

Cardiovascular Outcomes and Safety of GLP-1 Receptor Agonists in Elderly Patients with Type 2 Diabetes: A Systematic Review and Meta-Analysis

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Background: Glucagon-like peptide-1 receptor agonists (GLP-1 RAs) reduce major adverse cardiovascular events (MACE) in patients with type 2 diabetes. However, evidence specific to elderly patients remains limited. Elderly patients with diabetes are associated with high cardiovascular (CV) risk and increased susceptibility to adverse events. Therefore, this study systematically evaluated the CV outcomes and safety of GLP-1 RAs in elderly patients with T2DM.

Methods: PubMed, Embase and Web of Science were searched for randomized controlled trials (RCTs) published up to January 2024 that compared GLP-1 RAs with placebo or other controls in patients aged ≥ 65 years, with cardiovascular outcomes as the primary endpoint. Safety outcomes, including gastrointestinal adverse events and hypoglycemia, were also analyzed. Risk ratios (RRs) with 95% confidence intervals (CIs) were pooled using a random-effects model.

Results: The review was registered with PROSPERO (CRD42024582164). Of 2,425 screened articles, five full-text publications (reporting six independent RCTs) involving 8,889 patients were included. The mean age was 71.8 years. Compared with placebo, GLP-1 RAs significantly reduced MACE by 21% (RR 0.79, 95% CI 0.70–0.90; $p = 0.0003$) and non-fatal myocardial infarction by 25% (RR 0.75, 95% CI 0.62–0.91; $p = 0.003$). No significant reductions were observed in cardiovascular mortality (RR 0.86, 95% CI 0.69–1.07; $p = 0.17$) or non-fatal stroke (RR 0.91, 95% CI 0.70–1.18; $p = 0.49$). GLP-1 RAs were associated with increased risks of diarrhea (RR 2.33, 95% CI 1.35–4.01; $p = 0.002$) and nausea (RR 2.94, 95% CI 1.66–5.21; $p = 0.0002$).

Conclusion: These findings suggest that GLP-1 RAs confer significant cardioprotective benefits in elderly patients with T2DM, although gastrointestinal adverse effects warrant careful monitoring.

Keywords: GLP-1 receptor agonist, older, semaglutide, liraglutide, albiglutide

Introduction

Type 2 diabetes mellitus (T2DM) is a chronic, progressive metabolic disorder with multiple pathogenic determinants. Aging is a risk factor for T2DM development. According to the latest International Diabetes Federation (IDF) projections, the prevalence will peak at 24.79% in individuals aged 75–79 years and reach 23.72% in those aged ≥ 65 years by 2050.¹ Elderly patients with T2DM are characterised by a higher baseline cardiovascular (CV) risk and increased susceptibility to treatment-related adverse events (AEs).^{2,3} Consequently, the selection of antidiabetic drugs in elderly patients necessitates careful consideration due to their unique safety concerns and requirements.

Glucagon-like peptide-1 receptor agonists (GLP-1 RAs) are a pharmacologic class of peptide-based, glucose-lowering agents.⁴ These agents have demonstrated significant improvements in glycemic control and weight reduction.^{5–7} Additionally, several large randomized controlled trials (RCTs) and meta-analyses have reported efficacy of GLP-1 RAs in preventing CV events in patients with T2DM.^{8–11} Accordingly, the American Diabetes Association guidelines recommend the initiation of a GLP-1 RA among patients with high cardiovascular risk or patients with established atherosclerotic cardiovascular disease.¹² Despite these benefits of GLP-1 RAs, it is crucial to recognize the occurrence of

AEs, especially gastrointestinal - related AEs. Several studies have reported GLP-1 RAs significantly increased the incidence of gastrointestinal AEs compared with placebo or conventional treatment.^{13,14}

Evidence supporting the use of GLP-1 RAs in elderly patients remains limited. Age-related pharmacokinetic and pharmacodynamic alternations markedly impact drug absorption, distribution, metabolism and elimination, underscoring the need for prudent medication prescribing in elderly patients.¹⁵ Hence, this meta-analysis aimed to assess cardiovascular outcomes with GLP-1 RA initiation relative to placebo and evaluate the safety profile of these agents in elderly patients.

Methods

This systematic review and meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and registered with PROSPERO (CRD42024582164).

Search Strategy

PubMed, Embase and Web of Science were searched for randomized controlled trials (RCTs) published up to January 2024. Search terms included “glucagon-like peptide-1 receptor agonists”, “lixisenatide”, “liraglutide”, “semaglutide”, “exenatide”, “efpeglenatide”, “elderly”, “old”, “aged”, “advanced age” and “type 2 diabetes”. Only English-language studies were considered.

Inclusion Criteria

Eligible studies were RCTs evaluating GLP-1 RAs in patients with T2DM aged ≥ 65 years. Interventions included GLP-1 RA monotherapy, with placebo or another comparator as the control.

Exclusion Criteria

Studies were excluded if they were duplicate publications, involved non-T2DM patients (eg., type 1 diabetes), were protocols, abstracts, reviews, animal studies, or had methodological flaws, such as mismatched interventions or incomplete data.

Quality Assessment and Data Extraction

Two authors (X.C. and X.W.) independently screened studies and extracted data, disagreements were resolved with a third reviewer (W.G.). Extracted CV outcomes included MACE, CV death, non-fatal stroke and non-fatal myocardial infarction (MI). Safety outcomes included gastrointestinal adverse events (eg., diarrhea, nausea, vomiting).

Risk of bias was assessed independently by two reviewers (X.C. and X.W.) using the Cochrane Collaboration’s tool, covering seven domains: (1) random sequence generation, (2) allocation concealment, (3) blinding of participants and personnel, (4) blinding of outcome assessment, (5) incomplete outcome data, (6) selective reporting and (7) other bias. Disagreements were resolved by consensus with W.G. Inter-study heterogeneity was quantified using the I^2 statistic, with thresholds of $\leq 25\%$ (low), 26–50% (moderate) and $> 50\%$ (high). Subgroup interactions were tested using heterogeneity analysis, with $p < 0.05$ considered significant.

Statistical Analysis

All analyses were conducted using a random-effects model. Publication bias was assessed with funnel plots. Statistical analyses were performed using Review Manager (version 5.4.1).

Results

A total of 2,425 records were identified, of which 544 were duplicates. After screening titles and abstracts, 1,854 studies were excluded. Ultimately, five full-text articles (reporting six independent RCTs, including two from Yabe et al, 2022) comprising 8,889 patients were included. All studies were assessed as having a low risk of bias (Figure 1). The study selection process is illustrated in Figure 2.

The characteristics of the five included studies are presented in Table 1. All included studies were large RCTs designed for the general T2DM population, and all of them reported separate data for the subgroup of patients aged ≥ 65

| | Random sequence generation (selection bias) | Allocation concealment (selection bias) | Blinding of participants and personnel (performance bias) | Blinding of outcome assessment (detection bias) | Incomplete outcome data (attrition bias) | Selective reporting (reporting bias) | Other bias |
|--------------|---|---|---|---|--|--------------------------------------|------------|
| Gilbert 2018 | + | + | + | + | + | + | + |
| Gilbert 2024 | + | + | + | + | + | + | + |
| Leiter 2019 | + | + | + | + | + | + | + |
| Warren 2018 | + | + | + | + | + | + | + |
| Yabe 2022 | + | + | + | + | + | + | + |

Figure 1 Quality assessment (Cochrane risk of bias tool) for included randomized controlled trials.

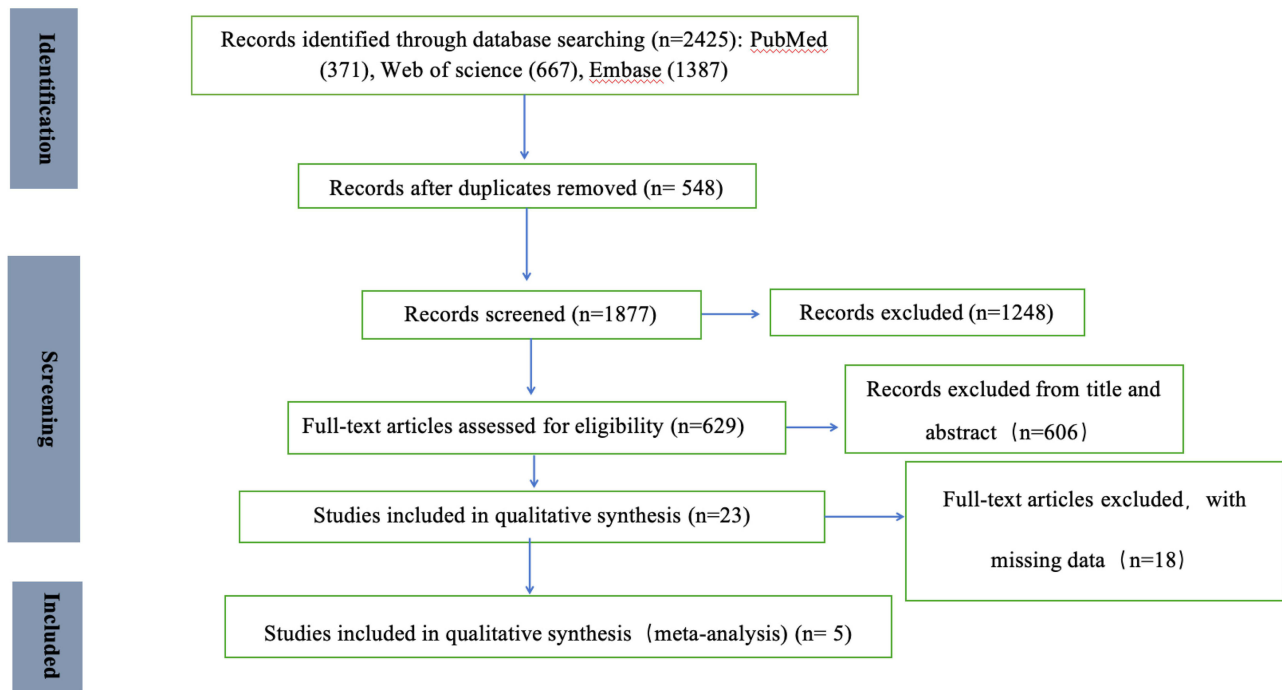


Figure 2 Flow diagram for study selection.

years. Semaglutide was investigated in three studies ($n=2,165$),^{16–18} liraglutide in one ($n=836$)¹⁹ and albiglutide in one ($n=5,888$)²⁰ of these, two studies reported results for patients ≥ 75 years.^{19,20}

CV Outcomes

GLP-1 RAs significantly reduced the risk of MACE by 21% compared with placebo (RR 0.79, 95% CI 0.70–0.90; $p = 0.0003$) and the risk of non-fatal MI by 25% (RR 0.75, 95% CI 0.62–0.91; $p = 0.003$). No heterogeneity was observed for either outcome ($I^2 = 0\%$; [Figure 3](#)). In contrast, no significant differences were observed for CV death (RR 0.86, 95% CI 0.69–1.07; $p = 0.17$) or non-fatal stroke (RR 0.91, 95% CI 0.70–1.18; $p = 0.49$), with $I^2 = 0\%$ for both endpoints ($I^2=0\%$; [Figure 3](#)).

Table 1 Characteristics of Included Studies

| Variables | Warren et al ¹⁶ 2018 | Gilbert et al ¹⁹ 2018 | Leiter et al ¹⁷ 2019 | Yabe et al ¹⁸ 2022 | | Gilbert et al ²⁰ 2024 |
|--------------------------------|------------------------------------|----------------------------------|------------------------------------|----------------------------------|-----------------------------|-------------------------------------|
| Drug | Semaglutide | Liraglutide | Semaglutide | Semaglutide | Semaglutide | Albiglutide |
| Comparator | Pooled controls | Placebo | Placebo | Sitagliptin | Additional OAD | Placebo |
| Administration route | Subcutaneous | Subcutaneous | Subcutaneous | Subcutaneous | Subcutaneous | Subcutaneous |
| Dose | 0.5mg/week or 1.0mg/week | 1.8mg/day | 0.5mg/week or 1.0mg/week | 0.5mg/week or 1.0mg/week | 0.5mg/week or 1.0mg/week | 30mg/week or 50mg/week |
| Total number of patients | 560 | 836 | 1418 | 67 | 120 | 5888 |
| Mean age (years) | 69.7 | 78.0 | 71.5 | 69.5 | 69.5 | 72.4 |
| Sex (%) | | | | | | |
| Female | 246 (43.9) | 304 (36.4) | NA | 12 (17.9) | 39 (32.5) | 1835 (31.1) |
| Male | 314 (56.1) | 532 (63.6) | NA | 55 (82.1) | 81 (67.5) | 4053 (68.9) |
| Mean BMI (kg/m ²) | 31.2 | 30.6 | 32.4 | 23.4 | 24.7 | NA |
| Mean diabetes duration (years) | 11.2 | 16.4 | 15.8 | 11.4 | 11.2 | NA |

Notes: Pooled controls: including placebo, sitagliptin, exenatide or insulin.

Abbreviations: OAD, oral antidiabetic drug; BMI, Body mass index.

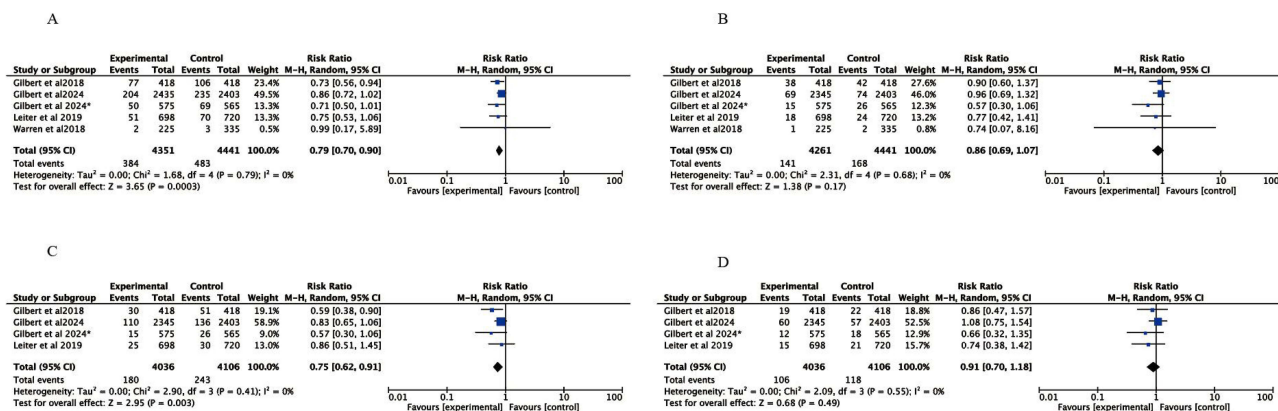


Figure 3 Forest plots of cardiovascular outcomes included in meta-analysis. *patients included aged ≥ 75 years; (A) Major adverse cardiovascular events; (B) Cardiovascular death; (C) non-fatal myocardial infarction; (D) non-fatal stroke.

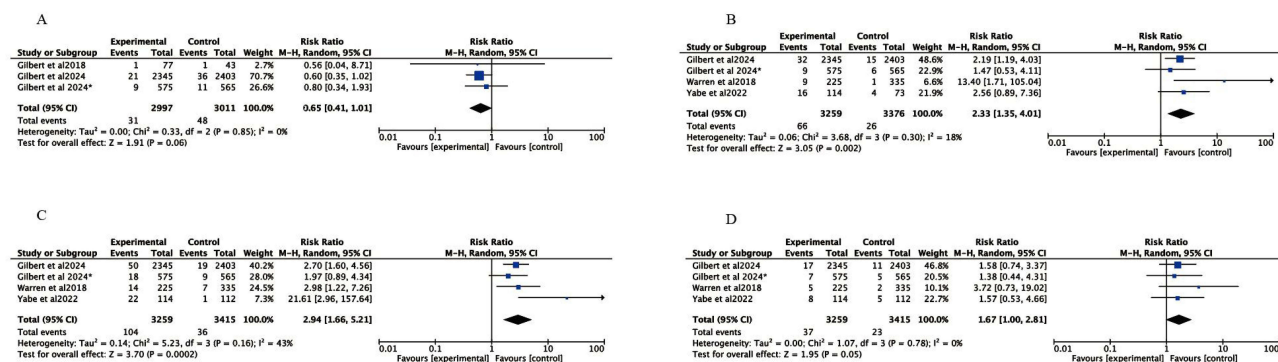


Figure 4 Forest plots of safety outcomes included in meta-analysis. *patients included aged ≥ 75 years; (A) Hypoglycemia; (B) Diarrhea; (C) Nausea; (D) Vomiting.

Safety Outcomes

There was no significant difference in the incidence of severe hypoglycemia between GLP-1 RAs and placebo (RR 0.65, 95% CI 0.41–1.01; $p = 0.06$; $I^2 = 0\%$; Figure 4). However, GLP-1 RAs were associated with a higher risk of diarrhea (RR 2.33, 95% CI 1.35–4.01; $p = 0.002$) and nausea (RR 2.94, 95% CI 1.66–5.21; $p = 0.0002$). The risk of vomiting was not significantly different, though it approached statistical significance (RR 1.67, 95% CI 1.00–2.81, $p = 0.05$).

Discussion

Incretin based therapies, such as the GLP-1 RAs, represent a major advancement in T2DM treatment. In the present meta-analysis, we analyzed 6 randomized control trials, including 8,889 participants. The analysis was designed to compare the efficacy of cardiovascular outcomes and safety of GLP-1 RAs in older adults living with diabetes.

Compared to placebo, GLP-1 RAs significantly reduced the risk of MACE and non-fatal MI, confirming the benefit of GLP-1 RAs on cardiovascular outcomes in elderly patients with T2DM. These findings align with a recent network meta-analysis by Lin et al, which reported greater reductions in MACE among patients aged >65 years.²¹ GLP-1 RAs and their cardioprotective effects have been a topic of interest ever since their introduction in 2005.⁸ This effect is attributed to its potential systemic anti-inflammatory properties, with its clinical significance deemed to extend far beyond mere hypoglycemia efficacy. GLP-1 RAs lower inflammatory biomarkers that are closely associated with CV risk, including interleukin-6, tumor necrosis factor- α , and c-reactive protein.²²

However, in this meta-analysis, we found no significant effect of GLP-1 RAs on non-fatal stroke or CV death. This contrasts with some prior reports suggesting benefit in these outcomes. A network meta-analysis conducted by Fei et al, GLP-1 RA drugs showed a significant reduction in the incidence of stroke²³ Another meta-analysis including 87,000

patients found that GLP-1 RA was associated with a low risk of CV death.²⁴ Notably, no dedicated subgroup analysis was performed for the elderly population in either study. Therefore, more high-quality studies specifically targeting elderly patients with diabetes are warranted.

With regard to safety, hypoglycemia is one of the most adverse events (AEs) related to glucose-lowering medications in patients with diabetes. It is a leading cause of hospital admissions and emergency department visits in older adults aged 65 years and older.^{25,26} The risk of hypoglycemia is a critical consideration in the management of T2DM. In our analysis, GLP-1 RAs did not significantly increase the risk of severe hypoglycemia compared with controls, supporting their safety profile in this regard.

Meanwhile, important gastrointestinal adverse events (nausea, vomiting, and diarrhea) warrant mention. These typically occur within the first month of treatment and often diminish thereafter.²⁷ Indeed, the side effects were the reasons most commonly reported for discontinuing GLP-1 RAs, which occurs in about 5% of patients.²⁸ Gastrointestinal AEs are thought to result from delayed gastric emptying and activation of neural pathways.²⁹ Our analysis demonstrated that GLP-1 RAs significantly increased the risk of diarrhea and nausea, consistent with previous studies.^{30–32} Regarding vomiting, our meta-analysis revealed a trend toward a higher incidence in the GLP-1 RAs group compared with controls. However, the magnitude of risk from vomiting is smaller than that observed for nausea and diarrhea. Thus, GLP-1 RAs may have a weak association with vomiting symptoms in elderly patients with T2DM.

This study has several limitations. First, only a small number of eligible trials met the inclusion criteria. Although most landmark RCTs do not exclude elderly patients, efficacy and safety outcomes for this subgroup are rarely reported, resulting in only five studies being included out of 2,425 screened. Second, all included data were derived from post hoc analyses, which may not fully reflect the baseline characteristics or prespecified outcomes of the original trials. Therefore, a large randomized, controlled, clinically comparative trials focusing on elderly populations are warranted.

Conclusion

In conclusion, GLP-1 RAs have demonstrated additional cardiovascular benefits among elderly patients with T2DM. However, gastrointestinal AEs remain a concern and should be closely monitored to guide individualized treatment decisions.

Data Sharing Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

The Ethics Committee of Hangzhou Third People's Hospital deemed that this research is based on open-source data, so the need for ethics approval was waived.

Author Contributions

Weifei Gao: Conceptualization, Methodology, Formal Analysis, Writing – original draft; Xiaoming Cai: Methodology, Writing – Review & Editing; Xiaolu Wang: Formal Analysis, Writing – original draft; Peng Li: Conceptualization, Supervision, Resources, Writing – Review & Editing, Validation. All authors gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests.

References

- Genitsaridi I, Salpea P, Salim A, et al. 11th edition of the IDF Diabetes Atlas: global, regional, and national diabetes prevalence estimates for 2024 and projections for 2050. *Lancet Diabetes Endocrinol.* 2026;14(2):149–156. doi:10.1016/S2213-8587(25)00299-2
- Gado K, Tabak GA, Vingender I, Domjan G, Dornyei G. Treatment of type 2 diabetes mellitus in the elderly - Special considerations. *Physiol Int.* 2024;111(2):143–164. doi:10.1556/2060.2024.00317
- Yang X, Xue C, Chen K, Gao D, Wang H, Tang C. Characteristics of elderly diabetes patients: focus on clinical manifestation, pathogenic mechanism, and the role of traditional Chinese medicine. *Front Pharmacol.* 2023;14:1339744. doi:10.3389/fphar.2023.1339744
- MacConell L, Gurney K, Malloy J, Zhou M, Kolterman O. Safety and tolerability of exenatide once weekly in patients with type 2 diabetes: an integrated analysis of 4,328 patients. *Diabetes Metab Syndr Obes.* 2015;8:241–253. doi:10.2147/DMSO.S77290
- Mehta A, Marso SP, Neeland IJ. Liraglutide for weight management: a critical review of the evidence. *Obes Sci Pract.* 2017;3(1):3–14. doi:10.1002/osp4.84
- Watanabe JH, Kwon J, Nan B, Reikes A. Trends in glucagon-like peptide 1 receptor agonist use, 2014 to 2022. *J Am Pharm Assoc.* 2024;64(1):133–138. doi:10.1016/j.japh.2023.10.002
- Siniukovich A, Travlos CK, Freedman S, Mavrakanas TA, Gariani K. Impact of GLP-1 receptor agonist-based therapies on cardiovascular and renal outcomes in diabetic and non-diabetic patients with CKD. *Diabetol Metab Syndr.* 2025;17(1):247. doi:10.1186/s13098-025-01831-4
- Rahman A, Alqaisi S, Saith SE, Alzakhari R, Levy R. The Impact of Glucagon-Like Peptide-1 Receptor Agonist on the Cardiovascular Outcomes in Patients With Type 2 Diabetes Mellitus: a Meta-Analysis and Systematic Review. *Cardiol Res.* 2023;14(4):250–260. doi:10.14740/cr1523
- Giugliano D, Scappaticcio L, Longo M, et al. GLP-1 receptor agonists and cardiorenal outcomes in type 2 diabetes: an updated meta-analysis of eight CVOIs. *Cardiovasc Diabetol.* 2021;20(1):189. doi:10.1186/s12933-021-01366-8
- Verma S, Bhatt DL, Bain SC, et al. Effect of Liraglutide on Cardiovascular Events in Patients With Type 2 Diabetes Mellitus and Polyvascular Disease: results of the LEADER Trial. *Circulation.* 2018;137(20):2179–2183. doi:10.1161/CIRCULATIONAHA.118.033898
- Dagenais GR, Ryden L, Leiter LA, et al. Total cardiovascular or fatal events in people with type 2 diabetes and cardiovascular risk factors treated with dulaglutide in the REWIND trial: a post hoc analysis. *Cardiovasc Diabetol.* 2020;19(1):199. doi:10.1186/s12933-020-01179-1
- American Diabetes Association Professional Practice Committee for D. Pharmacologic Approaches to Glycemic Treatment: standards of Care in Diabetes-2026. *Diabetes Care.* 2026;49(Supplement_1):S183–S215. doi:10.2337/dc26-S009.
- Kuang J, Zhu J, Liu S, Li Q. Efficacy and Safety of Once-Weekly Dulaglutide in Elderly Chinese Patients with Type 2 Diabetes: a Post Hoc Analysis of AWARD-CHN Studies. *Diabetes Ther.* 2020;11(10):2329–2339. doi:10.1007/s13300-020-00910-1
- Klein KR, Clemmensen KKB, Fong E, Olsen S, Abrahamsen T, Lingvay I. Occurrence of Gastrointestinal Adverse Events Upon GLP-1 Receptor Agonist Initiation With Concomitant Metformin Use: a Post Hoc Analysis of LEADER, STEP 2, SUSTAIN-6, and PIONEER 6. *Diabetes Care.* 2024;47(2):280–284. doi:10.2337/dc23-1791
- Bonikowska I, Szwamel K, Uchmanowicz I. Adherence to Medication in Older Adults with Type 2 Diabetes Living in Lubuskie Voivodeship in Poland: association with Frailty Syndrome. *J Clin Med.* 2022;11(6):1707. doi:10.3390/jcm11061707
- Warren M, Chaykin L, Trachtenberg D, Nayak G, Wijayasinghe N, Cariou B. Semaglutide as a therapeutic option for elderly patients with type 2 diabetes: pooled analysis of the SUSTAIN 1–5 trials. *Diabetes Obes Metab.* 2018;20(9):2291–2297. doi:10.1111/dom.13331
- Leiter LA, Bain SC, Hramiak I, et al. Cardiovascular risk reduction with once-weekly semaglutide in subjects with type 2 diabetes: a post hoc analysis of gender, age, and baseline CV risk profile in the SUSTAIN 6 trial. *Cardiovasc Diabetol.* 2019;18(1):73. doi:10.1186/s12933-019-0871-8
- Yabe D, Yamada Y, Kaku K, Nishida T, Sato T, Seino Y. Efficacy and safety of once-weekly semaglutide in Japanese individuals with type 2 diabetes by baseline age and body mass index. *J Diabetes Investig.* 2022;13(7):1161–1174. doi:10.1111/jdi.13773
- Gilbert MP, Bain SC, Franek E, et al. Effect of Liraglutide on Cardiovascular Outcomes in Elderly Patients: a Post Hoc Analysis of a Randomized Controlled Trial. *Ann Intern Med.* 2019;170(6):423–426. doi:10.7326/M18-1569
- Gilbert MP, Skelly J, Hernandez AF, et al. Effect of albiglutide on cardiovascular outcomes in older adults: a post hoc analysis of a randomized controlled trial. *Diabetes Obes Metab.* 2024;26(5):1714–1722. doi:10.1111/dom.15479
- Lin DS, Lee JK, Hung CS, Chen WJ. The efficacy and safety of novel classes of glucose-lowering drugs for cardiovascular outcomes: a network meta-analysis of randomised clinical trials. *Diabetologia.* 2021;64(12):2676–2686. doi:10.1007/s00125-021-05529-w
- Ngabea MA, Dimeji IY. GLP-1 receptor agonists and inflammatory pathway modulation: dual targeting of metabolic and immune dysfunction in insulin resistance. *Biochem Biophys Res Commun.* 2025;789:152822. doi:10.1016/j.bbrc.2025.152822
- Fei Y, Tsoi MF, Cheung BMY. Cardiovascular outcomes in trials of new antidiabetic drug classes: a network meta-analysis. *Cardiovasc Diabetol.* 2019;18(1):112. doi:10.1186/s12933-019-0916-z
- Siddiqi TJ, Khan MS, Waqas SA, et al. Effect of glucagon-like peptide-1 receptor agonists on heart failure outcomes and cardiovascular death across varying cardiovascular-kidney-metabolic comorbidity. *Eur J Heart Fail.* 2025;27(12):2844–2854. doi:10.1002/ehf.70048
- Grajower MM. Hypoglycemia in the Elderly with Diabetes: a Growing Problem with Emerging Solutions. *Endocr Pract.* 2018;24(3):312–314. doi:10.4158/EP-2017-0182
- Wondimkun YA, Caughey GE, Inacio MC, et al. Factors Associated With Hospitalization for Hypoglycemia and Hyperglycemia Among Older People in Long-Term Care Facilities. *J Am Geriatr Soc.* 2025;73(9):2859–2867. doi:10.1111/jgs.19553
- Liu L, Chen J, Wang L, Chen C, Chen L. Association between different GLP-1 receptor agonists and gastrointestinal adverse reactions: a real-world disproportionality study based on FDA adverse event reporting system database. *Front Endocrinol.* 2022;13:1043789. doi:10.3389/fendo.2022.1043789
- Prasad-Reddy L, Isaacs D. A clinical review of GLP-1 receptor agonists: efficacy and safety in diabetes and beyond. *Drugs Context.* 2015;4:212283. doi:10.7573/dic.212283
- Frazier RD, Hasler WL. Impact of GLP-1 receptor agonists on gastrointestinal function and symptoms. *Expert Rev Gastroenterol Hepatol.* 2025;19(11):1181–1195. doi:10.1080/17474124.2025.2579117
- Heimbürger SM, Bronden A, Johansen NJ, Dejgaard TF, Vilsboll T, Knop FK. The efficacy and safety of exenatide once weekly in patients with type 2 diabetes. *Expert Opin Pharmacother.* 2019;20(5):501–510. doi:10.1080/14656566.2019.1571040
- Zhou Y, Chen M, Liu L, Chen Z. Difference in Gastrointestinal Risk Associated with Use of GLP-1 Receptor Agonists: a Real-World Pharmacovigilance Study. *Diabetes Metab Syndr Obes.* 2022;15:155–163. doi:10.2147/DMSO.S348025
- Aldhaleei WA, Abegaz TM, Bhagavathula AS. Glucagon-like Peptide-1 Receptor Agonists Associated Gastrointestinal Adverse Events: a Cross-Sectional Analysis of the National Institutes of Health All of Us Cohort. *Pharmaceuticals.* 2024;17(2):199. doi:10.3390/ph17020199

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