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Strict fasting, clear fluids until 2 hours, or carbohydrate loading before elective surgery in adults: a rapid systematic review and network meta-analysis of randomized trials.

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Abstract

Background: Many surgical patients still fast from midnight even though guidelines permit clear fluids until 2 hours before anaesthesia. Whether a carbohydrate drink adds anything beyond plain water is unsettled. We compared strict fasting, water or placebo until 2 hours, and carbohydrate loading in adults having elective surgery. ***Methods***: This rapid review used web-indexed literature searches to 2026. Outcomes were length of stay, postoperative nausea or vomiting, preoperative thirst and hunger, gastric volume, insulin resistance, complications and aspiration. We pooled direct comparisons with restricted maximum likelihood random-effects models and Hartung-Knapp intervals, and fitted a frequentist network model where the evidence connected. Risk of bias was assessed with RoB 2 and certainty with GRADE. ***Results***: Eighteen trials with 1,698 participants were included. Compared with fasting, carbohydrate loading did not change length of stay (mean difference 0.06 (95% CI −0.56 to 0.67) days; 5 comparisons; I^2=0%). Against water or placebo, the estimate was −1.53 (95% CI −3.66 to 0.61) days (I^2=90%), and it was −0.22 (95% CI −1.33 to 0.88) days without two trials reporting stays over 3 days shorter. Nausea or vomiting was not clearly reduced against fasting (risk ratio 0.62 (95% CI 0.21 to 1.79)) or water (risk ratio 0.39 (95% CI 0.09 to 1.64)). Against fasting, carbohydrate reduced thirst (standardized mean difference −1.11 (95% CI −2.18 to −0.03)) and hunger (−0.83 (95% CI −1.66 to −0.01)), though heterogeneity was high and the upper limits were near zero. Gastric volume tended to be larger with carbohydrate than with fasting (0.51 (95% CI −0.03 to 1.04); 3 trials). No aspiration occurred in six trials reporting it (0 of 245 carbohydrate participants). ***Conclusions***: Low to very low certainty evidence suggests that carbohydrate loading eases preoperative thirst and hunger compared with fasting, with no demonstrated effect on length of stay. Any advantage over water is unresolved, because two trials showed large reductions in stay and the others showed none. Allowing clear fluids until 2 hours appears reasonable in low-risk adults.

Keywords: preoperative fasting; carbohydrate loading; enhanced recovery after surgery; clear fluids; network meta-analysis.

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INTRODUCTION

Fasting before anaesthesia exists to protect the airway from regurgitated gastric contents. In everyday practice the instruction often becomes far longer than anyone intended. In one Brazilian audit of elective digestive and abdominal wall surgery, patients actually fasted for about 16 hours against the 11 hours prescribed, and hunger and thirst grew worse with time.1 A later nurse-led quality improvement project reported less dehydration and distress after nurses introduced a liberal fluid regimen, with no aspiration recorded.2

The physiological argument against long fasts is that they add to the insulin resistance that surgery itself provokes.3,4 Two practice changes have followed. The first is simple shortening of the fluid fast: a Cochrane review of 22 trials found no evidence that it raised the risk of aspiration, regurgitation or related morbidity.5 The second is to give a carbohydrate drink, a step now built into enhanced recovery pathways. The 2023 American Society of Anesthesiologists update supports carbohydrate-containing clear liquids until 2 hours before elective procedures in healthy adults.6,7

What these two steps contribute separately is less clear. Earlier syntheses often merged water, placebo and fasting into one control group, which cannot show whether benefit comes from the carbohydrate or just from drinking.8,9 Network analyses that kept the groups apart reached mixed conclusions. Amer and colleagues found a stay about 0.2 to 0.4 days shorter than with fasting, and no benefit over water or placebo.10 Ricci and colleagues found that both carbohydrate and clear water beat fasting for morbidity in abdominal surgery,11 while Tong and colleagues reported less insulin resistance but no clear gain in comfort.12 A 2026 review of 98 trials again rated most outcomes as low to moderate certainty.13

We therefore compared the three strategies that a clinician actually chooses between (strict fasting, water or placebo until 2 hours, and carbohydrate loading), and we added trials published up to early 2026.

MATERIALS AND METHODS

Protocol and reporting

This rapid review was reported with reference to PRISMA 2020.14 No protocol was registered, and deviations from a full systematic review are stated below.

Eligibility

We included randomized trials in adults having elective surgery that compared at least two of: (1) strict fasting, with no oral intake from midnight or for at least 6 hours; (2) water or a non-caloric placebo drink up to about 2 hours before surgery; and (3) an oral carbohydrate drink of at least 10 g in the same window. We excluded paediatric, obstetric, emergency and non-randomized studies, and trials whose arms differed by a second co-intervention. In three-arm designs with such a co-intervention, we used only the arms that differed by carbohydrate. Trials of intravenous carbohydrate were excluded.

Search strategy

Searches were run on 2 and 3 November 2026 through a general web search tool, using combinations of preoperative, carbohydrate loading, oral carbohydrate, fasting, clear fluids, water, surgery and randomized controlled trial. Publisher sites and open-access full texts were then read directly. We also checked recent reviews9,10,12,13 and a supplied set of notes. PubMed, Embase, CENTRAL and Web of Science could not be queried directly, so database record counts are not available and no language or date limits were applied.

Selection and data extraction

One reviewer screened reports and extracted data with the assistance of an artificial intelligence tool; there was no independent second reviewer. We extracted design, population, drink, dose, timing, comparator and outcome data. For nausea and vomiting, we took a composite when reported, otherwise vomiting at the earliest postoperative window. Thirst and hunger were pooled only when measured before surgery.

Risk of bias and certainty

Risk of bias was assessed with RoB 2,15 and certainty for each main outcome with GRADE.16

Statistical analysis

We pooled mean differences for length of stay, risk ratios for binary outcomes and Hedges' g for outcomes measured on different scales. Random-effects models used restricted maximum likelihood, with Hartung-Knapp intervals when three or more comparisons were available17 and Wald intervals otherwise. Medians and interquartile ranges were converted to means and standard deviations by the method of Wan and colleagues.18 Binary thirst and hunger data were converted to standardized differences through the odds ratio.19 Zero cells received a 0.5 continuity correction. Heterogeneity was described by I^2 and τ^2. Trials with zero events in both arms contributed no estimate, so aspiration was summarized descriptively.

Where outcomes formed a connected network, we fitted a contrast-based frequentist model with restricted maximum likelihood, allowing for correlation within three-arm trials. Consistency was checked by comparing direct and indirect estimates where a closed loop existed. Sensitivity analyses removed outlying trials and tested assumptions about arm sizes. Funnel plots were not drawn because no comparison had 10 trials. Analyses were run in Python with SciPy.

RESULTS

Study selection and characteristics

We sought 48 reports. Six could not be retrieved and 24 were excluded, leaving 18 trials with 1,698 participants (Figure 1, Table 1).[20-37] Twelve compared carbohydrate with fasting, seven with water or placebo, and three provided water-versus-fasting data; three were three-arm trials or designs with two carbohydrate arms (Figure 2). Three trials enrolled only people with diabetes.[25,28,30] Most procedures were cholecystectomy or abdominal and colorectal resection. Doses ranged from about 25 g to 150 g, and most trials gave the final drink about 2 hours before surgery. One trial allowed ad libitum clear liquids in cardiac procedures but gave no extractable data; it found no benefit in satisfaction.[38] One trial combining carbohydrate with goal-directed fluid therapy was excluded because the two interventions could not be separated.[39]

Table 1. Characteristics of included trials.

Study	Country	Surgery	N	Carbohydrate regimen	Comparator	Outcomes used

Sada 2014[20]	Kosovo	Colorectal; open cholecystectomy	142	CHO 12.5%: 800 mL evening + 400 mL 2 h (≈150 g)	Placebo; fasting	LOS
Lee 2025[21]	South Korea	Colorectal cancer	54	400 mL 2 h (≈51 g)	Fasting from midnight	LOS, complications
He 2025[22]	China	Colorectal cancer	212*	800 mL evening + 400 mL 2 h (≈150 g)	Conventional fasting	LOS, complications
Singh V 2025[23]	India	Mixed elective general, urological and breast surgery	40	75 g glucose in 1 L, 2-4 h	Fasting ≥6 h	LOS
Abo-Omar 2025[24]	Egypt	Major abdominal	54	Honey drink 200 mL, ≥2 h (≈34 g)	200 mL water	LOS, PONV, thirst, hunger
Wang 2026[25]	China	Laparoscopic non-gastrointestinal surgery, T^2DM	60	Isomaltulose 50 g, 2-3 h	300 mL water	LOS, PONV, thirst, hunger, HOMA-IR, aspiration
Singh BN 2015[26]†	India	Laparoscopic cholecystectomy	120	Carbohydrate drink	Placebo; fasting	PONV
Gök 2020[27]	Turkey	Cholecystectomy	42	12.5% dextrose: 800 mL 8 h + 200 mL 2 h	Fasting from midnight	PONV, thirst, hunger, aspiration
Yadav 2023[28]	India	Laparoscopic cholecystectomy, diabetes	64	50 g maltodextrin, 2 h	Fasting	PONV, gastric volume, HOMA-IR, aspiration
Ge 2023[29]	China	Laparoscopic cholecystectomy	91	12.5% maltodextrin 800 + 400 mL (≈150 g)	Overnight fasting	PONV, thirst, hunger, gastric volume, aspiration
Li 2022[30]†	China	GI surgery, T^2DM	63	50 g dextrose with insulin, 2 h	Overnight fasting	PONV
Yildiz 2013[31]†	NR	Laparoscopic cholecystectomy	60	NR	Fasting	Thirst, hunger
Helminen 2019[32]†	Finland	Laparoscopic cholecystectomy	113	67 g	Fasting	Thirst, hunger
Zhang Z 2020[33]	China	Ambulatory surgery	64‡	200 mL 14.2% (≈28 g), 2 h	200 mL water	Hunger, gastric volume, aspiration
Wang X 2024[36]	China	Laparoscopic cholecystectomy	129	200 or 400 mL 12.5% (≈25 or 50 g), 2-4 h; arms combined	Overnight fasting	Thirst, hunger, gastric volume, HOMA-IR, aspiration
Urkan 2025[37]	Türkiye	Colorectal	50‡	12.5%: 800 mL evening + 400 mL 2-3 h (≈150 g)	Water, same volumes	LOS
Vishak 2023[34]	India	Regional anaesthesia, with and without diabetes	240	50 g dextrose in 400 mL, 2 h	400 mL water	Gastric volume
Dalal 2010[35]	India	Mixed elective (age 12-60 y)	100	None (water arm only)	150 mL water 2 h vs overnight fasting	Gastric volume

*Carbohydrate-only and conventional arms only. †Extracted from a secondary report or abstract. ‡Arm split assumed equal. Sada 2014: arm sizes 22/23/26 applied to both cohorts. NR, not reported in the source available. Carbohydrate grams with ≈ are calculated from reported concentration and volume.

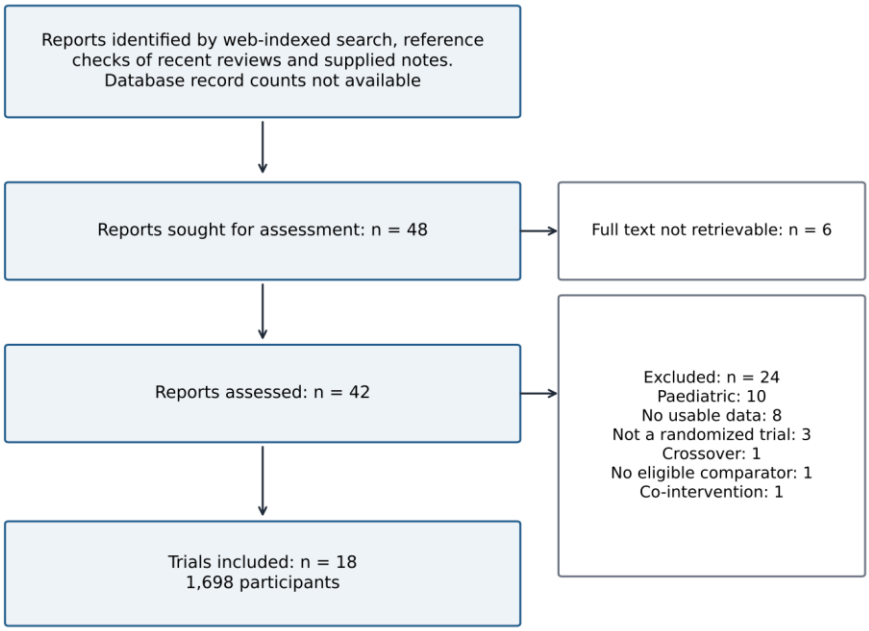


Figure 1. Flow of reports through the review, adapted from the PRISMA 2020 diagram.

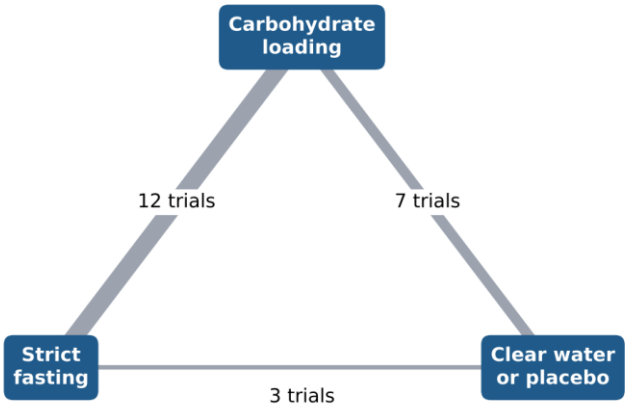


Figure 2. Evidence network. Line width reflects the number of trials contributing to each comparison for any outcome; three-arm trials contribute to all three edges.

Risk of bias

Of the 14 trials we could assess from the full report, 11 raised some concerns and three were at high risk of bias (Table 2). The common problems were undisclosed allocation concealment, no patient blinding for subjective outcomes, and per-protocol or completer analyses. Four trials known to us only through abstracts or secondary reports could not be rated.

Table 2. Risk of bias (RoB 2).

Study	D[1] Randomization	D[2] Deviations	D[3] Missing data	D[4] Measurement	D[5] Reporting	Overall
Sada 2014	Some	Low	Some	Low	Some	Some concerns
Lee 2025	Low	High	Some	Low	Some	High
He 2025	Some	High	Some	Low	Some	High
Singh V 2025	Low	Some	Some	Some	Some	Some concerns

Abo-Omar 2025	Some	Some	Low	Low	Some	Some concerns
Wang 2026	Low	Some	Low	Low	Low	Some concerns
Gök 2020	Some	Some	Low	High	Some	High
Yadav 2023	Some	Some	Low	Some	Some	Some concerns
Ge 2023	Some	Some	Some	Some	Some	Some concerns
Zhang Z 2020	Low	Low	Low	Low	Some	Some concerns
Wang X 2024	Low	Some	Some	Some	Some	Some concerns
Urkan 2025	Some	Low	Low	Low	Some	Some concerns
Vishak 2023	Low	Some	Low	Some	Some	Some concerns
Dalal 2010	Some	Some	Some	Low	Some	Some concerns
Singh BN 2015	-	-	-	-	-	Not assessed
Li 2022	-	-	-	-	-	Not assessed
Yildiz 2013	-	-	-	-	-	Not assessed
Helminen 2019	-	-	-	-	-	Not assessed

Length of stay

Against fasting, carbohydrate loading made no detectable difference to length of stay (mean difference 0.06 (95% CI −0.56 to 0.67) days; I^2=0%; Figure 3). Against water or placebo the pooled estimate was −1.53 (95% CI −3.66 to 0.61) days, with marked heterogeneity (I^2=90%). Two trials reported stays more than 3 days shorter,[24,37] while three comparisons showed almost no change. Without the two trials, the estimate was −0.22 (95% CI −1.33 to 0.88) days with I^2=0%. Table 3 shows the network estimates with and without these two trials.

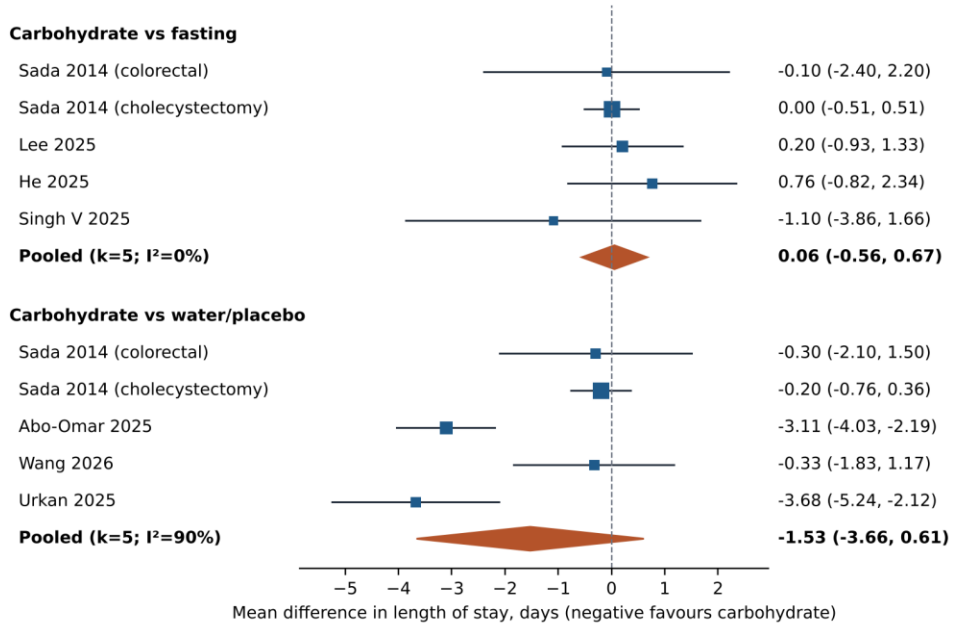


Figure 3. Length of stay. Squares are trial estimates and diamonds pooled estimates, with Hartung-Knapp intervals for three or more comparisons.

Nausea and vomiting

The risk ratio was 0.62 (95% CI 0.21 to 1.79) against fasting (I^2=72%) and 0.39 (95% CI 0.09 to 1.64) against water or placebo (I^2=0%; Figure 4). The estimate against fasting depended heavily on one trial in which carbohydrate increased nausea and vomiting; that trial gave a further 800 mL drink 8 hours before surgery.[27] Removing it gave 0.41 (95% CI 0.18 to 0.93) (I^2=0%). Keeping only the trials we read in full gave 0.92 (95% CI 0.10 to 8.45), so this result should not be regarded as stable.

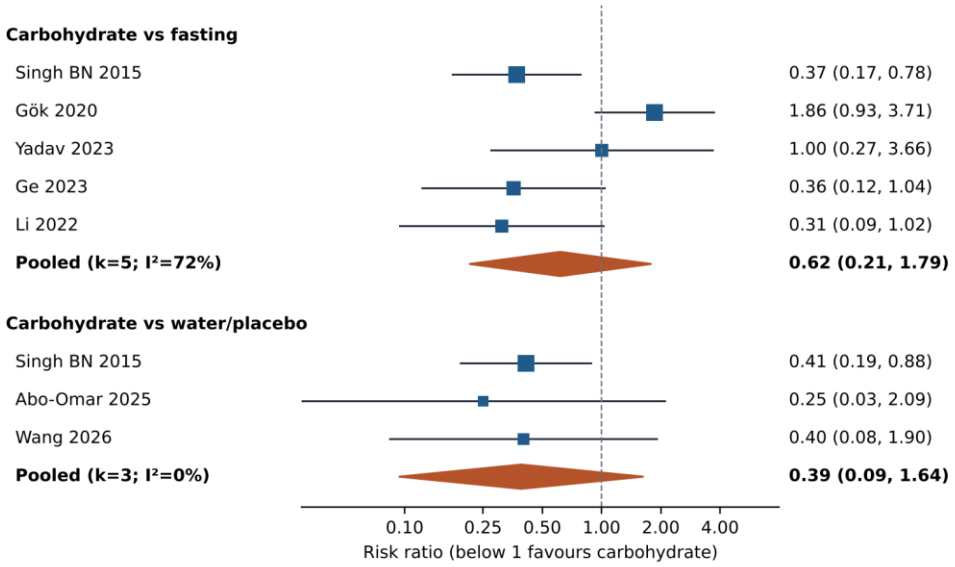


Figure 4. Postoperative nausea or vomiting.

Thirst and hunger

Against fasting, the standardized mean difference was −1.11 (95% CI −2.18 to −0.03) for thirst (I^2=90%) and −0.83 (95% CI −1.66 to −0.01) for hunger (I^2=69%; Figure 5). All five trials pointed the same way for each symptom, but none of the assessed trials had secure patient blinding, and these are self-reported outcomes. Against water or placebo, the results were −0.48 (95% CI −1.65 to 0.68) for thirst (2 trials) and −0.56 (95% CI −1.33 to 0.21) for hunger (3 trials). Thirst did not differ at all in the isomaltulose trial, where both arms drank 300 mL.[25] One double-blind trial reported less postoperative thirst and hunger with carbohydrate than water, but those time points were outside our preoperative window.[37]

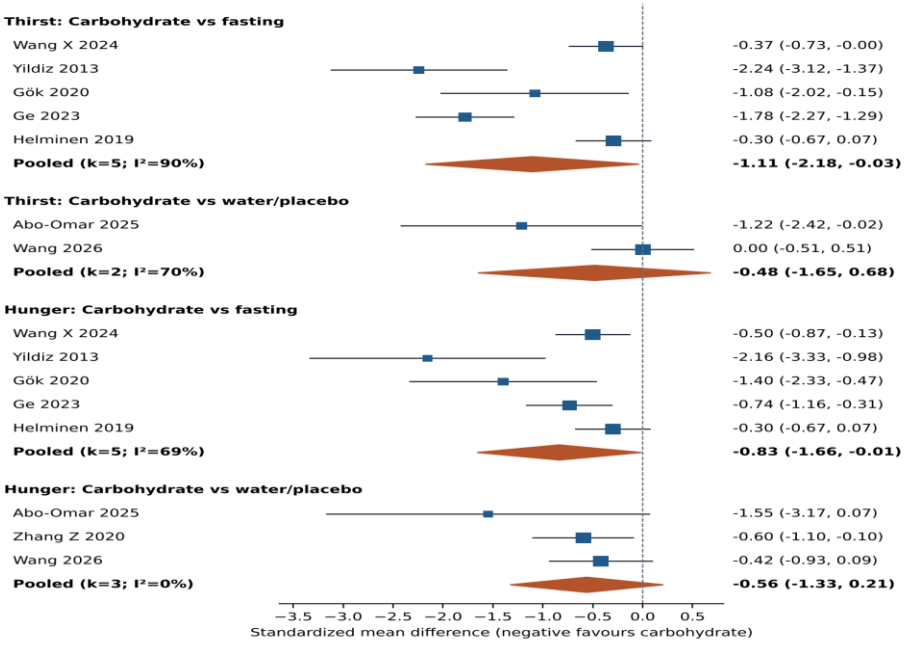


Figure 5. Preoperative thirst and hunger.

Gastric volume and aspiration

Gastric volume tended to be larger after carbohydrate than after fasting (0.51 (95% CI −0.03 to 1.04); 3 trials; Figure 6), and was similar to water or placebo (0.10 (95% CI −0.99 to 1.18); 3 comparisons). The single trial comparing water with fasting showed less gastric fluid with water.[35] Direct and indirect estimates of that comparison disagreed strongly (direct −1.81, indirect 0.41; P<0.001), so we did not report a network estimate for this outcome. Measurement method also varied, from ultrasound to aspiration. No aspiration occurred in the six trials reporting it: 0 of 245 participants given carbohydrate and 0 of 205 controls. With these numbers, the upper 95% limit for the risk in the carbohydrate arm is about 1.2%, which is too imprecise to exclude a rare harm.

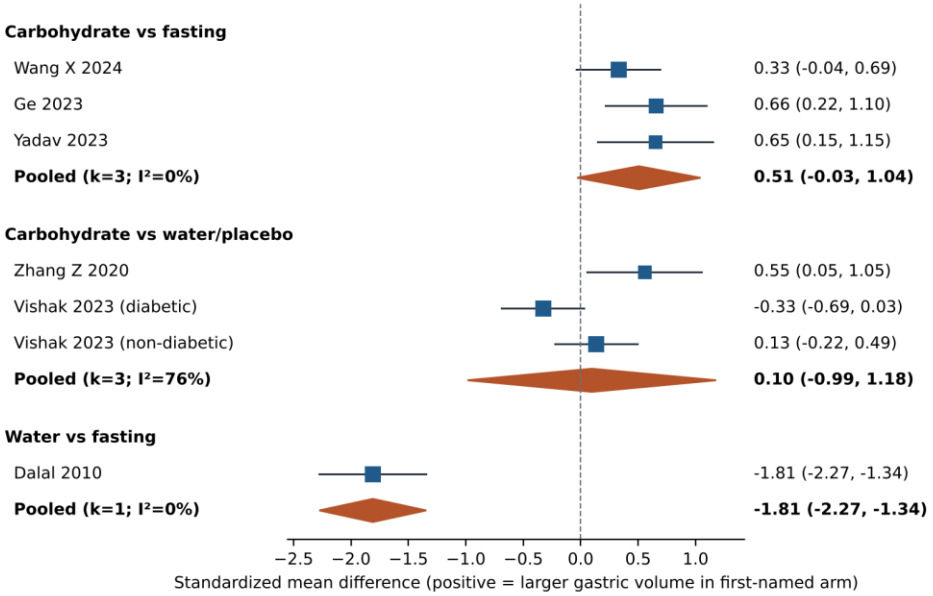


Figure 6. Gastric volume. Positive values indicate larger volume in the first-named arm.

Insulin resistance and complications

Three trials gave usable postoperative HOMA-IR values, and we did not pool them because timing and populations differed. In type 2 diabetes, HOMA-IR at 24 hours was lower with carbohydrate than with fasting (mean difference −2.27 (95% CI −3.16 to −1.38))[28] and with isomaltulose than with water (−4.71 (95% CI −6.68 to −2.74)).25 In non-diabetic patients, there was no clear difference 1 hour after surgery (−0.35 (95% CI −1.16 to 0.45)).36 Another trial reported lower values without giving numbers.24 Complications were reported in two comparisons against fasting (risk ratio 0.86 (95% CI 0.39 to 1.88); I^2=0%).21,22

Network estimates and certainty

Network estimates appear in Table 3. Carbohydrate was close to fasting for length of stay. Against water or placebo the network estimate favoured carbohydrate by about 1.5 days, but this depended on the two trials with large effects and disappeared without them. No network contrast showed a clear difference for nausea and vomiting. The water-versus-fasting edge rests on few trials, so its estimates are imprecise. Certainty of evidence was low or very low for all outcomes (Table 4).

Table 3. Network meta-analysis estimates. MD, mean difference; RR, risk ratio.

Contrast	Length of stay, MD in days (95% CI)	Length of stay without Abo-Omar 2025 and Urkan 2025	Nausea or vomiting, RR (95% CI)
Carbohydrate vs fasting	−0.20 (−1.43 to 1.02)	0.06 (−0.38 to 0.49)	0.61 (0.31 to 1.20)
Carbohydrate vs water/placebo	−1.45 (−2.61 to −0.30)	−0.22 (−0.73 to 0.28)	0.42 (0.15 to 1.13)
Water/placebo vs fasting	1.25 (−0.26 to 2.76)	0.28 (−0.39 to 0.94)	1.47 (0.48 to 4.51)

Table 4. Summary of findings. SMD, standardized mean difference.

Outcome (comparison)	Comparisons	Effect (95% CI)	Certainty	Reasons for rating down

Length of stay (carbohydrate vs fasting)	5	MD 0.06 (−0.56 to 0.67)	Low	Risk of bias, imprecision
Length of stay (carbohydrate vs water)	5	MD −1.53 (−3.66 to 0.61)	Very low	Risk of bias, inconsistency, imprecision
Nausea or vomiting (carbohydrate vs fasting)	5	RR 0.62 (0.21 to 1.79)	Very low	Risk of bias, inconsistency, imprecision
Thirst (carbohydrate vs fasting)	5	SMD −1.11 (−2.18 to −0.03)	Very low	Risk of bias, inconsistency, imprecision
Hunger (carbohydrate vs fasting)	5	SMD −0.83 (−1.66 to −0.01)	Very low	Risk of bias, inconsistency, imprecision
Gastric volume (carbohydrate vs fasting)	3	SMD 0.51 (−0.03 to 1.04)	Very low	Risk of bias, indirect surrogate, imprecision
Aspiration	6 trials	0/245 vs 0/205	Very low	Imprecision, risk of bias, no events

DISCUSSION

This review found no firm evidence that carbohydrate loading shortens hospital stay compared with fasting, and the comparison with water was unresolved. Patients given carbohydrate felt less thirsty and hungry than those who fasted, although the trials differed greatly. Insulin resistance was lower in two small diabetic trials but not in one non-diabetic trial measured early, and no aspiration occurred.

The length of stay result sits at the sceptical end of the literature. Amer and colleagues reported a small saving against fasting and none against water or placebo,10 and the recent large review put the saving at about 0.4 days.13 Our estimate cannot exclude a benefit of that size, because the interval reaches −0.56 days. The difference is more likely to reflect fewer trials than a true conflict. Against water, the picture splits. Three comparisons agree with earlier work in showing no benefit,10 but two trials reported stays 3 to 4 days shorter. One used 34 g of honey-based carbohydrate, and its control arm drank water despite being labelled a fasting arm.24 The other was double-blind and gave about 150 g, yet reported baseline imbalances and a long stay in the water arm.37 We could not explain the split, and effects this large are hard to attribute to a drink alone.

The comfort signal is plausible and agrees with the guidance that patients prefer drinking to absolute fasting.6 Yet thirst is relieved by fluid, not sugar, and the two trials against water disagreed about thirst. For hunger, the data against water were few but pointed mildly towards carbohydrate, in line with the guideline statement that carbohydrate liquids appear to reduce hunger compared with non-caloric liquids.6 This matters in low-resource settings, where a carbohydrate product adds cost and supply steps while water does not.

Although carbohydrate loading showed a tendency towards higher gastric volumes in some trials, no aspiration events were reported. Previous Cochrane evidence also found no increased aspiration risk with shortened fluid fasting.[5] These findings are reassuring, although larger studies are needed to assess rare complications. Increased glucose levels reported in some diabetic participants highlight the need for individualized perioperative management.[25, 34]

Limitations and Future Directions

This review provides a comparative assessment of three clinically relevant fasting strategies. However, the rapid-review approach, limited database access, single-reviewer data extraction and incomplete availability of some trial reports may have affected study identification and data assessment. Variations in interventions, outcome measurements and study populations also contributed to heterogeneity. Some analyses involved converted data or assumed group sizes, and one study included participants from 12 years of age.[35]

Future multicentre trials should compare all three strategies using standardized protocols, adequate sample sizes and clearly defined outcomes. Plain water should be included as a comparator to establish whether carbohydrate loading offers additional benefits beyond liberal fluid intake.

CONCLUSION

In adults having elective surgery, carbohydrate loading may ease thirst and hunger compared with strict fasting, but the certainty is low to very low and no effect on length of stay was shown. Whether carbohydrate beats plain water is

unresolved. Replacing midnight fasting with clear fluids until 2 hours seems a sensible first step for low-risk patients; the case for adding carbohydrate needs better trials.

Declarations
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Conflicts of interest: None declared.

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