coffee used in this study was a common amount, and considering the safety of coffee, which is widely used, it is not a phenomenon that should be of great concern [47]. Whether hypertensive patients need to refrain from coffee consumption after surgery requires further study.

Our study showed that the certainty of the evidence was low to moderate because of the high risk of bias and inconsistency based on the GRADE approach. The overall risk of bias was high because the concealment of the allocation sequence was unclear, and the outcomes of interest, POI and LOS, were not included in the protocol. Further studies are needed to clarify allocation concealment and clarify outcomes, such as POI and LOS, in protocols. Additionally, the definitions of POI and LOS were unclear and may be affected by blinding and socioeconomic confounds. In the present review, many studies reported that POI was the indication for reinsertion of the nasogastric tube. POI and LOS should be clearly defined and recorded by blinded outcome assessors. When interpreting our results, heterogeneity in variables such as age, comorbidities, and surgical invasiveness in each population undergoing the procedure should be considered. In the case of cesarean section, the impact of coffee on LOS after cesarean section may be small because the hospital stay is short to begin with [48,49]. In the case of colorectal surgery, coffee had a relatively weak effect on POI, which may be due to other factors related to POI, such as postoperative exercise and nutrition [35,50].

This review has additional limitations. First, the dose–response relationship between coffee consumption and outcomes was not evaluated. In the studies included in this review, the amount of coffee consumed was 100–150 mL, three times per day over 10–20 min. Second, the characteristics of coffee consumers, such as the relationship between regular and non-regular coffee drinkers, have not been clearly reported. Third, our results may not be generalizable to all populations because the compounds in coffee may vary by region, bean type, roast, and brewing method. Furthermore, none of the studies included data collected from children or low-income countries.

5. Conclusions

The findings of this updated systematic review and meta-analysis indicate that postoperative coffee consumption, with or without caffeine consumption, may reduce POI and LOS after colorectal surgery, cesarean section, and gynecological surgery. The findings suggest that patients and surgeons should preferably use postoperative coffee to reduce POI. More RCTs are needed to verify the effect of postoperative coffee consumption because the evidence for its consumption is limited by variations in surgeries.

Author Contributions: Conceptualization, J.W. and K.K.; methodology, J.W., A.M. and K.K.; software, J.W. and A.M.; validation, J.W., A.M. and K.K.; formal analysis, J.W. and A.M.; investigation, J.W., A.M., M.K., K.K. and N.S.; resources, J.W., data curation, J.W., A.M. and K.K; writing—original draft preparation, J.W.; writing—review and editing, A.M., M.K., K.K. and N.S; visualization, J.W. and A.M.; supervision, A.M., M.K., K.K. and N.S.; project administration, M.K., K.K. and N.S.; funding acquisition, J.W. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: As this review did not involve animals, neither ethical review board approval nor patient consent was required.

Informed Consent Statement: Not applicable.

Data Availability Statement: All data relevant to the study are included in the article.

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Conflicts of Interest: The authors declare no conflicts of interest in association with the present study.

Appendix A

Table A1. PRISMA 2020 Checklist.

Section and Topic	Item	Checklist Item	Location Where Item Is Reported
		TITLE	
Title	1	Identify the report as a systematic review.	1
		ABSTRACT	
Abstract	2	See PRISMA 2020 for the Abstract checklist.	1
		INTRODUCTION	
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	1
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	2
		METHODS	
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	2
Information sources	6	Specify all databases, registers, websites, organizations, reference lists, and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	2
Search strategy	7	Present the full search strategies for all databases, registers, and websites, including any filters and limits used.	Appendixes B and C
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved; whether they worked independently; and if applicable, details of automation tools used in the process.	2, 3
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report; whether they worked independently; any processes for obtaining or confirming data from study investigators; and if applicable, details of automation tools used in the process.	2, 3
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g., for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	2, 3
	10b	List and define all other variables for which data were sought (e.g., participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	2, 3

Study risk-of-bias assessment	11	Specify the methods used to assess the risk of bias in the included studies, including details of the tool(s) used; how many reviewers assessed each study and whether they worked independently; and if applicable, details of automation tools used in the process.	2, 3
Effect measures	12	Specify for each outcome the effect measure(s) (e.g., risk ratio, mean difference) used in the synthesis or presentation of results.	2, 3
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g., tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	2, 3
	13b	Describe any methods required to prepare the data for presentation; synthesis, such as handling of missing summary statistics; or conversions.	2, 3
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	2, 3
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	2, 3
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g., subgroup analysis, meta-regression).	2, 3
	13f	Describe any sensitivity analyses conducted to assess the robustness of the synthesized results.	2, 3
Reporting bias assessment	14	Describe any methods used to assess the risk of bias due to missing results in a synthesis (arising from reporting biases).	3
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	3
		RESULTS	
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	3
	16b	Cite studies that might appear to meet the inclusion criteria but were excluded and explain why they were excluded.	3
Study characteristics	17	Cite each included study and present its characteristics.	4
Risk of bias in studies	18	Present assessments of the risk of bias for each included study.	4, Table 2, Appendixes D and E
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g., confidence/credible interval), ideally using structured tables or plots.	4, Table 1
	20a	For each synthesis, briefly summarize the characteristics and the risk of bias among contributing studies.	5, 6, 7, 8

Results of syntheses	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g., confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	5, 6, 7, 8
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	5, 6, 7, 8
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	8
Reporting biases	21	Present assessments of the risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	8
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Table 3
		DISCUSSION	
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	8
	23b	Discuss any limitations of the evidence included in the review.	9
	23c	Discuss any limitations of the review processes used.	9
	23d	Discuss implications of the results for practice, policy, and future research.	9
		OTHER INFORMATION	
Registration and protocol	24a	Provide registration information for the review, including the register name and the registration number, or state that the review was not registered.	2
	24b	Indicate where the review protocol can be accessed or state that a protocol was not prepared.	2
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	2
Support	25	Describe sources of financial or non-financial support for the review and the role of the funders or sponsors in the review.	9
Competing interests	26	Declare any competing interests of review authors.	10
Availability of data, code, and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms, data extracted from included studies, data used for all analyses, analytic code, and any other materials used in the review.	24, 25, 26

Appendix B. Search Strategy for Electronic Databases

MEDLINE (PubMed) search strategy

#1. ("coffee"[Mesh] OR "coffee"[tiab]) OR ("caffeine"[Mesh] OR "caffeine"[tiab])

#2. ("abdomen"[Mesh] OR "abdomen"[tiab] OR "abdominal"[tiab]) OR ("surgical procedures, operative"[Mesh] OR "surgical" OR "producer" OR "operation" OR "operative")

#3. #1 AND #2

#4. (randomized controlled trial [pt] OR controlled clinical trial [pt] OR randomized [tiab] OR drug therapy[sh] OR placebo [tiab] OR randomly[tiab] OR trial[tiab] OR groups[tiab]) NOT (animals [mh] NOT humans [mh])

#5. #3 AND #4

CENTRAL (Cochrane Library) search strategy

([mh coffee] OR coffee:ti,ab OR ([mh caffeine] OR caffeine:ti,ab)) AND ([mh abdomen] OR abdomen:ti,ab OR abdominal:ti,ab OR ([mh "surgical procedures, operative"] OR surgical OR producer OR operation OR operative))

EMBASE (Dialog) search strategy

S1 (EMB.EXACT.EXPLODE("coffee") OR (ab("coffee") OR ti("coffee")) OR EMB.EXACT.EXPLODE("caffeine") OR (ab("caffeine") OR ti("caffeine")))

S2 EMB.EXACT.EXPLODE("abdomen") OR (ab("abdomen") OR ti("abdomen")) OR (ab("abdominal") OR ti("abdominal")) OR (EMB.EXACT.EXPLODE("abdominal surgery")) OR (ab("surgical") OR ti("surgical")) OR (ab("producer") OR ti("producer")) OR (ab("operation") OR ti("operation")) OR (ab("operative") OR ti("operative"))

S3 S1 AND S2

S4 (ab(random*) OR ti(random*)) OR (ab(placebo*) OR ti(placebo*)) OR (ab(double NEAR/1 blind*) OR ti(double NEAR/1 blind*))

S5 S3 AND S4

Appendix C. Search Strategy for Clinical Trial Registries

ICTRP search strategy

(Coffee OR Caffeine) AND (abdomen OR abdominal OR surgical OR producer OR operation OR operative)

ClinicalTrials.gov search strategy

Condition or disease: (abdomen OR abdominal OR surgical OR producer OR operation OR operative)

Intervention: Coffee OR Caffeine

Appendix D

Table A2. Risk of Bias for Eligibility Studies for the Length of Hospital Stay.

Authors [ref no.]	Risk of Bias 2 Tool Assessment					
	Bias Arising from the Randomization Process	Bias Due to Deviations from Intended Interventions	Bias Due to Missing Outcome Data	Bias in the Measurement of the Outcome	Bias in the Selection of the Reported Results	Overall Risk of Bias
Müller [20]	Low	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
Dulskas [21]	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
Piric [22]	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns

Güngördük [24]	Some concerns	Low	Low	Some concerns	High	High
Mohamed [25]	Some concerns	High	High	Some concerns	Some concerns	High
Rabiepoor [26]	Some concerns	Low	Low	Some concerns	Some concerns	Some concerns
Hasler-Gehrer [27]	Low	Some concerns	Some concerns	Some concerns	High	High
Hayashi [28]	Low	Low	Low	Some concerns	Low	High
Güngördük [30]	Low	Some concerns	Some concerns	Some concerns	High	High
Parnasa [32]	Low	Some concerns	Some concerns	Some concerns	Low	Some concerns

Appendix E

Table A3. Risk of Bias for the Eligibility Studies for Postoperative Ileus.

Authors [ref no.]	**Risk of Bias 2 Tool Assessment**					
	Bias Arising from the Randomization Process	**Bias Due to Deviations from Intended Interventions**	**Bias Due to Missing Outcome Data**	**Bias in the Measurement of the Outcome**	**Bias in the Selection of the Reported Results**	**Overall Risk of Bias**
Müller [20]	Low	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
Dulskas [21]	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
Piric [22]	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
Güngördük [24]	Some concerns	Low	Low	Some concerns	High	High
Mohamed [25]	Some concerns	High	High	Some concerns	Some concerns	High
Hasler-Gehrer [27]	Low	Some concerns	Some concerns	Some concerns	High	High
Bozkurt Koseoglu [29]	Low	Some concerns	Some concerns	Some concerns	High	High
Güngördük [30]	Low	Some concerns	Some concerns	Some concerns	High	High
Parnasa [32]	Low	Some concerns	Some concerns	Some concerns	High	High

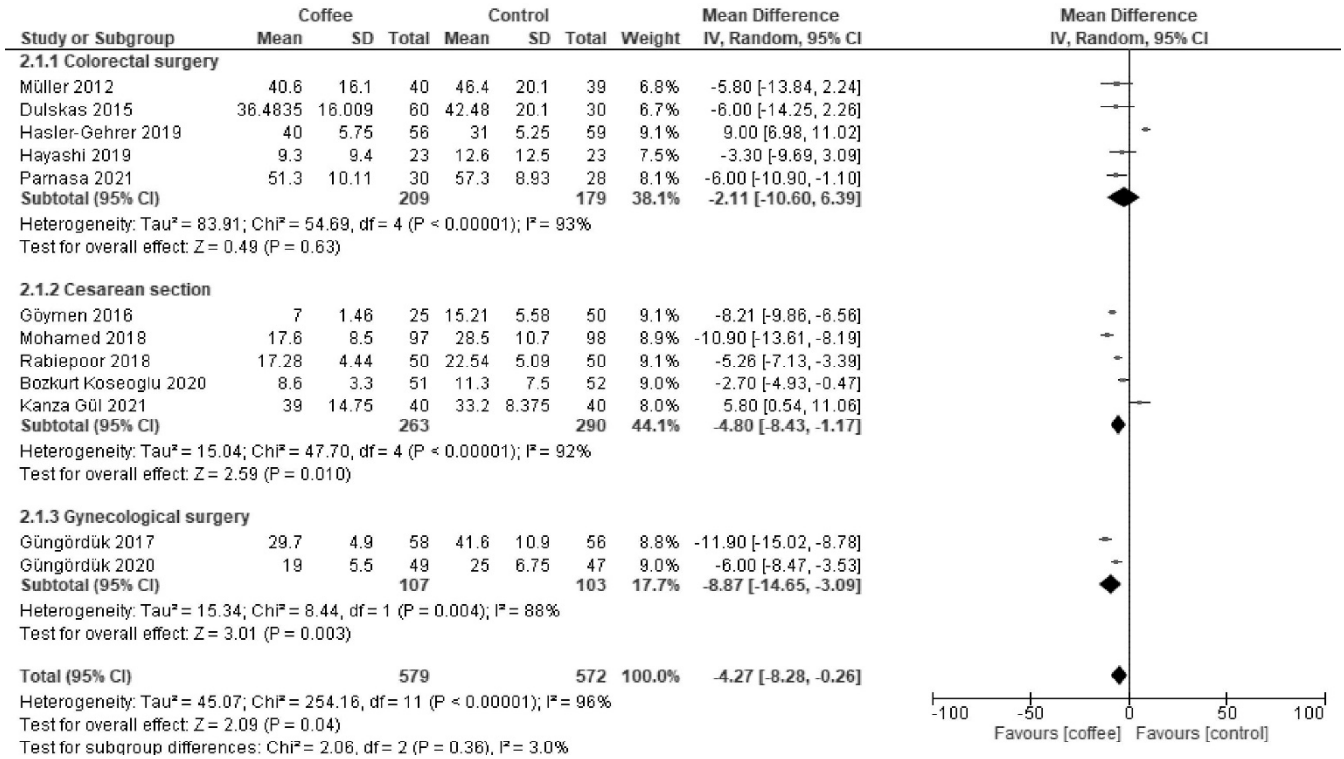

Figure A1. Forest plot of the time to first flatus.

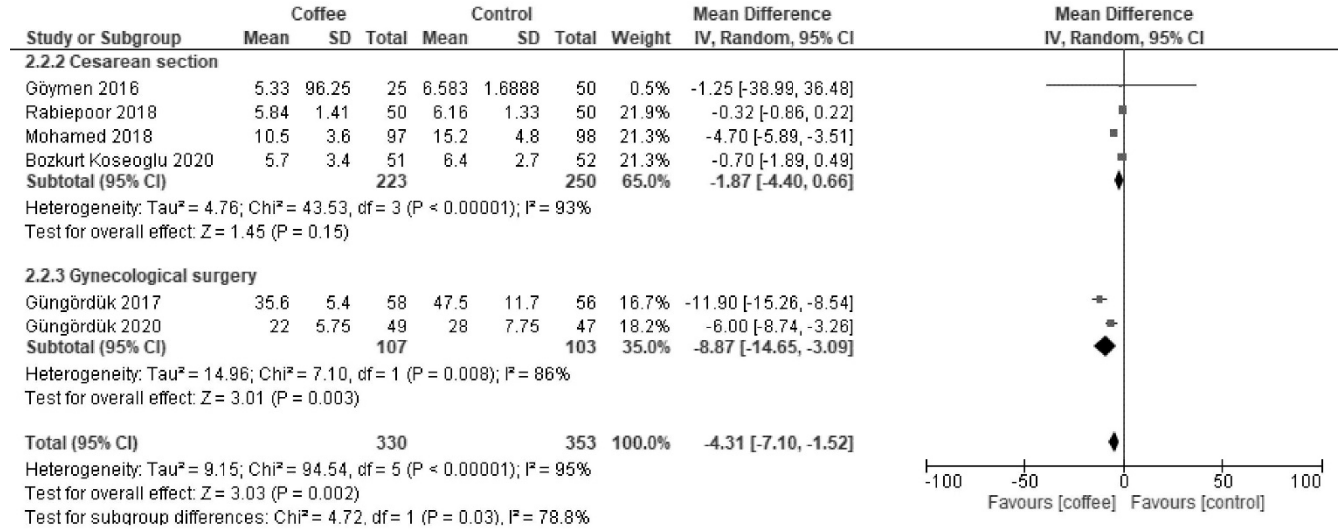

Figure A2. Forest plot of the time to first bowel sound.

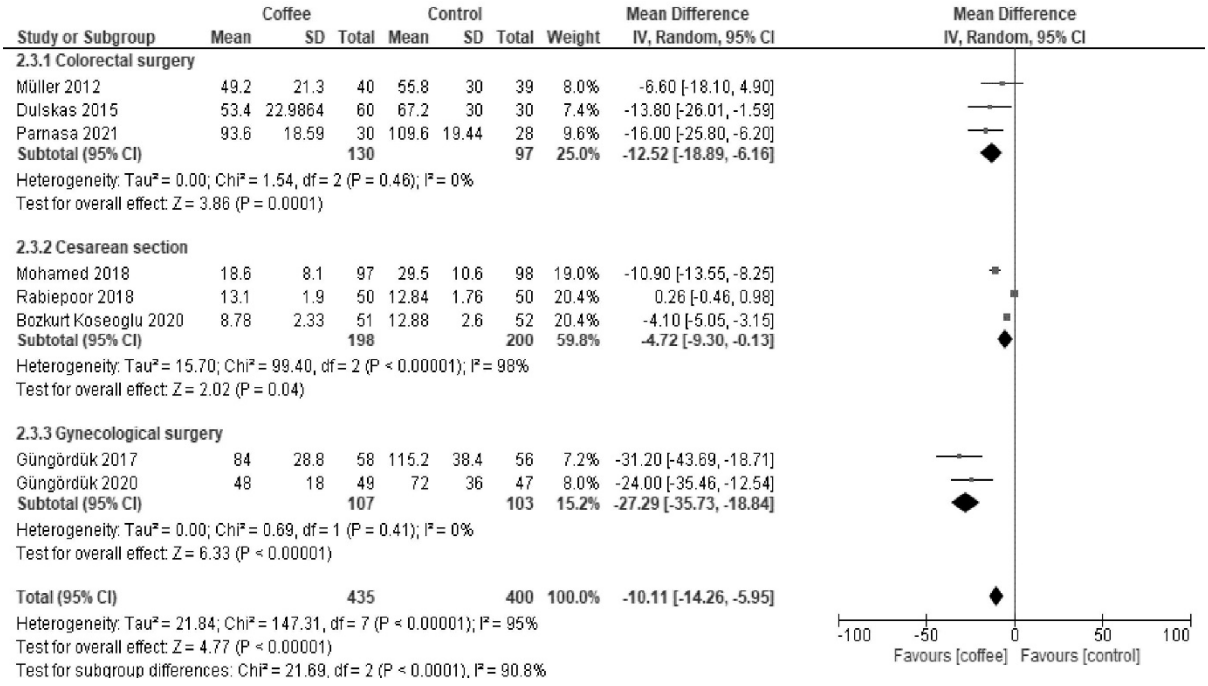

Figure A3. Forest plot of the time to toleration of solid food.

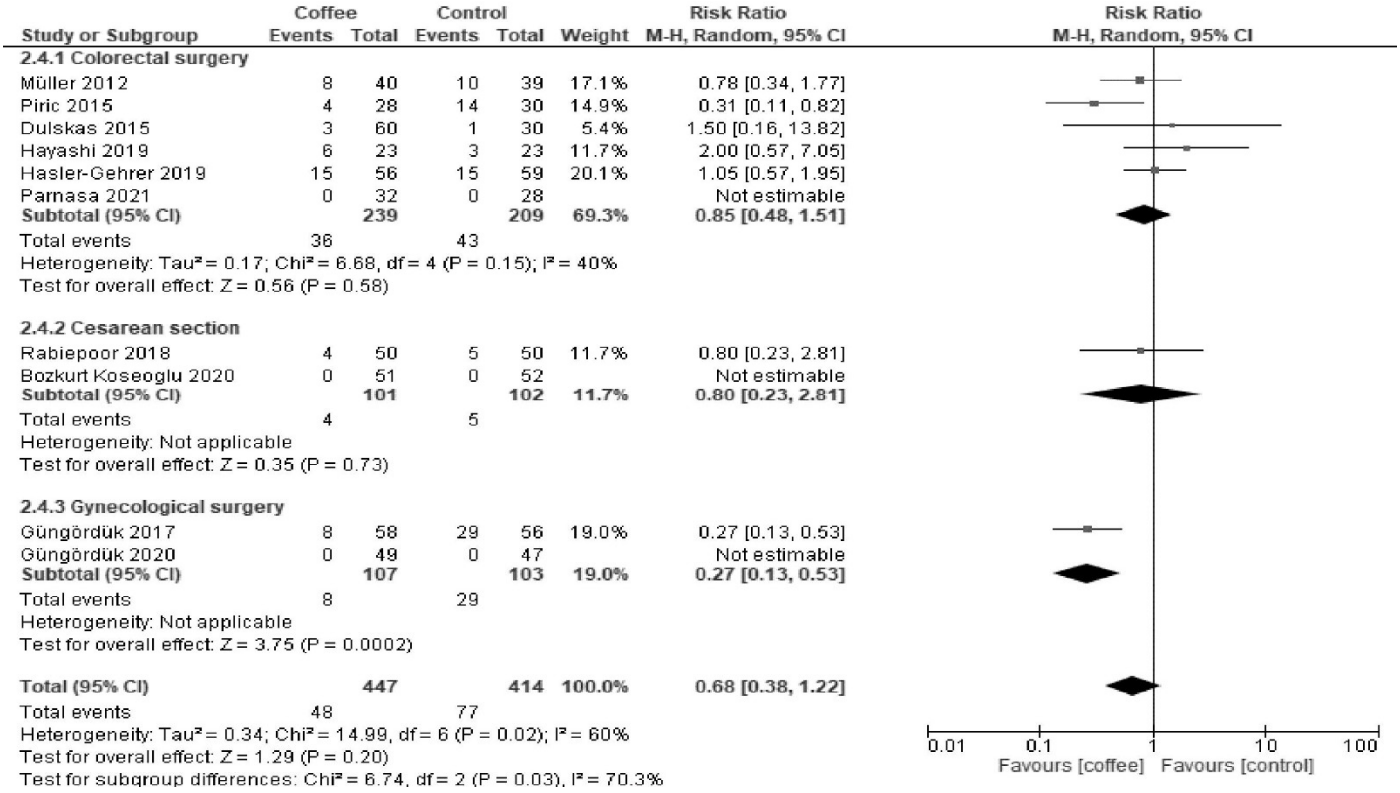

Figure A4. Forest plot of complications/adverse events.

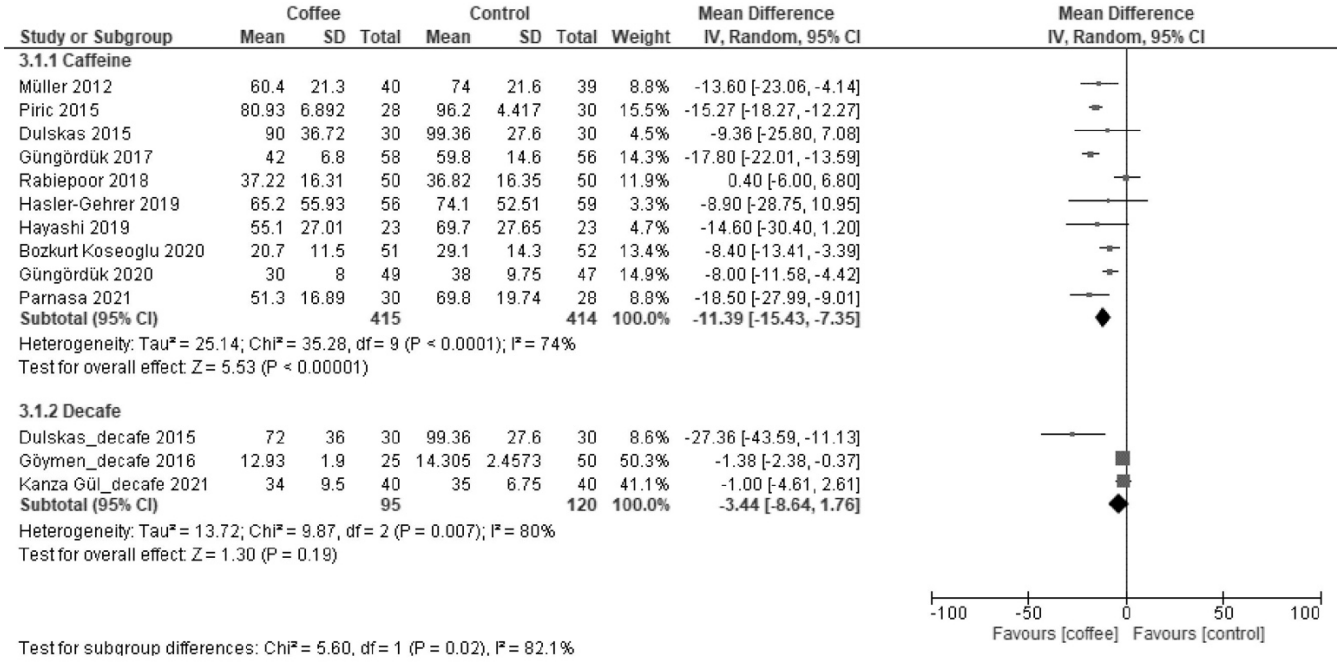

Figure A5. Forest plot of time to first defecation by coffee types (caffeinated or decaffeinated coffee).

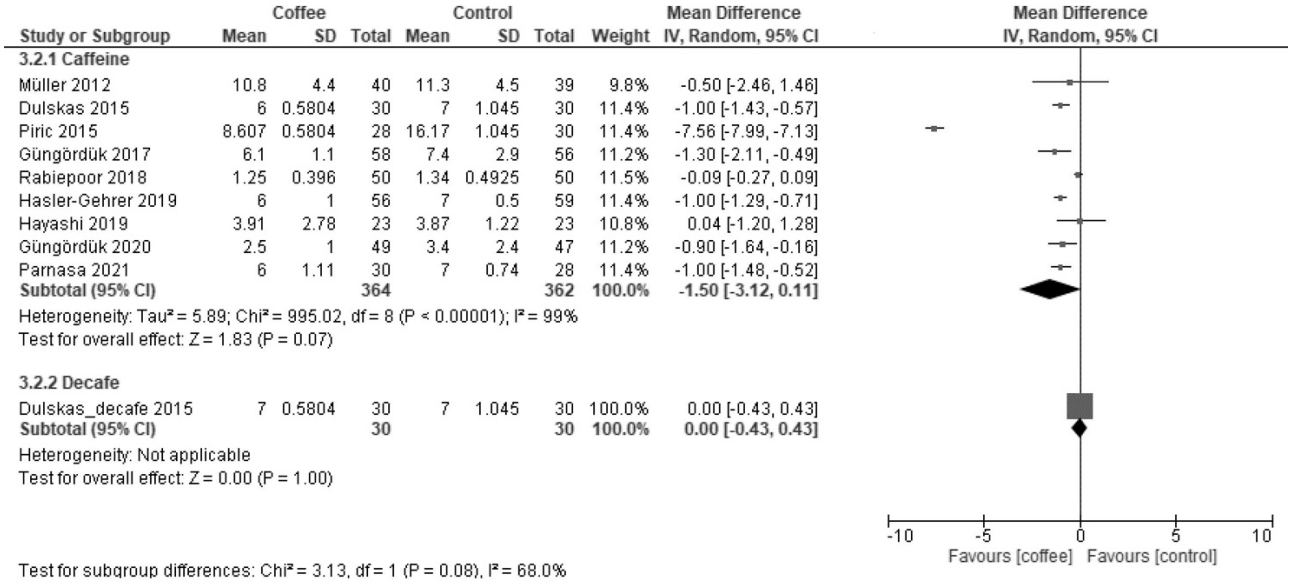

Figure A6. Forest plot of length of hospital stay by coffee types (caffeinated or decaffeinated coffee).

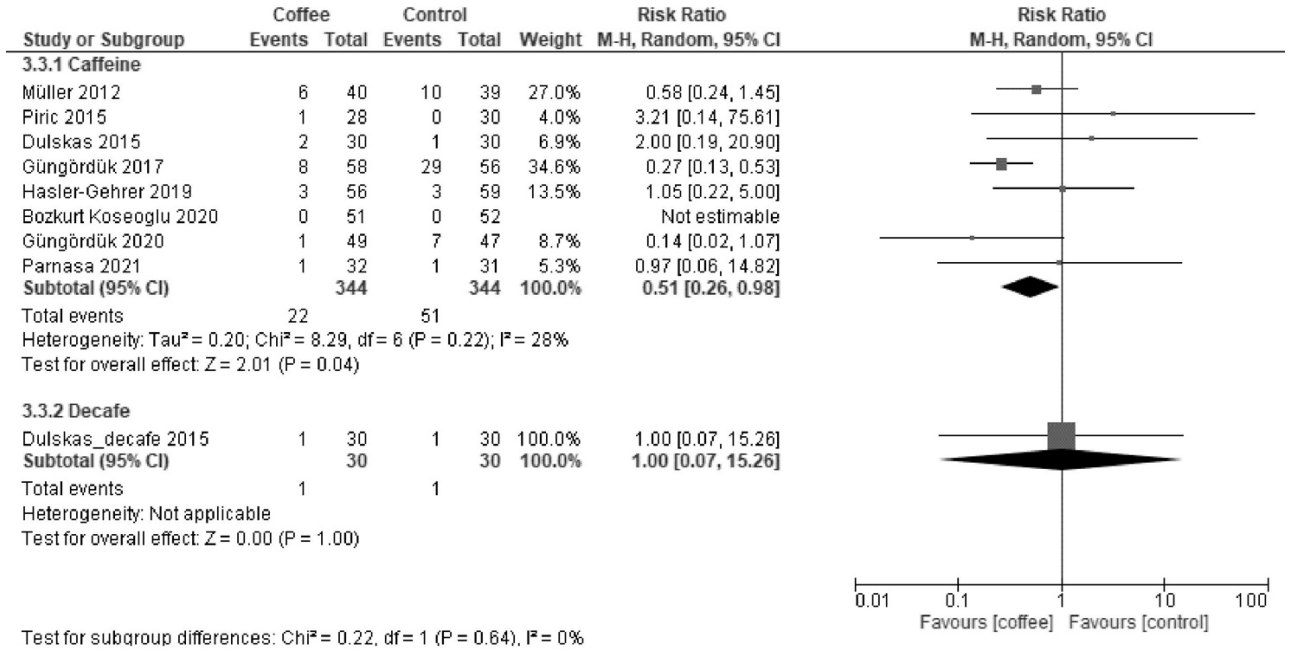

Figure A7. Forest plot of postoperative ileus by coffee types (caffeinated or decaffeinated coffee).

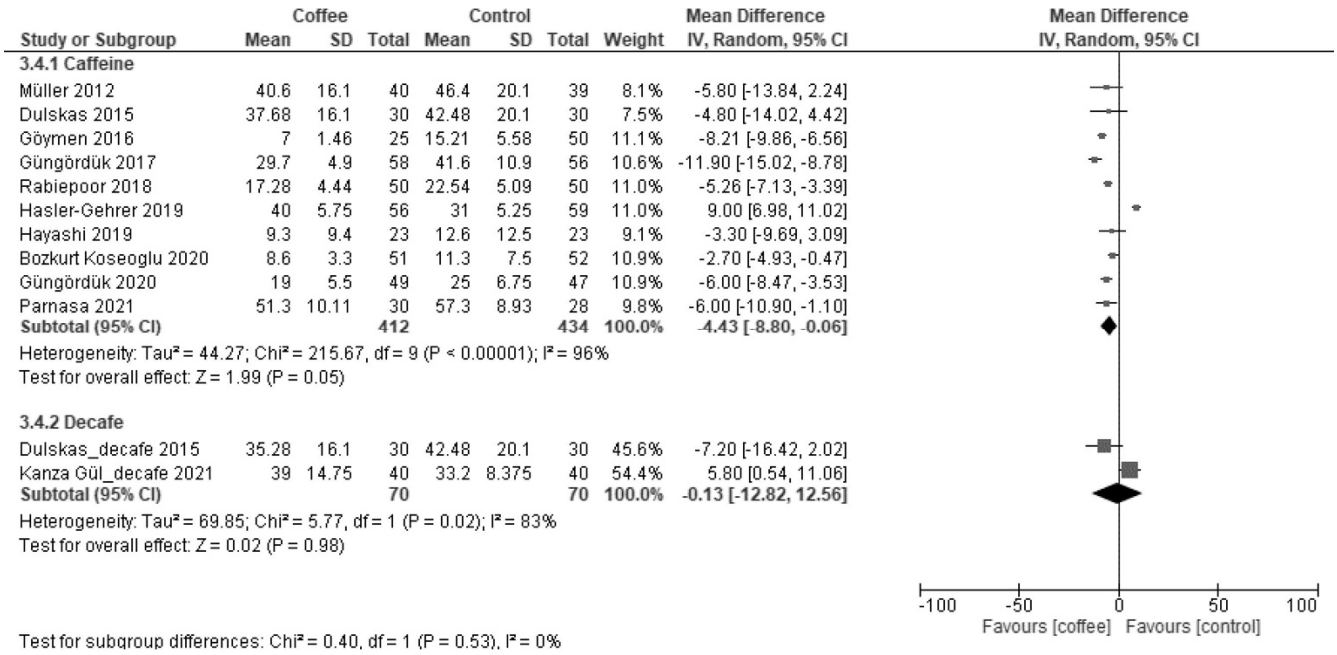

Figure A8. Forest plot of time to first flatus by coffee types (caffeinated or decaffeinated coffee).

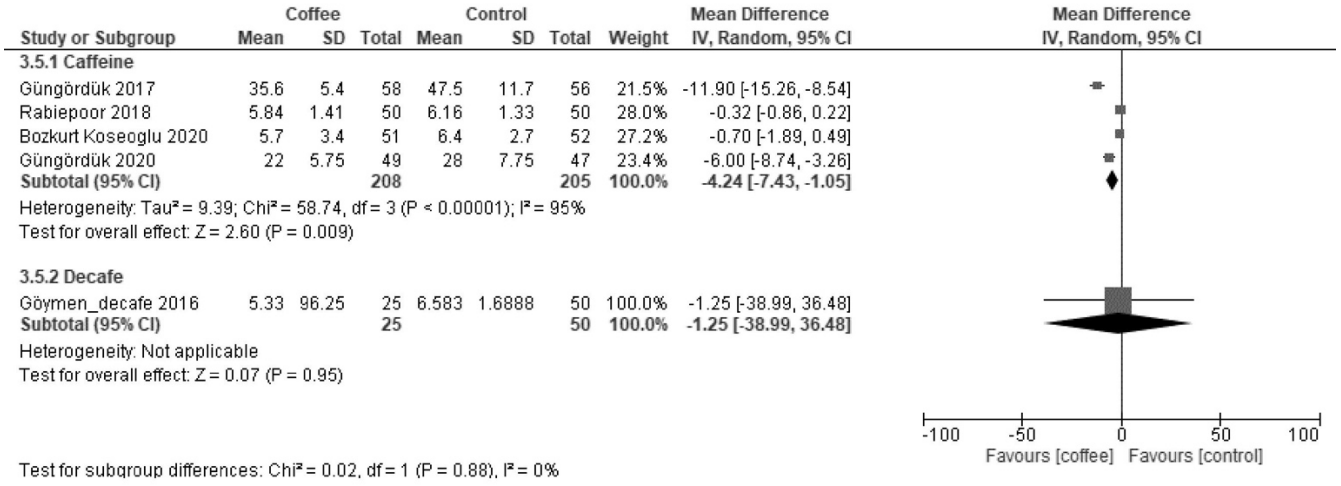

Figure A9. Forest plot of time to first bowel sound by coffee types (caffeinated or decaffeinated coffee).

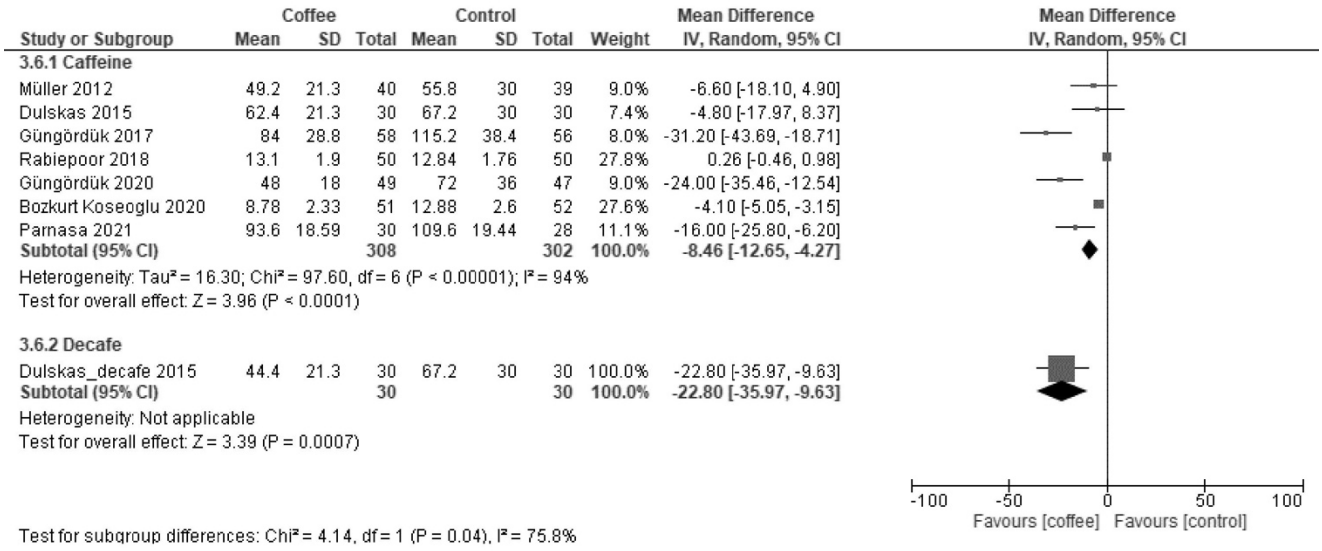

Figure A10. Forest plot of time to toleration of solid food by coffee types (caffeinated or decaffeinated coffee).

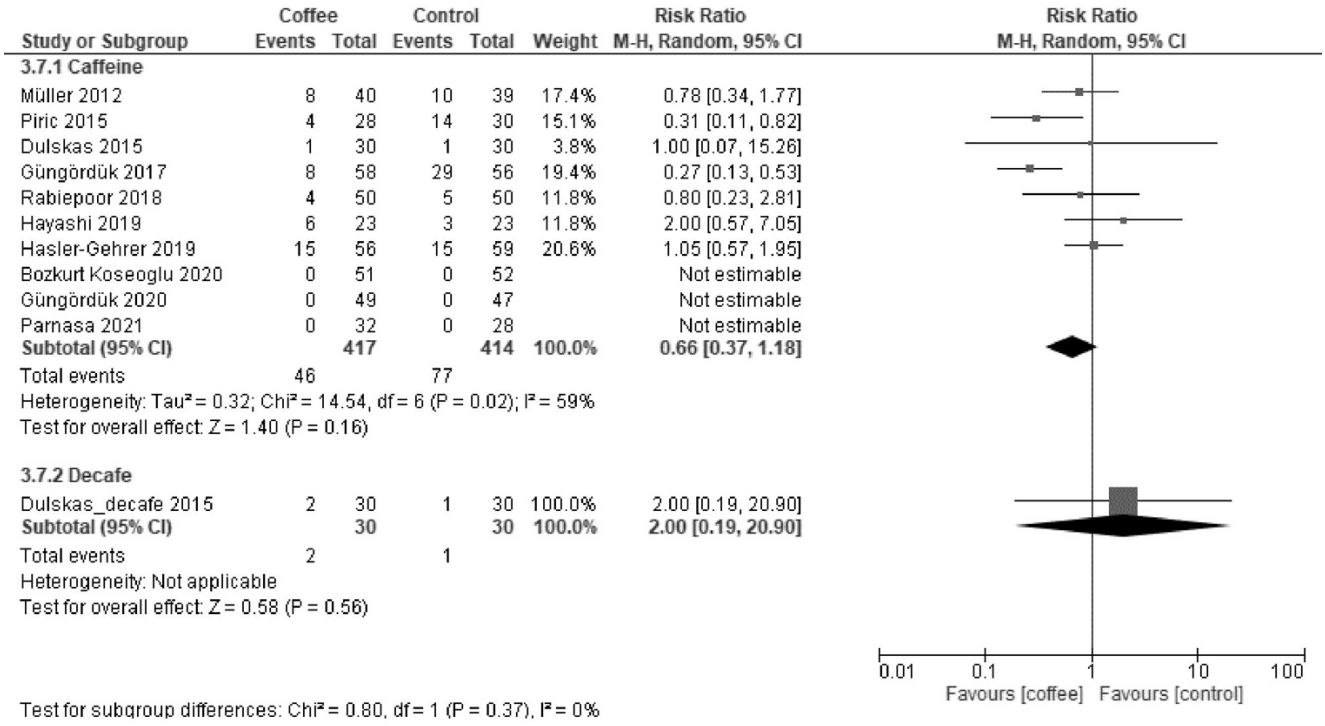

Figure A11. Forest plot of complications/adverse events by coffee types (caffeinated or decaffeinated coffee).

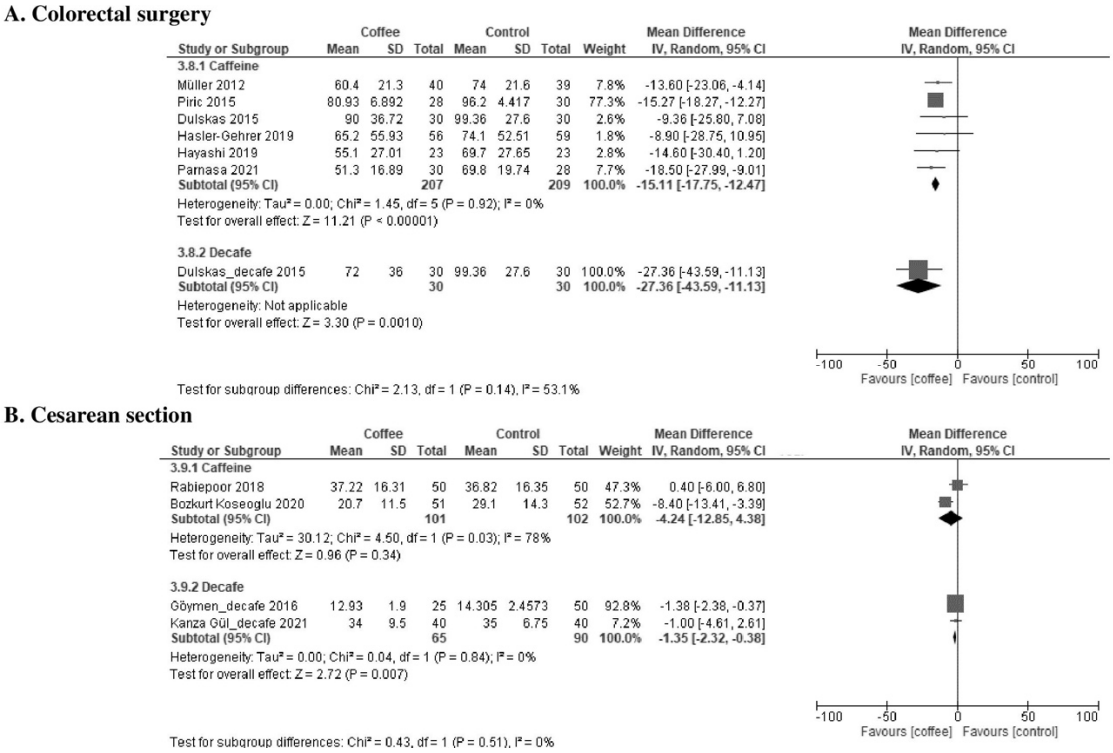

Figure A12. Forest plot of time to first defecation by coffee types (caffeinated or decaffeinated coffee) in (**A**) colorectal surgery and (**B**) cesarean section.

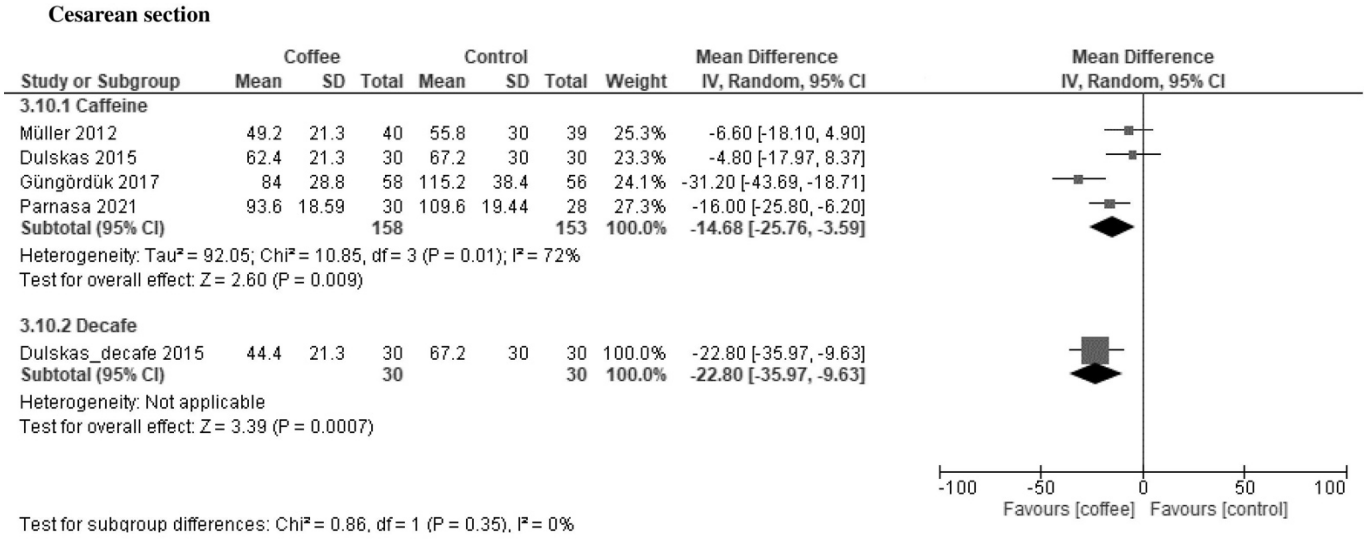

Figure A13. Forest plot of time to toleration of solid food by coffee types (caffeinated or decaffeinated coffee) in cesarean section.

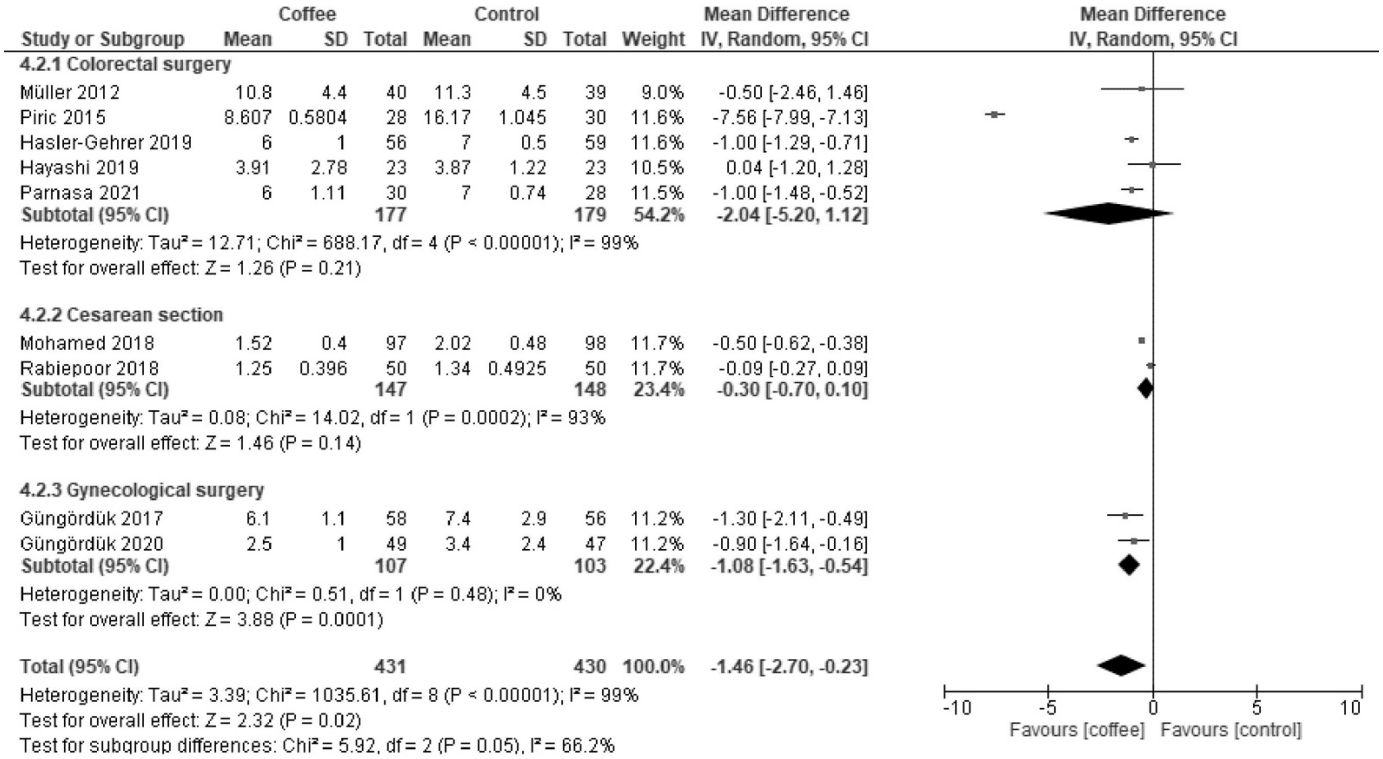

Figure A14. Forest plot of length of hospital stay excluding studies using imputed statistics.

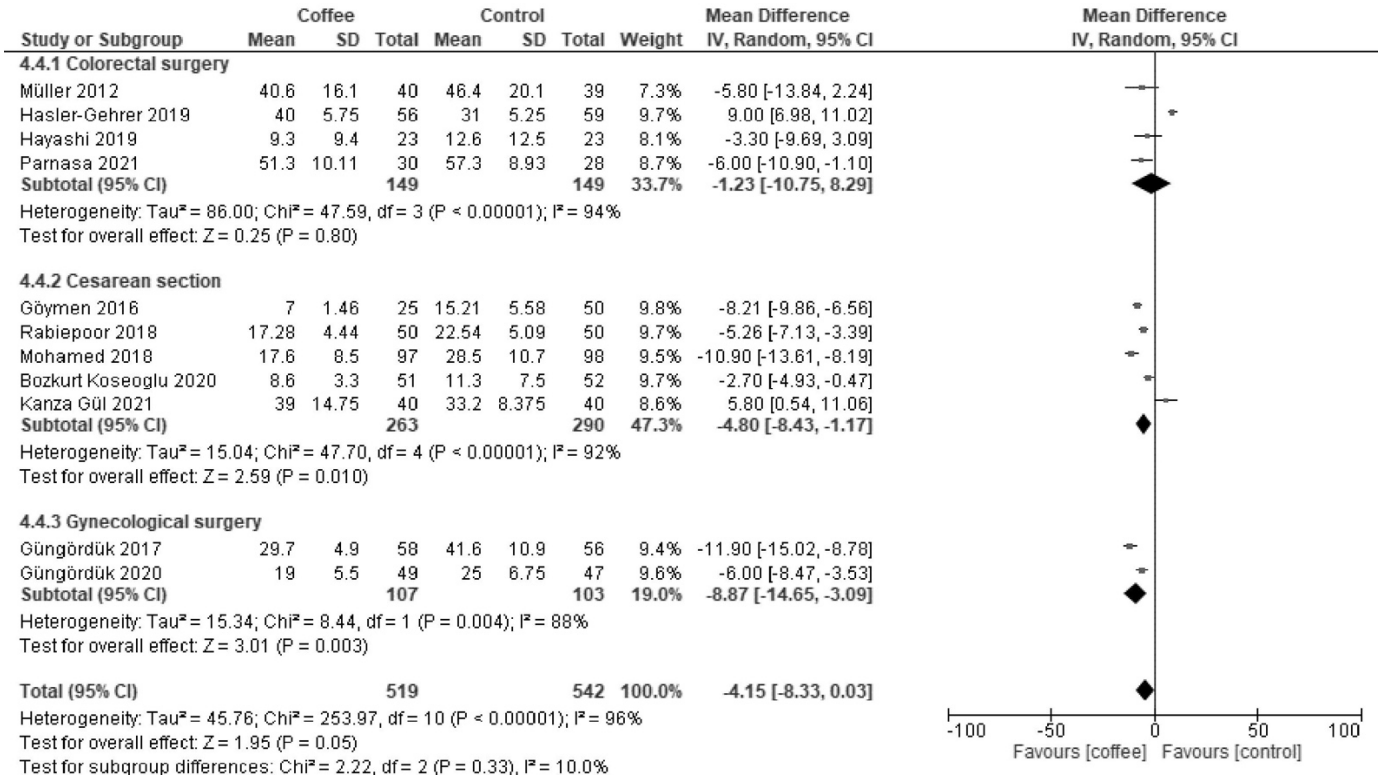

Figure A15. Forest plot of time to first flatus excluding studies using imputed statistics.

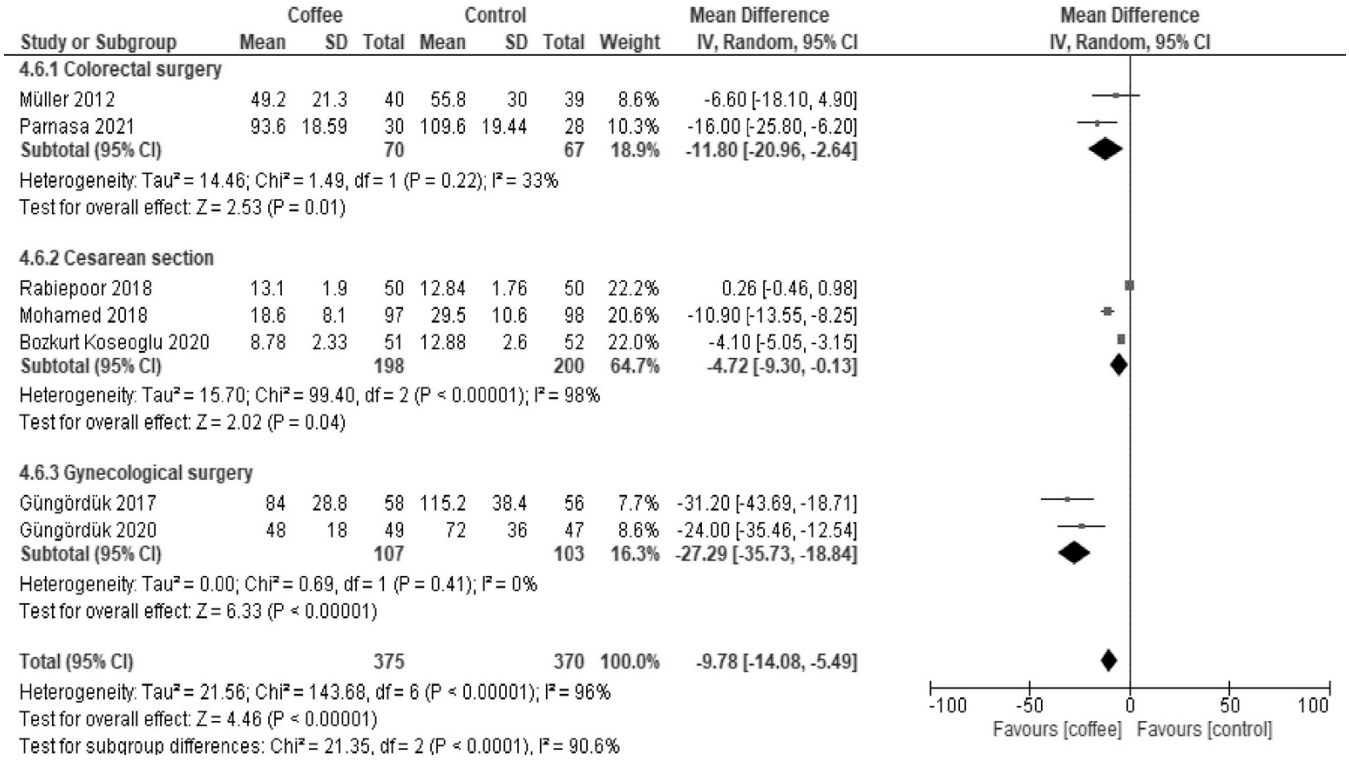

Figure A16. Forest plot of time to toleration of solid food excluding studies using imputed statistics.

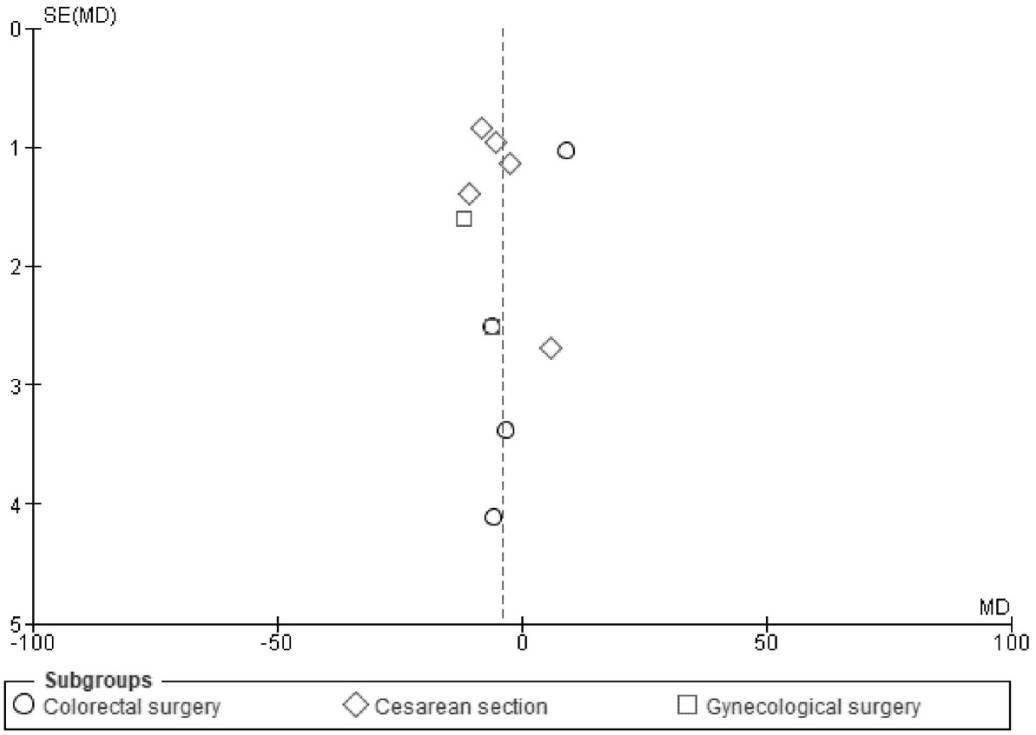

Figure A17. The funnel plot.

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