Association between glucagon-like peptide-1 receptor agonists, residual gastric content, and bronchopulmonary aspiration after fasting: an ongoing systematic review and meta-analysis

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Summary

Glucagon-like peptide-1 receptor agonists (GLP-1 RAs) are increasingly being prescribed, raising concerns about their potential impact on gastric emptying and subsequent bronchopulmonary aspiration risk. This ongoing systematic review and meta-analysis assesses the association between GLP-1 RA use, residual gastric content (RGC), and aspiration events in fasting patients. A systematic literature search in Google Scholar identified 60 relevant studies. Inclusion criteria focused on studies evaluating RGC or aspiration incidence in fasted GLP-1 RA users. Studies employing indirect gastric emptying assessments, case reports, and non-English publications were excluded. Data extraction included control groups where available. Periodic literature search updates are planned. Among UGI endoscopy patients, the overall RGC incidence was 9.5% (886/9,343). Incidence varied by procedure type: 12.8% for UGI endoscopy alone, 4.3% with concomitant colonoscopy, and 9.3% for unspecified colonoscopy status. Control groups consistently showed lower RGC rates (2.1%). In non-endoscopy populations, RGC incidence was significantly higher at 50.5% (98/194) in GLP-1 RA users versus 8.5% in controls. Pooled aspiration incidence was 17.5 per 10,000 in the GLP-1 RA UGI endoscopy populations versus 13.6 in controls. surgical populations showing no significant increase in aspiration risk. Aspiration meta-analyses are likely to be underpowered. GLP-1 RAs are associated with increased RGC incidence, particularly in non-endoscopy populations, but aspiration risk remains unclear. Further research is required to refine fasting guidelines and perioperative management recommendations for GLP-1 RA users.

Introduction

Glucagon-like peptide-1 receptor agonists (GLP-1 RAs) are increasingly used for type 2 diabetes mellitus and obesity. Concerns exist regarding their potential to increase peri-procedural bronchopulmonary aspiration risk due to delayed gastric emptying. Multiple international guidelines offer conflicting recommendations,[1] likely due to the rapidly evolving evidence base.

Previous reviews primarily focused on the upper gastrointestinal (UGI) endoscopy population, with their findings often extrapolated to perioperative patients.[2–4] However, compared to perioperative patients, UGI endoscopy allows for direct confirmation of RGC and patients will have undergone a stricter fasting regimen if having concomitant colonoscopy. Given the fast-paced publication of new studies, systematic reviews and meta-analyses on this topic rapidly become outdated.

This ongoing systematic review and meta-analysis aims to assess:
- The association between GLP-1 RA use and RGC after fasting
- The association between GLP-1 RA use and bronchopulmonary aspiration after fasting

Sub-analyses will distinguish patients undergoing UGI endoscopy alone, UGI endoscopy with colonoscopy, and non-endoscopy populations. This review will be published as a preprint and updated periodically until the evidence base stabilises.

Methods

A systematic search was conducted in Google Scholar using the query: *"GLP-1 receptor agonist AND residual gastric content OR aspiration"* without date limits. Screening was halted once no relevant citations were found in the last 100 citations.

Inclusion criteria:
- Studies investigating the association between GLP-1 RA use and RGC or bronchopulmonary aspiration in fasted patients
- Journal articles, abstracts, non-peer-reviewed publications, reviews, and meta-analyses

Exclusion criteria:
- Studies using capsule endoscopy, scintigraphy, or paracetamol absorption to assess gastric emptying
- Individual case reports
- Non-English publications

Control group data (patients not on GLP-1 RAs) were extracted where available. Statistical analyses, including odds ratios and forest plots, will be incorporated in future updates. The latest search was conducted on 18 February 2025, with planned updates every four months or as significant new evidence emerges. The study was reported using the Preferred Reporting

Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 statement,[5] with detailed bias risk assessments to be included in future updates.

Results

60 publications are included in this meta-analysis, comprising six prospective studies, 39 retrospective data analyses, 14 reviews/meta-analyses, and one case series. Of the 60 publications, one (1.7%) was published in 2022, three (5.0%) in 2023, 48 (80.0%) in 2024, and eight (13.3%) in 2025 Three publications were excluded as they presented redundant data.[6–8] The literature search process is outlined in Figure 1.

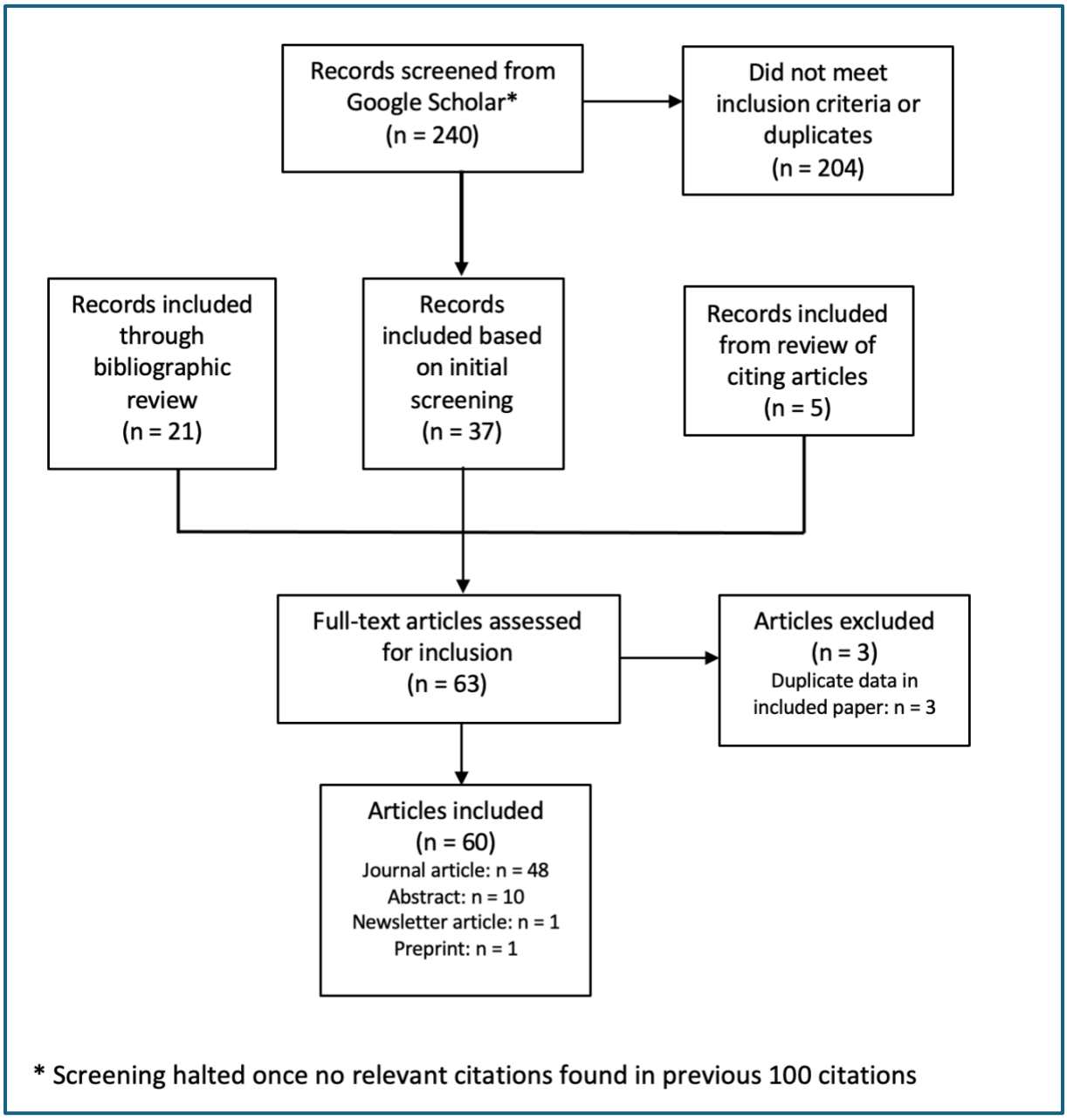

Figure 1: Literature search flowchart

Upper GI endoscopy

A total of 25 studies examined RGC incidence in UGI endoscopy, using visible food residue as direct confirmation. The pooled incidence of RGC in patients on GLP-1 RAs undergoing UGI endoscopy was 9.5% (886/9,343). Sub-analyses are detailed in Table 1.

Table 1: Incidence of residual gastric content in fasted patients on GLP-1 receptor agonists undergoing upper gastrointestinal endoscopy

	Patients on GLP-1 RAs	Patients with RGC	Incidence
UGI endoscopy only[9–17]	2,415	310	12.8%
UGI endoscopy and colonoscopy[9–17]	1,428	62	4.3%
UGI endoscopy (colonoscopy status unclear)[18–33]	5,500	514	9.3%
Total	**9,343**	**886**	**9.5%**

Three studies used both high-volume fluid or visible food residue as markers of RGC, with 182 of 1,744 patients on GLP-1 RAs (10.4%) having RGC.[10, 22, 31] Among 21 studies with control groups, RGC incidence was 10.0% (623/6,227) vs 2.1% (3,443/165,047) in controls. Four studies that separated UGI endoscopy from concomitant colonoscopy procedures utilised control groups, outlined in Table 2. Additional data to aid analysis was obtained from authors for three papers.[10, 14, 17]

Table 2: Incidence of residual gastric content in fasted patients undergoing upper gastrointestinal endoscopy as a single procedure and with concomitant colonoscopy

	Patients on GLP-1 RAs	GLP-1 RA with RGC	Incidence	Control group	Control with RGC	Incidence
UGI endoscopy only						
Korlipara et al (2024)[14]	364	45	12.4%	380	9	2.4%
Nasser et al (2024)[15]	23	4	17.4%	46	0	0.0%
Panchal et al (2025)[16]	263	33	12.5%	172	9	5.2%
Robalino Gonzaga et al (2024)[17]	39	9	23.7%	493	11	2.2%
Total	**689**	**91**	**13.2%**	**1,091**	**29**	**2.7%**
UGI endoscopy and colonoscopy						
Korlipara et al (2024)[14]	238	11	4.6%	230	2	0.9%
Nasser et al (2024)[15]	24	0	0.0%	48	0	0.0%
Panchal et al (2025)[16]	97	2	2.1%	66	0	0.0%
Robalino Gonzaga et al (2024)[17]	35	1	2.9%	480	4	0.8%
Total	**394**	**14**	**3.6%**	**824**	**6**	**0.7%**

16 studies used the incidence of aborted procedures as a surrogate for RGC severity, outlined in Table 3. One study reported on the rate of repeat UGI endoscopy as a surrogate for aborted procedures due to RGC, with 97/1,795 repeats (5.4%) in the GLP-1 RA group vs 76/1,795 repeats (4.2%) in the control group.[34]

A study of 57 patients on GLP-1 RAs presenting for endoscopic sleeve gastroplasty showed no RGC or aspiration events.[35] These patients underwent a colonoscopy-type fasting and bowel preparation regimen.

Five studies reported on the indication for being on GLP-1 RAs, being diabetes or obesity or both, in demographic data without further analysis.[12, 17, 21, 28, 31] One study investigated RGC incidence based on GLP-1 RA dose and showed no significant difference but this analysis may have been underpowered.[11]

Table 3: Incidence of aborted procedures in fasted patients undergoing upper gastrointestinal endoscopy

	Patients on GLP-1 RAs	GLP-1 RA procedures aborted	Incidence	Control group	Control procedures aborted	Incidence
Alkabbani et al (2024)[36]	23,183	534	2.3%	17,093	314	1.8%
Ayoub et al (2024)[19]	101	2	2.0%	104	0	0.0%
Chapman et al (2024)[20]	84	4	4.8%	84	0	0.0%
Dev at el (2024)[21]	1,023	8	0.8%	31,202	30	0.1%
Garza et al (2024)[11]	306	14	4.6%	306	0	0.0%
Hernandez et al (2024)[22]	109	4	3.7%	949	19	2.0%
Karlson et al (2024)[13]	581	2	0.3%	403	0	0.0%
Markley et al (2024)[25]	47	0	0.0%	324	1	0.3%
Nadeem et al (2024)[27]	922	14	1.5%	34,261	103	0.3%
Panchal et al (2025)[16]	360	8	2.2%	172	0	0.0%
Peng et al (2024)[28]	104	3	2.9%	49	0	0.0%
Stark et al (2022)[32]	59	0	0.0%	118	0	0.0%
Total with controls	**26,879**	**593**	**2.2%**	**85,065**	**467**	**0.5%**
Firkins et al (2024)[10]	1,512	30	2.0%			
Jirapinyo et al (2025)[23]*	483	7	1.4%			
Phan et al (2024)[29]	815	14	1.7%			
Total overall	**29,689**	**644**	**2.2%**			
Korlipara et al (2024)[14]†	602 in GLP-1 RA group vs 610 in control group. GLP-1 RAs associated with aborted procedures (OR, 3.09; 95% CI, 1.11-8.55; P = 0.02)					

*Control group only withheld GLP-1 RA.
† Data presented as odds ratios

Non-endoscopy

Five studies investigated RGC incidence in fasted non-endoscopy populations, finding that approximately 50% of individuals on GLP-1 RAs had RGC after standard fasting periods (Table 4). Four were prospective studies with control groups,[37–40] while one was a case series.[41] All studies used gastric ultrasound to assess RGC.

Table 4: Incidence of residual gastric content in the fasted non-endoscopy population

	Patients on GLP-1 RAs	GLP-1 RA with RGC	Incidence	Control group	Control with RGC	Incidence
Sherwin et al (2023)[37]*	10	9	90.0%	10	1	10.0%
Queiroz et al (2024)[38]*	15	11	73.3%	15	1	6.7%
Sen at al (2024)[39]	62	35	56.5%	62	12	19.4%
Nersessian et al (2024)[40]	107	43	40.2%	113	3	2.7%
Total with controls	**194**	**98**	**50.5%**	**200**	**17**	**8.5%**
Kwon et al (2024)[41]	7	3	42.9%			
Total overall	**201**	**101**	**50.2%**			

*Studies performed in fasted volunteers

Aspiration

A total of 26 studies assessed aspiration incidence in fasted GLP-1 RA patients, comprising 20 from the UGI endoscopy population (Table 5) and six from various other surgeries (Table 6).

Table 5: Aspiration incidence in upper GI endoscopy patients

	Patients on GLP-1 RAs	Aspiration events	Incidence (per 10,000)	Control group	Aspiration events	Incidence (per 10,000)
Al Sakka Amini (2024)[42]	59,323	10	1.7	59,323	0	0
Alkabbani et al (2024)[36]	23,183	14	6.0	17,093	12	7.0
Ayoub et al (2024)[19]	101	0	0	104	0	0
Barlowe et al (2024)[43]	15,119	7	4.6	14,407	10	6.9
Garza et al (2024)[11]	306	0	0	306	0	0
Karlson et al (2024)[13]	581	0	0	403	0	0
Nadeem et al (2024)[27]	922	0	0	34,261	1	0.3
Nasser et al (2024)[15]	47	0	0	94	0	0
Peng et al (2024)[44]	29,075	160	55.0	29,075	143	49.2
Quinn et al (2025)[30]	470	2	42.6	470	1	21.3
Santos et al (2024)[31]	123	1	81.3	971	0	0
Suresh Kumar et al (2024)[45]*	61,355	38	6.2	61291	68	11.1
Velji-Ibrahim et al (2024)[46]*	23,474	29	12.4	23,474	26	11.1
Wu et al (2024)[33]	90	1	111.1	102	0	0
Yeo et al (2024)[47]	6,214	124	199.5	6,159	75	121.8
Total with controls	**220,383**	**386**	**17.5**	**247,533**	**336**	**13.6**
Anazco et al (2023)[48]	4,134	2	4.8			
Firkins et al (2024)[10]	1,512	2	13.2			
Ghazanfar et al (2024)[12]	306	0	0			
Jirapinyo et al (2025)[23]†	483	0	0			
Total overall	**29,689**	**390**	**17.2**			
Chapman et al (2024)[20]	84 patients in GLP-1 RA group and 84 in control. No difference in aspiration rates but figures not reported.					

* Aspiration pneumonitis used as endpoint. † Control group only withheld GLP-1 RA.

Data from four studies on UGI endoscopy with colonoscopy,[11, 13, 15, 36] combined with an endoscopic sleeve gastrectomy study with similar fasting and bowel preparation regimens to colonoscopy,[35] showed a pooled incidence of 6 per 10,000 cases (14 aspiration events in 23,474 cases). However, this was heavily weighted to a single study that contained all the aspiration events from 23,138 cases.[36] In the surgical population, no significant increase in aspiration incidence was observed across six studies (Table 6).

Table 6: Studies investigation aspiration in surgical patients on GLP-1 RAs

Paper	Surgery type	Results
Buddhiraju et al (2024)[49]	Hip and knee arthroplasty	No aspiration cases (n = 3,139)
Dixit et al (2024)[50]	Emergency surgery	No difference in respiratory complications (adjusted OR = 1.03; 95% CI = 0.82-1.29; p = 0.80)
Klonoff et al (2024)[51]	Surgeries requiring tracheal intubation	2,256 in GLP-1 RA group vs 11,405 control, with 9 aspirations in GLP-1 RA group (39 per 10,000) vs 70 in control (61.4 per 10,000).
Milne et al (2024)[52]	All surgeries	Investigated incidence of reflux, regurgitation, or aspiration in all patients – showed no change over 12-month period where semaglutide use increased
Nersessian et al (2024)[40]	Elective surgery	No aspiration cases (n = 107)
Welk et al (2024)[53]*	Elective surgery	3,833 with GLP-1 RA vs 14,072 control. Aspiration pneumonia cases within 14 days of operation = ≤ 5 in GLP-1 vs ≤ 15 in control (p = 0.69)

*Exact event figure not published to protect anonymity

Reviews and meta-analyses

14 review papers related to RGC or bronchopulmonary aspiration in patients taking GLP-1 RAs were identified, outlined in the table below. Half the papers were systematic reviews/meta-analyses, with four scoping and three narrative reviews.

Table 7: Review papers related to RGC or bronchopulmonary aspiration in patients taking GLP-1 RAs

Paper	Review type	Topic	Notes
Baig et al (2025)[2]	Systematic and meta-analysis	Aspiration in UGI endoscopy	Identified 20 studies reporting on RGC and 5 reporting on aspiration.
Chang et al (2024)[54]	Scoping	RGC, regurgitation, and aspiration	24 papers identified. Included case reports. Abstracts excluded. Included other modes such as capsule endoscopy, etc.
do Nascimento et al (2024)[55]	Systematic and meta-analysis	General anaesthesia and sedation	Included 3 papers on UGI endoscopy and RGC.
Elkin et al (2024)[56]	Systematic and meta-analysis	Aspiration	Included 11 studies on aspiration and 17 studies on RGC, which did not separate UGI endoscopy combined with colonoscopy or non-endoscopy procedures

Facciorusso et al (2024)[3]	Meta-analysis	UGI endoscopy	Identified 13 studies investigation RGC and aspiration
Goldenberg et al (2025)[57]	Narrative	Perioperative and periprocedural management	Identified 14 UGI studies on RGC and 10 on aspiration
Hiramoto et al (2024)[58]	Systematic and meta-analysis	Gastric emptying delay	Discussed gastric emptying measured by various modes, with three papers on RGC in UGI endoscopy
Milder et al (2024)[59]	Narrative	GLP-1 RA pharmacology and implications for anaesthesia	Discussed a number of RGC studies in the UGI endoscopy and surgical populations
Mizubuti et al (2024)[60]	Narrative	Perioperative management	General discussion on clinical outcomes
Pai et al (2024)[61]	Narrative	Perioperative considerations	Specific to semaglutide
Peppas et al (2024)[62]	Systematic and meta-analysis	Upper and lower GI endoscopy	Identified five studies on RGC in UGI endoscopy
Singh et al (2025)[4]	Systematic and meta-analysis	RGC and aspiration endoscopy	Identified 17 papers in UGI endoscopy
Singh et al (2024)[63]	Narrative	Gastrointestinal endoscopy	General discussion on guidelines and available studies
Wookey et al (2025)[64]	Scoping	Cardiac procedures	Identified three studies, none of which address aspiration

Discussion

The large number of very recent publications in the field highlights the necessity for an ongoing review format to ensure that evidence remains current. As new data emerges, this online preprint review will allow clinicians to see up-to-date analyses and synthesise findings to guide clinical practice.

Among UGI endoscopy patients, the RGC incidence varied by procedure type, notably 12.8% for UGI endoscopy alone versus 4.3% with concomitant colonoscopy. This highlights the need for future studies to distinguish between these two groups when performing analyses. In non-endoscopy populations, RGC incidence was significantly higher at 50.5% (98/194) in GLP-1 RA users versus 8.5% in controls. The differences in patient populations must be considered when formulating clinical guidelines and caution should be used when extrapolating findings from one procedural context to another.

The endpoint for upper gastrointestinal (UGI) studies is typically the presence of visible food residue that impacts visualisation, which differs significantly from the context of surgical populations. All studies in the surgical population used gastric ultrasound to determine RGC. Notably, most UGI studies are retrospective database analyses in which solid gastric content was documented upon direct visualisation. However, high-volume fluid retention was only accounted for in 3 out of 25 UGI studies. This distinction is clinically relevant, as fluid content in the stomach over 1.5 mL/kg is generally considered high-risk for aspiration in surgical populations, but can be readily suctioned during UGI endoscopy.

There is considerable variability in GLP-1 RA agents and dosing regimens across studies. In addition, the dosing regimen for weight loss is higher than that prescribed for diabetes management. This variation in dosage and drug selection may impact gastric emptying and, consequently, RGC incidence, yet these factors are not always consistently accounted for in study designs.

Whilst published studies assessing aspiration risk have shown no increase in GLP-1 RA patients, they lack sufficient power to detect a meaningful difference. This is largely due to the inherently low baseline rates of aspiration, making it challenging to draw definitive conclusions regarding risk stratification. Three seminal studies inform our knowledge of baseline aspiration rates under anaesthesia. Olsson et al (1986) showed 83 cases of aspiration in 185,358 cases, or 1:2,131.[65] Warner et al (1993) showed rates ranging from 1:895 in emergency surgery to 1:9,299 in ASA 1 elective cases, with an overall rate of 1:3,216 (67 incidents in 215,488).[66] Sakai et al (2006) investigated the non-obstetric population, revealing a rate of 1:7,103 (14 in 99,441).[67] The pooled result of these three studies is a rate of 1:3,051, though a range of 1:900 to 1:10,000 is often cited in the literature.

We should not assume a linear relationship exists between increased RGC incidence and aspiration rates. Many factors may influence the latter, most notably our increased awareness of the former. Furthermore, there is no consensus on what constitutes a clinically meaningful increase in aspiration rates. Assuming that a 20% increase is clinically meaningful in the surgical population with a baseline rate of 1:3,000, we would require a sample size of over 600,000 GLP-1 RA surgical patients to power a study sufficiently. Table 8 lists a range of scenarios for a required sample size.

Table 8: Required sample size to show increase from baseline aspiration rate (one study group vs population, α = 0.05, power = 80%, analyses from ClinCalc online statistical calculator*)

Baseline rate of aspiration	Required sample size to show increase from baseline		
	10% increase	20% increase	50% increase
1:2,000	1,615,314	415,050	71,514
1:3,000	2,423,630	622,748	107,303
1:5,000	4,039,536	1,037,958	178,848
1:8,000	6,463,757	1,660,865	286,182

* https://clincalc.com/stats/samplesize.aspx

Limitations

This systematic review has several limitations. Firstly, the search was conducted using a single database (Google Scholar). However, by incorporating forward and backward referencing, this review identified more relevant publications than previous reviews, suggesting comprehensive coverage of the available literature. Secondly, statistical analyses are currently incomplete. While odds ratios and forest plots are planned for future updates, the priority at this stage was to rapidly synthesise and disseminate the available data. As more studies emerge, future iterations will incorporate more detailed statistical analyses to strengthen the findings. Studies were selected by a single author, which increases the risk of error or bias. Finally, this review

has not yet undergone formal peer review. Future updates may incorporate informal peer feedback to refine the methodology, clarify interpretations, and ensure robustness of conclusions. Additional authors will be recruited to complete the meta-analysis prior to peer-reviewed publication.

Conclusion

This ongoing systematic review and meta-analysis evaluates the association between glucagon-like peptide-1 receptor agonists (GLP-1 RAs), residual gastric content (RGC), and bronchopulmonary aspiration after fasting. The findings indicate that patients on GLP-1 RAs exhibit a higher incidence of RGC than control groups, particularly in non-endoscopy patient groups and those undergoing upper gastrointestinal (UGI) endoscopy without colonoscopy. The incidence of RGC is significantly lower in patients undergoing UGI endoscopy with concomitant colonoscopy, potentially due to stricter fasting and bowel preparation regimens. Regarding aspiration risk, the available data does not suggest an elevated aspiration risk but is not sufficiently powered to show a difference. The variability in findings across studies underscores the need for further high-quality, prospective research to better quantify the clinical implications of GLP-1 RA use. Future studies should aim to refine fasting guidelines and identify subpopulations at higher risk. As new evidence emerges, this review will be periodically updated to ensure the most current and comprehensive understanding of the relationship between GLP-1 RAs, RGC, and aspiration risk.

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Version Change Register

Version 2 (19 March 2025)

- Corrected various typos
- Added a review article that was omitted in error