



QUALITY IN SPORT

eISSN 2450-3118 · Open Access · Peer-reviewed

apcz.umk.pl/QS Nicolaus Copernicus University in Toruń



Cite as: BUZEK, Emilia, TOMASZEWSKA, Anna, KACZMAREK, Marcelina, POJAWA, Maria, CHUDZIK, Aleksandra, PRZĄDKA, Jagoda and WITKOWSKA, Wioletta. Beyond Pharmacology: Transitioning Off Incretin-Based Therapies and the Role of Lifestyle Interventions in Weight Maintenance. *Quality in Sport*. 2026;56:71975. <https://doi.org/10.12775/QS.2026.56.71975>

ARTICLE TIMELINE

Received: 16.05.2026 Revised: 20.05.2026

Accepted: 20.05.2026 Published: 24.05.2026

INDEXING & EVALUATION

MEiN points: 20 Unique ID: 201398

Disciplines: Economics & Finance; Management & Quality Sciences

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal Identifier: 201398. Scientific disciplines: Economics and Finance (Social Sciences); Management and Quality Sciences (Social Sciences).

Punkty Ministerialne z 2019 – aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych). © The Authors 2026.

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Beyond Pharmacology: Transitioning Off Incretin-Based Therapies and the Role of Lifestyle Interventions in Weight Maintenance

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Abstract Incretin-based therapies facilitate substantial weight loss; however, nearly 68% of patients discontinue treatment within the first year. When patients withdraw, they often regain weight quickly because their metabolism slows down from losing muscle, and their appetite increases, a problem

called "food noise." No standard clinical guidelines exist for this transition. This review aims to identify practical lifestyle interventions that support weight maintenance and health after cessation of these medications. A targeted literature search of PubMed/MEDLINE, Scopus, and Google Scholar was conducted. Through May 2026, we identified English-language, peer-reviewed studies on post-withdrawal metabolic changes, body composition, nutrition, and behavioral strategies. The problem of preventing weight regain calls for structured clinical transition strategies. A balanced, eucaloric diet is preferred. Studies suggest that dietary interventions can help patients, as sufficient protein intake supports energy expenditure. Progressive resistance training is critical for restoring muscle mass, which frequently declines during active weight reduction. The active treatment phase should be used to establish long-lasting habits. Discontinuation of pharmacotherapy poses a significant challenge, as maintaining weight loss afterward can be extremely difficult for patients. If cessation is inevitable, the medical approach should integrate tailored nutrition, structured physical activity, and ongoing behavioral support.

Keywords: obesity, weight maintenance, GLP-1 receptor agonists, treatment discontinuation, lifestyle interventions, metabolic adaptation

Introduction

Obesity is still a major global health issue, contributing directly to cardiovascular disease and type 2 diabetes. Incretin-based therapies have recently transformed obesity management. Agents such as the GLP-1 receptor agonist semaglutide and the dual GIP/GLP-1 receptor agonist tirzepatide typically achieve weight loss of 15% to 20% or more. These results are comparable to those seen with bariatric surgery. Beyond their primary role in managing type 2 diabetes and obesity, GLP-1 therapies improve cardiovascular outcomes through lowering blood pressure and offer renal protection (Karaban et al. 2025). New multi-agonist drugs are currently nearing market approval.

Despite strong initial results, maintaining weight loss after stopping treatment is challenging. Up to 68% of patients discontinue GLP-1 RA therapy within the first year (Gleason et al. 2024). Common reasons for stopping include side effects, high costs, inconsistent insurance coverage (Di Dalmazi et al. 2022), or pregnancy planning. Most frequent side effects include gastrointestinal problems (e.g. nausea and vomiting) and more rare like cholelithiasis (mainly occurring due to rapid weight loss)

(Kasprzak et al. 2025). Access barriers frequently coincide with social and economic factors. White patients are more likely to receive GLP-1 prescriptions than Black and Hispanic patients, highlighting concerns about racial disparities in access to these medications (Kukhareva et al. 2024).

Unlike metabolic and bariatric surgery, incretin-based therapies must be taken continuously to maintain their effectiveness. Rapid weight regain is consistently documented across landmark trials—whether following the withdrawal of semaglutide (STEP 4 and STEP 1 extension) or the dual-agonist tirzepatide (SURMOUNT-4). It also ultimately results in the rapid reversal of initial cardiometabolic benefits (Rubino et al. 2021; Wilding et al. 2022; Aronne et al. 2024). According to a recent study by Tajerian and colleagues, adults with overweight or obesity who stopped GLP-1 receptor agonist treatment within one year faced higher long-term risks of coronary artery disease and heart failure when compared to those who continued the medication for at least a year (Tajerian et al. 2026). Pharmacokinetic models can precisely predict the pattern and time of relapse (Budini et al. 2026). Real-world data prove the high probability of weight regain. The data underscore the need for long-term treatment or, when this is not possible, structured transition plans (Hall and Kahan 2018; Wharton et al. 2020; Ard et al. 2021; Tchang et al. 2021; Abdel-Bary et al. 2025).

Ceasing pharmacotherapy triggers a neuroendocrine rebound. Patients undergo reduced resting metabolic rate, mainly due to loss of lean body mass. The metabolic slowdown is accompanied by higher ghrelin levels and lower leptin sensitivity, leading to a return of "food noise," or persistent food cravings and overeating (Mudaliar and Henry 2012; Polidori et al. 2016, Janik et al. 2026). As there are no uniform protocols for the post-incretin transition, this review aims to identify practical lifestyle approaches to reduce weight regain and assess whether the existing data support their reliability.

Review

Review methods

We performed a literature examination using PubMed/MEDLINE, Scopus, and Google Scholar. Search phrases included "GLP-1 receptor agonists," "treatment discontinuation," "weight regain," "metabolic adaptation," "lean body mass," and "resistance training." Inclusion criteria were restricted to English-language peer-reviewed articles, clinical trial extension data (like STEP and SURMOUNT studies), and specified guidelines. Limitations of the studies' literature include a restricted number of long-term studies on lifestyle interventions applied at the end of therapy, so the main sources were

studies on weight-maintenance techniques, lean body mass maintenance, and the psychology of patients who need to withdraw from therapy.

Pathophysiology of weight regain and metabolic adaptation

Pharmacologically, incretin-based therapies cause weight loss by delaying gastric emptying, modulating glucose-dependent insulin secretion, and decreasing central appetite signaling. While these medications create a favorable window for mass reduction, abrupt cessation of treatment deactivates receptors (Müller et al. 2019).

According to a systematic review, some evidence suggests that GLP-1 receptor agonists can reduce brain responses to food cues in appetite and reward regions, but these effects are inconsistent and may diminish over time. This elevated appetite is worsened by ongoing metabolic changes (Dang et al. 2026). Weight loss during therapy often includes significant lean tissue loss (Gabery et al. 2020). After stopping treatment, most of the regained weight is fat, which further lowers resting metabolic rate and increases the risk of sarcopenic obesity. Loss of anti-inflammatory effects may also diminish cognitive control, making patients more prone to stress eating (Cava et al. 2017). Inflammation in enlarged fat tissue can trigger insulin resistance (Hotamisligil 2017; Saltiel and Olefsky 2017).

Multi-domain strategies for weight maintenance

Although nutritional counseling is important, many clinicians receive limited nutrition training during their education (Devries et al. 2017). For instance, up to approximately 90% of cardiologists report receiving no nutrition education during their fellowship training. The active treatment phase provides a window during which cravings for ultra-processed foods are reduced. Clinicians should use this period to help patients build lasting habits (Kukhareva et al. 2024). They should provide patients with a safe and empathetic environment to build trust and increase the adherence to lifestyle recommendations (Janik et al. 2026).

Studies advise against strict calorie restriction during withdrawal, as severe diets can trigger hormonal changes that increase hunger (MacLean et al. 2011). Gradual dose titration is critical to minimize the gastrointestinal adverse effects—primarily nausea and constipation—that remain the leading drivers of premature medication discontinuation. A practical nutritional transition should focus on a balanced, eucaloric diet. Clinicians should prioritize monitoring and, if necessary, supplementation of micronutrients frequently compromised during rapid weight loss, specifically vitamin B12, iron, and

vitamin D. Patients' diets should be advised to maintain adequate intake of high-quality protein to support metabolic health. Meals should be rich in functional fibers (MacLean et al. 2011; Pasiakos et al. 2013). Viscous soluble fibers form a gel that slows gastric emptying and enhances satiety through vagal signaling (Lattimer and Haub 2010; Wanders et al. 2011). In addition, physical activity and behavioral strategies must shift from a focus on further weight reduction toward weight maintenance, emphasizing muscle preservation and the consolidation of healthy habits.

As there are no particular diets clinically proven to be best for patients after incretin cessation, the best option to help them prevent symptom recurrence seems to be a diet that mimics the action of incretins (Feltrin et al. 2004; Zhao et al. 2018). For instance, the intake of monounsaturated fatty acids (MUFAs, such as extra virgin olive oil or avocado) triggers an early satiety signal in the duodenum (Feltrin et al. 2004). Also, dietary fiber and microbiota-accessible carbohydrates (MACs, highly concentrated in oats and legumes) undergo sequential fermentation in the colon, stimulating local L-cells. The cells produce endogenous GLP-1 and PYY secretion via the vagus nerve (Chambers et al. 2015; Zhao et al. 2018). Given the current lack of long-term clinical trials on these specific nutritional recommendations, any recommendations should be applied with flexibility, in shared decision-making, and in adherence to standard principles of obesity management.

Clinical targets during the post-discontinuation phase and active treatment are detailed in Table 1, below:

Table 1. Strategic comparison of targeted clinical parameters over active incretin pharmacotherapy versus the structured post-discontinuation "off-ramp" phase.

Clinical Domain & Parameter	Active Incretin Treatment Phase	Post-Cessation Transition ("Off-Ramp") Strategy
Nutritional Architecture	Hypocaloric deficit (typically a 16% to 39%)	Adjusted eucaloric framework; strict avoidance of aggressive deficits to prevent orexigenic surges (MacLean et al. 2011).

	reduction) (Kukhareva et al. 2024).	
	Managing GI intolerance via titration; using suppressed appetite to introduce sustainable habits (Di Dalmazi et al. 2022; Kukhareva et al. 2024).	Protein Pacing: Targeted intake of 1.2 to 1.6 g/kg/day (IBW or LBM) to defend baseline RMR (Arciero et al. 2013; Lundgren et al. 2021; Kukhareva et al. 2024).
	Micronutrients: Routine laboratory monitoring and targeted supplementation (Kukhareva et al. 2024).	Gut-Brain Axis Support: Integration of viscous soluble fibers (Lattimer and Haub 2010; Wanders et al. 2011); consumption of MUFAs and MACs (Feltrin et al. 2004; Chambers et al. 2015; Zhao et al. 2018); low-glycemic-load designs (Ludwig and Ebbeling 2018).
Physical Conditioning	Physical activity to actively preserve skeletal muscle mass during rapid hypocaloric weight reduction (Mitoiu et al. 2024; Kukhareva et al. 2024).	Prescribed progressive resistance exercises (Mitoiu et al. 2024).

	<p>Diagnostics: Utilizing baseline and periodic evaluations with advanced modalities (DXA or BIA) (Kukhareva et al. 2024).</p>	<p>Physiological Goal: Restore peripheral metabolic flexibility and desired systemic insulin sensitivity (Beavers et al. 2017; Mitoiu et al. 2024).</p>
	<p>Close monitoring to detect rapid degradation of functional lean tissue (Gabery et al. 2020).</p>	<p>Continuous monitoring to prevent sarcopenic obesity and preferential fat regain.</p>
<p>Behavioral Support</p>	<p>Behavioral Automation: Using the therapeutic window to establish core self-monitoring skills (Gokey-Larose et al. 2009).</p>	<p>Paradigm Shift: Deliberate operational transition from weight reduction regimens to maintenance protocols.</p>
	<p>Implementing Intensive Behavioral Therapy (IBT), if needed, to construct foundational self-regulation routines (Gokey-Larose et al. 2009; Kukhareva et al. 2024).</p>	<p>Psychosocial Buffering: Integration of emotion regulation strategies and body image support (Gokey-Larose et al. 2009; Heitmann 2025).</p>

	<p>Pre-Cessation Screening: Systematic implementation of inventories (BES, PHQ-9) to identify emotional eating risk (Gokee-Larose et al. 2009).</p>	<p>Routine psychological check-ins to monitor for recurrence of cravings or distress.</p>
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Abbreviations: GI, gastrointestinal; IBW, ideal body weight; LBM, lean body mass; RMR, resting metabolic rate; MUFAs, monounsaturated fatty acids; MACs, microbiota-accessible carbohydrates; DXA, dual-energy X-ray absorptiometry; BIA, bioelectrical impedance analysis; IBT, intensive behavioral therapy; BES, Binge Eating Scale; PHQ-9, Patient Health Questionnaire-9.

Behavioral and physical preservation

Gokee-Larose et al. point out the importance of using the period of reduced appetite during treatment to establish self-regulation techniques, such as control skills (Gokee-Larose et al. 2009). Cognitive Behavioral Therapy for Obesity (CBT) provides tools to manage “emotional noise”, which is a tendency to regulate emotions with eating. It helps patients understand their food craving and work on new habits. CBT seems to reduce the risk of relapse to compulsive eating after losing weight (Janik et al. 2026). Social stigma related to GLP-1 use increases psychological stress. Patients report being judged for using medication and, consequently, for regaining weight (Heitmann 2025). Behavioral coaching should shift from weight loss strategies to maintenance, as shown in Table 1.

Physical exercises seem to provide a helpful tool during incretin cessation. Independent, long-term exercise programs have proven highly effective in significantly improving body composition and preventing abdominal obesity in overweight middle-aged women (Andrieieva and Nahorna 2020). Using physical activity programs can reduce the energy expenditure gap and reduce the “food noise” (Janik et al. 2026). Combining pharmacotherapy with exercise during incretin treatment is associated with better long-term outcomes than medication alone (Beavers et al. 2017; Lundgren et al. 2021; Reizer et al. 2026). Patients who used both regained less weight after GLP-1 discontinuation (Zdziebkowski et al. 2025). Finding strictly recommended types of exercises to combine with incretin

therapy is still under the investigation (Łupina-Romaniuk et al. 2026), however, e.g. resistance lowers ghrelin and leptin levels (Mitoiu et al. 2024).

Patients during GLP-1 therapy report better quality of life and improved physical functioning (Łupina-Romaniuk et al. 2026). However, according to a recent systematic review, lean mass loss comprises approximately 25% of the total weight loss associated with incretin therapies. While tirzepatide and semaglutide are the most effective for fat mass reduction, they are also associated with a significant reduction in lean mass (Karakasis et al. 2025). This highlights that BMI alone does not provide a complete picture; advanced methods of assessing body composition are necessary. Reduced lean mass lowers energy expenditure and increases the risk of frailty (Batsis and Villareal 2018; Prado et al. 2018; Mitoiu et al. 2024).

Transitional pharmacotherapy and digital health

Alternative transition strategies can facilitate managing neuroendocrine rebound. Instead of sudden discontinuation, transitioning off GLP-1 therapies can be optimized through gradual dose tapering or extending dosing intervals to establish the lowest effective dose. Rotating to alternative oral agents or utilizing low-dose combination therapies (GLP-1 with SGLT2 inhibitors or centrally acting appetite suppressants) may mitigate the hormonal rebound and minimize weight regain (Babik et al. 2026). Sequential use of older oral agents seems to be a viable bridge (Garber et al. 2020; Davies et al. 2022). Different medications are also being studied for their ability to maintain weight loss (Srivastava and Apovian 2018). Digital applications that combine personalized meals with coaching apps provide scalable alternatives to long-term medication use (Patel et al. 2015).

Summary

In real-world settings, few patients maintain GLP-1 RA treatment, and many experience weight regain within a year of discontinuation. To reduce relapse, clinicians should implement a structured transition plan that combines initial pharmacotherapy with ongoing education in self-regulation, physical activity, and personalized nutrition. Recommended strategies include initiating resistance training during treatment to preserve lean mass, gradually adjusting dietary macronutrient composition, and regularly assessing for psychological barriers. Healthcare agencies and policymakers should address barriers to healthy food and medical care to improve long-term outcomes and reduce health disparities. This review highlights the need for additional clinical trials to evaluate lifestyle protocols following

medication discontinuation. Nonetheless, emerging anti-obesity treatments appear promising. In the future, more effective, affordable, and widely accessible medications may eliminate the need for discontinuation, enabling lifelong metabolic health management.

Disclosure

Author's contribution Conceptualization, EB and AT; methodology, EB and MK; investigation, MP, AC, JP and WW; resources, EB; writing - rough preparation, EB, AT, MK and MP; writing - review and editing, AC, JP and WW; visualization, AT; supervision, EB. All authors have read and agreed with the published version of the manuscript.

Funding Statement This research received no external funding.

Institutional Review Board Statement Not applicable.

Informed Consent Statement Not applicable.

Data Availability Statement Data sharing is not applicable to this article as no new data were created or analyzed in this study.

Acknowledgments Not applicable.

Conflict of Interest Statement The authors declare no conflict of interest.

References

1. Abdel-Bary M, Brody A, Schmitt J, Prieto K, Wetzel A, Juo YY. Real-world weight change pattern after glucagon-like peptide-1 receptor agonist discontinuation: a 1-year observational study. *Obesity Medicine*. 2025;100658. <https://doi.org/10.1016/j.obmed.2025.100658>
2. Andrieieva O, Nahorna A. Evaluation of the effectiveness of the program of independent preventive and health-enhancing exercise classes for middle-aged overweight women. *Pedagogy and Psychology of Sport*. 2020;6(4):36-44. <https://doi.org/10.12775/PPS.2020.06.04.004>
3. Arciero PJ, Ormsbee MJ, Gentile CL, Nindl BC, Brestoff JR, Ruby M. Increased protein intake and meal frequency reduces abdominal fat during energy balance and energy deficit. *Obesity*. 2013;21(7):1357-1366. <https://doi.org/10.1002/oby.20296>

4. Ard JD, Fitch A, Fruh S, Herman L. Weight loss and maintenance related to the mechanism of action of glucagon-like peptide 1 receptor agonists. *Adv Ther.* 2021;38(6):2821-2839. <https://doi.org/10.1007/s12325-021-01710-0>
5. Aronne LJ, Sattar N, Horn DB, Bays HE, Wharton S, Lin WY, Ahmad NN, Zhang S, Liao R, Bunck MC, Jouravskaya I, Murphy MA. Continued treatment with tirzepatide for maintenance of weight reduction in adults with obesity: the SURMOUNT-4 randomized clinical trial. *JAMA.* 2024;331(1):38-48. <https://doi.org/10.1001/jama.2023.24945>
6. Babik K, Bartkowska O, Banatkiewicz J, Deka E, Domińczak J, Czarnecka S, Łuczyńska G, Dobosz A, Wojnowski A, Bojanowska HM. Metabolic Adaptation and Weight Regain Phenomenon After Cessation of GLP-1 Analogue Pharmacotherapy – A Review of Preventive Strategies. *Journal of Education, Health and Sport.* 2026;90:70450. <https://doi.org/10.12775/JEHS.2026.90.70450>
7. Batsis JA, Villareal DT. Sarcopenic obesity in older adults: aetiology, epidemiology and treatment strategies. *Nat Rev Endocrinol.* 2018;14(9):513-537. <https://doi.org/10.1038/s41574-018-0062-9>
8. Beavers KM, Ambrosius WT, Rejeski WJ, Burdette JH, Walkup MP, Sheedy JL, Nesbit BA, Gaukstern JE, Nicklas BJ, Marsh AP. Effect of exercise type during intentional weight loss on body composition in older adults with obesity. *Obesity (Silver Spring).* 2017;25(11):1823-1829. <https://doi.org/10.1002/oby.21977>
9. Budini B, Luo S, Tam M, Stead I, Lee A, Akrami A, Vidal-Puig A, Park A. Trajectory of weight regain after cessation of GLP-1 receptor agonists: a systematic review and nonlinear meta-regression. *EClinicalMedicine.* 2026;93:103796. <https://doi.org/10.1016/j.eclinm.2026.103796>
10. Cava E, Yeat NC, Mittendorfer B. Preserving healthy muscle during weight loss. *Adv Nutr.* 2017;8(3):511-519. <https://doi.org/10.3945/an.116.014506>
11. Chambers ES, Viardot A, Psichas A, Morrison DJ, Murphy KG, Zac-Varghese SEK, MacDougall K, Preston T, Tedford C, Finlayson GS, Blundell JE, Bell JD, Thomas EL, Mt-Isa S, Ashby D, Gibson GR, Kolida S, Dhillo WS, Bloom SR, Morley W, Clegg S, Frost G. Effects of targeted delivery of propionate to the human colon on appetite regulation, body weight maintenance and adiposity in overweight adults. *Gut.* 2015;64(11):1744-1754. <https://doi.org/10.1136/gutjnl-2014-307913>

12. Dang V, Sambuco N, Yammine L, Versace F. Do GLP-1 receptor agonists alter brain responses to reward-related cues? A systematic review. *bioRxiv*. 2026;2026.01.31.702984. <https://doi.org/10.64898/2026.01.31.702984>
13. Davies MJ, Aroda VR, Collins BS, Gabbay RA, Green J, Maruthur NM, Rosas SE, Del Prato S, Mathieu C, Mingrone G, Rossing P, Tankova T, Tsapas A, Buse JB. Management of hyperglycemia in type 2 diabetes, 2022. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care*. 2022;45(11):2753-2786. <https://doi.org/10.2337/dci22-0034>
14. Devries S, Agatston A, Aggarwal M, Aspary KE, Esselstyn CB, Kris-Etherton P, Miller M, O'Keefe JH, Ros E, Rzeszut AK, White BA, Williams KA, Freeman AM. A deficiency of nutrition education and practice in cardiology. *Am J Med*. 2017;130(11):1298-1305. <https://doi.org/10.1016/j.amjmed.2017.04.043>
15. Di Dalmazi G, Coluzzi S, Baldassarre MPA, Ghit A, Graziano G, Rossi MC, Ciappini B, Milo M, Carrieri F, Nicolucci A, Consoli A, Formoso G. Effectiveness and tolerability of once-weekly GLP-1 receptor agonists in clinical practice: a focus on switching between once-weekly molecules in type 2 diabetes. *Front Endocrinol (Lausanne)*. 2022;13:892702. <https://doi.org/10.3389/fendo.2022.892702>
16. Feltrin KL, Little TJ, Meyer JH, Horowitz M, Smout AJPM, Wishart J, Pilichiewicz AN, Rades T, Chapman IM, Feinle-Bisset C. Effects of intraduodenal fatty acids on appetite, antropyloroduodenal motility, and plasma CCK and GLP-1 in humans vary with their chain length. *Am J Physiol Regul Integr Comp Physiol*. 2004;287(3):R524-R533. <https://doi.org/10.1152/ajpregu.00039.2004>
17. Gabery S, Salinas CG, Paulsen SJ, Ahnfelt-Rønne J, Alanentalo T, Baquero AF, Buckley ST, Farkas E, Fekete C, Frederiksen KS, Hogendorf WFJ, Helms HCC, Jeppesen JF, John LM, Pyke C, Nøhr J, Lu TT, Poley-Wolf J, Prevot V, Raun K, Simonsen L, Sun G, Szilvasy-Szabo A, Willenbrock H, Secher A, Knudsen LB. Semaglutide lowers body weight and food intake via targeting appetite and reward centers in the brain. *JCI Insight*. 2020;5(11):e133429. <https://doi.org/10.1172/jci.insight.133429>
18. Garber AJ, Handelsman Y, Grunberger G, Einhorn D, Abrahamson MJ, Barzilay JI, Blonde L, Bush MA, DeFronzo RA, Garber JR, Garvey WT, Hirsch IB, Jellinger PS, McGill JB, Mechanick JI, Perreault L, Rosenblit PD, Samson S, Umpierrez GE. Consensus statement by the American Association of Clinical Endocrinologists and American College of

- Endocrinology on the comprehensive type 2 diabetes management algorithm. *Endocr Pract.* 2020;26(1):107-139. <https://doi.org/10.4158/CS-2019-0472>
19. Gleason PP, Urick BY, Marshall LZ, Friedlander N, Qiu Y, Leslie RS. Real-world persistence and adherence to glucagon-like peptide-1 receptor agonists among obese commercially insured adults without diabetes. *Journal of Managed Care & Specialty Pharmacy.* 2024;30(8):860-867. <https://doi.org/10.18553/jmcp.2024.23332>
 20. Gokee-Larose J, Gorin AA, Wing RR. Behavioral self-regulation for weight loss in young adults: a randomized controlled trial. *Int J Behav Nutr Phys Act.* 2009;6:10. <https://doi.org/10.1186/1479-5868-6-10>
 21. Hall KD, Kahan S. Maintenance of lost weight and long-term management of obesity. *Med Clin North Am.* 2018;102(1):183-197. <https://doi.org/10.1016/j.mcna.2017.08.012>
 22. Heitmann BL. The Impact of Novel Medications for Obesity on Weight Stigma and Societal Attitudes: A Narrative Review. *Curr Obes Rep.* 2025;14(1):18. <https://doi.org/10.1007/s13679-025-00611-5>
 23. Hotamisligil GS. Inflammation, metaflammation and immunometabolic disorders. *Nature.* 2017;542(7640):177-185. <https://doi.org/10.1038/nature21363>
 24. Janik D, Sochocka A, Sikorska A, Mian E, Zapart Z, Szepietowska M, Nowicka N, Bundyra J, Gańska OZ, Parda J. Deciphering 'Food Noise' in the Era of GLP-1 Receptor Agonists: A Comprehensive Narrative Review of Neurobiological Mechanisms and Clinical Implications for Health Education. *Journal of Education, Health and Sport.* 2026;88:69532. <https://doi.org/10.12775/JEHS.2026.88.69532>
 25. Jastreboff AM, Aronne LJ, Ahmad NN, Wharton S, Connery L, Alves B, Kiyosue A, Zhang S, Liu B, Bunck MC, Stefanski A. Tirzepatide Once Weekly for the Treatment of Obesity. *N Engl J Med.* 2022;387(3):205-216. <https://doi.org/10.1056/NEJMoa2206038>
 26. Karaban Ł, Kuźnieców T, Paszkowska M, Mularczyk K, Borawski M, Ciuła A, Jakubiak A, Miśkiewicz J, Znamirska P, Kupis M. GLP-1 Receptor Agonists: Therapeutic Benefits in Renal Function, Cardiovascular Risk, and Physical Activity – A Systematic Review. *Quality in Sport.* 2025;41:60343. <https://doi.org/10.12775/QS.2025.41.60343>
 27. Karakasis P, Patoulias D, Fragakis N, Mantzoros CS. Effect of glucagon-like peptide-1 receptor agonists and co-agonists on body composition: Systematic review and network meta-analysis. *Metabolism.* 2025;156113. <https://doi.org/10.1016/j.metabol.2024.156113>

28. Kasprzak A, Kułaga M, Grzybek M, Mazur-Lesińska D, Szostak B, Wielgosz-Biała S, Tyszkiewicz K, Łozowski B, Kasprzak M, Wilczyńska B. Adverse effects of GLP-1 Receptor Agonists. *Journal of Education, Health and Sport*. 2025;78:57774. <https://doi.org/10.12775/JEHS.2025.78.57774>
29. Kukhareva PV, Facelli JC, O'Brien MJ, Gouripeddi R, Kawamoto K, Zhang Y, Reddy D, Malone DC. Racial and Ethnic Disparities in Prescribing of GLP-1 Receptor Agonists in the United States: A Retrospective Cohort Analysis. *medRxiv*. 2024;2024.10.28.24316312. <https://doi.org/10.1101/2024.10.28.24316312>
30. Lattimer JM, Haub MD. Effects of dietary fiber and its components on metabolic health. *Nutrients*. 2010;2(12):1266-1289. <https://doi.org/10.3390/nu2121266>
31. Ludwig DS, Ebbeling CB. The carbohydrate-insulin model of obesity: beyond "calories in, calories out". *JAMA Intern Med*. 2018;178(8):1098-1103. <https://doi.org/10.1001/jamainternmed.2018.2933>
32. Lundgren JR, Janus C, Jensen SBK, Juhl CR, Olsen LM, Christensen RM, Svane MS, Bandholm T, Bojsen-Møller KN, Blond MB, Jensen JEB, Stallknecht BM, Holst JJ, Madsbad S, Torekov SS. Healthy weight loss maintenance with exercise, liraglutide, or both combined. *N Engl J Med*. 2021;384(18):1709-1720. <https://doi.org/10.1056/NEJMoa2028198>
33. Łupina-Romaniuk M, Kołodziejczyk J, Pietrzak M, Chawryło A, Piecuch D, Oleksińska K, Świetlicka G, Pietraś P, Stolarczyk M, Pracon K. The Impact of GLP-1 Receptor Agonists on Physical Functioning and Quality of Life in Adults with Obesity: A Narrative Review. *Quality in Sport*. 2026;55:70903. <https://doi.org/10.12775/QS.2026.55.70903>
34. MacLean PS, Bergouignan A, Cornier MA, Jackman MR. Biology's response to dieting: the impetus for weight regain. *Am J Physiol Regul Integr Comp Physiol*. 2011;301(3):R581-R600. <https://doi.org/10.1152/ajpregu.00755.2010>
35. Mitoiu BI, Nartea R, Miclaus RS. Impact of Resistance and Endurance Training on Ghrelin and Plasma Leptin Levels in Overweight and Obese Subjects. *Int J Mol Sci*. 2024;25(15):8067. <https://doi.org/10.3390/ijms25158067>
36. Mudaliar S, Henry RR. The incretin hormones: from scientific discovery to practical therapeutics. *Diabetologia*. 2012;55:1865-1868. <https://doi.org/10.1007/s00125-012-2561-x>
37. Müller TD, Finan B, Bloom SR, D'Alessio D, Drucker DJ, Flatt PR, Fritsche A, Gribble F, Grill HJ, Habener JF, Holst JJ, Langhans W, Meier JJ, Nauck MA, Perez-Tilve D, Pocai A,

- Reimann F, Sandoval DA, Schwartz TW, Seeley RJ, Tschöp MH. Glucagon-like peptide 1 (GLP-1). *Mol Metab.* 2019;30:72-130. <https://doi.org/10.1016/j.molmet.2019.09.010>
38. Pasiakos SM, Cao JJ, Margolis LM, Sauter ER, Whigham LD, McClung JP, Rood JC, Carbone JW, Combs GF Jr, Young AJ. Effects of high-protein diets on fat-free mass and muscle protein synthesis following weight loss: a randomized controlled trial. *FASEB J.* 2013;27(9):3837-3847. <https://doi.org/10.1096/fj.13-230227>
39. Patel MS, Asch DA, Volpp KG. Wearable devices as facilitators, not drivers, of health behavior change. *JAMA.* 2015;313(5):459-460. <https://doi.org/10.1001/jama.2014.14781>
40. Polidori D, Sanghvi A, Seeley RJ, Hall KD. How strongly does appetite counter weight loss? Quantification of the feedback control of human energy intake. *Obesity (Silver Spring).* 2016;24(11):2289-2295. <https://doi.org/10.1002/oby.21653>
41. Prado CM, Purcell SA, Alish C, Pereira SL, Deutz NE, Heyland DK, Goodpaster BH, Tappenden KA, Heymsfield SB. Implications of low muscle mass across the continuum of care: a narrative review. *Ann Med.* 2018;50(8):675-693. <https://doi.org/10.1080/07853890.2018.1511918>
42. Reizer B, Botto Z, Krystek K, Felisiak P, Kowalczyk D, Śliwa Z, Ślęzyk DA. Semaglutide-Induced Weight Loss: Consequences for Muscle Mass and Functional Outcomes. *Journal of Education, Health and Sport.* 2026;88:68182. <https://doi.org/10.12775/JEHS.2026.88.68182>
43. Rubino D, Abrahamsson N, Davies M, Hesse D, Greenway FL, Jensen C, Lingvay I, Mosenzon O, Rosenstock J, Rubio MA, Rudofsky G, Tadayon S, Wadden TA, Dicker D. Effect of continued weekly subcutaneous semaglutide vs placebo on weight loss maintenance in adults with overweight or obesity: the STEP 4 randomized clinical trial. *JAMA.* 2021;325(14):1414-1425. <https://doi.org/10.1001/jama.2021.3224>
44. Saltiel AR, Olefsky JM. Inflammatory mechanisms linking obesity and metabolic disease. *J Clin Invest.* 2017;127(1):1-4. <https://doi.org/10.1172/JCI92035>
45. Srivastava G, Apovian CM. Current pharmacotherapy for obesity. *Nat Rev Endocrinol.* 2018;14(1):12-24. <https://doi.org/10.1038/nrendo.2017.122>
46. Tajerian A, Rahmani AR, Wong R, Skopicki H, Butler J, Kalogeropoulos A. One-year Heart Failure Outcomes On Glp1-ra Treatment And After Discontinuation: A Real-world Retrospective Cohort Study. *Journal of Cardiac Failure.* 2026;32(1):205-206. <https://doi.org/10.1016/j.cardfail.2025.11.082>

47. Tchang BG, Aras M, Wu A, Aronne LJ, Shukla AP. Long-term weight loss maintenance with obesity pharmacotherapy: a retrospective cohort study. *Obes Sci Pract.* 2021;8(3):320-327. <https://doi.org/10.1002/osp4.575>
48. Wanders AJ, van den Borne JJGC, de Graaf C, Hulshof T, Jonathan MC, Kristensen M, Mars M, Schols HA, Feskens EJM. Effects of dietary fibre on subjective appetite, energy intake and body weight: a systematic review of randomized controlled trials. *Obes Rev.* 2011;12(9):724-739. <https://doi.org/10.1111/j.1467-789X.2011.00895.x>
49. Wharton S, Lau DCW, Vallis M, Sharma AM, Biertho L, Campbell-Scherer D, Adamo K, Alberga A, Bell R, Boulé N, Boyling E, Brown J, Calam B, Clarke C, Crowshoe L, Divalentino D, Forhan M, Freedhoff Y, Gagner M, Glazer S, Grand C, Green M, Hahn M, Hawa R, Henderson R, Hong D, Hung P, Janssen I, Jacklin K, Johnson-Stoklossa C, Kemp A, Kirk S, Kuk J, Langlois MF, Lear S, McInnes A, Macklin D, Naji L, Manjoo P, Morin MP, Nerenberg K, Patton I, Pedersen S, Pereira L, Piccinini-Vallis H, Poddar M, Poirier P, Prud'homme D, Ramos Salas X, Rueda-Clausen C, Russell-Mayhew S, Shiau J, Sherifali D, Sievenpiper J, Sockalingam S, Taylor V, Toth E, Twells L, Tytus R, Walji S, Walker L, Wicklum S. Obesity in adults: a clinical practice guideline. *CMAJ.* 2020;192(31):E875-E891. <https://doi.org/10.1503/cmaj.191707>
50. Wilding JPH, Batterham RL, Calanna S, Davies M, Van Gaal LF, Lingway I, McGowan BM, Rosenstock J, Tran MTD, Wadden TA, Wharton S, Yokote K, Zeuthen N, Kushner RF. Once-weekly semaglutide in adults with overweight or obesity. *N Engl J Med.* 2021;384(11):989-1002. <https://doi.org/10.1056/NEJMoa2032183>
51. Wilding JPH, Batterham RL, Davies M, Van Gaal LF, Kandler K, Konakli K, Lingway I, McGowan BM, Oral TK, Rosenstock J, Wadden TA, Wharton S, Yokote K, Kushner RF. Weight regain and cardiometabolic effects after withdrawal of semaglutide: the STEP 1 trial extension. *Diabetes Obes Metab.* 2022;24(8):1553-1564. <https://doi.org/10.1111/dom.14725>
52. Zdziebkowski Ł, Wilska H, Szatkowska D, Ziętara D, Kmieć K, Topolska A, Komorowski M, Janiszewski M, Surosz N, Grochowalski M, Graczyk A, Szydło J. Role of physical activity in GLP-1 receptor agonist therapy for obesity treatment. *Quality in Sport.* 2025;43:62342. <https://doi.org/10.12775/QS.2025.43.62342>
53. Zhao L, Zhang F, Ding X, Wu G, Lam YY, Wang X, Fu H, Xue X, Lu C, Ma J, Yu L, Xu C, Ren Z, Xu Y, Xu S, Shen H, Zhu X, Shi Y, Shen Q, Dong W, Liu R, Ling Y, Zeng Y, Wang X, Zhang Q, Wang J, Wang L, Wu Y, Zeng B, Wei H, Zhang M, Peng Y, Zhang C. Gut bacteria

selectively promoted by dietary fibers alleviate type 2 diabetes. *Science*. 2018;359(6380):1151-1156. <https://doi.org/10.1126/science.aao5774>