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Narrative Review

Medical nutrition in the glucagon-like peptide-1 (GLP-1) era: Protein strategies, micronutrient monitoring, and lean mass preservation

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SUMMARY

Glucagon-like peptide-1 receptor agonists (GLP-1RAs) and dual glucose-dependent insulinotropic polypeptide (GIP)/GLP-1 agents produce substantial, sustained weight loss primarily by suppressing appetite and lowering ad libitum energy intake. While fat mass loss predominates, randomized trials with body-composition substudies indicate a clinically relevant reduction in absolute lean mass. Concurrently, baseline micronutrient inadequacies are common in people with obesity and may be exacerbated by reduced intake, nausea, or vomiting during therapy. This narrative review synthesizes evidence on energy/macronutrient dynamics, body-composition outcomes, and guideline-informed protein targets to present a practical, dietitian-led framework for care. We propose pragmatic energy floors to preserve micronutrient adequacy; daily protein intakes of ≥1.2 g/kg (up to 1.6 g/kg in appropriate adults without chronic kidney disease (CKD)) with meal-wise targets of ~0.3–0.4 g/kg and ~2.5–3 g leucine; a structured laboratory panel (vitamin D, B12, iron studies, folate, zinc, and thiamine in high-risk patients); and integration of progressive resistance training. We also outline monitoring schedules using dual-energy X-ray absorptiometry (DXA)/bioelectrical impedance analysis (BIA) and adaptations for special populations (older adults, type 2 diabetes, CKD, vegetarian/vegan, sarcopenic obesity). The goal is to preserve lean mass, prevent deficiencies, and optimize outcomes of GLP-1–based obesity pharmacotherapy.

1. Introduction

Glucagon-like peptide-1 receptor agonists are incretin-based therapies that enhance glucose-dependent insulin secretion, suppress glucagon, delay gastric emptying, and reduce appetite. Through these mechanisms, they improve glycemic control while also lowering spontaneous energy intake, which partly explains their growing role in obesity management beyond diabetes care [1,2]. Regulatory approval, reimbursement, and access to GLP-1-based agents vary across countries; in some settings, certain agents remain approved primarily for type 2 diabetes rather than obesity as a primary indication [3]. The rapid uptake of glucagon-like peptide-1 receptor agonists (GLP-1RAs) and dual GIP/GLP-1 agents has reshaped obesity care by enabling substantial and durable weight loss primarily through appetite suppression and reductions in ad libitum energy intake [1,2]. Controlled feeding and mechanistic studies further demonstrate decreased hunger, improved control of eating, and lower energy intake with GLP-1 therapy [4]. However, substantial weight loss during GLP-1-based therapy may be accompanied by loss of lean mass (LM), raising important concerns regarding muscle preservation, functional status, and long-term metabolic health. This issue is clinically relevant because disproportionate LM loss may adversely affect muscle strength, functional capacity, resting metabolic rate, frailty risk in susceptible individuals, and possibly weight-regain vulnerability after treatment discontinuation [5]. Importantly, LM loss is not unique to GLP-1-based pharmacotherapy and is also observed after bariatric surgery and intensive energy restriction; thus, the central clinical question is whether this loss can be mitigated through adequate protein intake, resistance exercise, and appropriate monitoring during pharmacotherapy-led weight reduction [6]. While fat mass loss predominates, body-composition substudies indicate that a meaningful fraction of total weight loss consists of absolute LM, with approximately three quarters of the weight lost as fat mass and about one quarter as LM in Dual-energy X-ray absorptiometry (DXA) analyses from

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tirzepatide trials; exploratory analyses and observational work suggest broadly similar patterns during semaglutide therapy [7,8] (see Table 1).

Concurrently, people living with obesity frequently present with baseline micronutrient inadequacies (e.g., vitamin D, iron, folate, vitamin B12, zinc), which may be exacerbated by lower total intake, food intolerance, or vomiting during therapy [9,10]. In addition, prolonged vomiting or very low intake can precipitate thiamine deficiency and, in severe cases, Wernicke's encephalopathy—necessitating a high index of suspicion and empiric thiamine when indicated [11]. Metformin, often co-prescribed in type 2 diabetes, is associated with vitamin B12 deficiency risk, and major guidelines advise periodic assessment in users [12].

Together, these dynamics create a new set of dietetic priorities in the GLP-1 era: preserving LM, preventing micronutrient deficiencies, and maintaining functional capacity while maximizing the benefits of pharmacotherapy. This critical review synthesizes evidence on energy/macronutrient dynamics and body-composition outcomes during GLP-1–based therapy and consolidates guideline-informed recommendations into a practical, clinician-oriented framework informed by GLP-1-specific evidence, guideline recommendations, and selected extrapolation from broader clinical nutrition and weight-loss literature [13].

Specifically, we define protein targets and per-meal distribution strategies, including the use of adjusted or ideal body weight when appropriate; propose a structured micronutrient monitoring panel and cadence; outline body-composition and functional assessments; integrate resistance training into dietary care; and tailor these elements to special populations. We also present a practical algorithm and summary tables to support implementation and identify research priorities for testing combined nutrition–exercise protocols alongside GLP-1 pharmacotherapy [14].

In practice, whole-food strategies should remain the foundation of care, but they are not always sufficient during GLP-1–induced appetite suppression. Therefore, high-protein oral nutrition supplements, protein modulars, or essential amino acid formulations should be considered early when patients are unable to meet daily protein or meal-level leucine targets through habitual food intake alone, even in the absence of severe gastrointestinal intolerance. This is particularly relevant during dose escalation, marked early satiety, reduced meal frequency, or persistent low-volume intake.

This work is a narrative review designed and reported according to good-practice guidance for narrative syntheses (e.g., SANRA) and with search reporting elements aligned to PRISMA-S where applicable [15,16]. We defined the population, interventions, outcomes, time window, and evidence hierarchy to guide this narrative synthesis, but did not register a protocol because this was not a systematic review. For consistency and to avoid overfeeding in clinical obesity care, protein prescriptions in this review are expressed per kilogram of adjusted body weight (AjBW) in adults with obesity, unless otherwise specified. Actual body weight may overestimate requirements at very high body mass, whereas ideal body weight may be overly conservative in some individuals. Accordingly, AjBW is used here as the default dosing weight for daily and meal-based protein targets.

2. Methods of evidence synthesis

2.1. Databases and sources

We searched PubMed/MEDLINE and PubMed Central (PMC), as the principal biomedical sources, together with ScienceDirect and Frontiers as supplementary full-text publisher platforms, for records published from January 1, 2015 to August 15, 2025. Reference lists of key articles and recent guidelines were also snowballed to identify additional relevant sources. Only English-language articles were considered. Because broader indexing databases such as Embase, Web of Science, and Scopus were not searched, this review should be interpreted as a narrative, clinician-focused synthesis rather than a fully exhaustive systematic review.

2.2. Search strategy

Core concepts and Boolean strings included: ("GLP-1 receptor agonist" OR semaglutide OR liraglutide OR "dual GIP/GLP-1" OR tirzepatide) AND (energy intake OR appetite OR "body composition" OR DXA OR "lean mass" OR "fat mass") AND (protein OR "protein distribution" OR leucine) AND (micronutrient* OR vitamin* OR iron OR zinc OR thiamine) AND (exercise OR "resistance training" OR strength). Search strings were adapted per database. Where relevant, guideline and position papers (e.g., ADA, KDIGO, ESPEN, PROT-AGE) were included to support practice-oriented recommendations [12,15,17,18].

Table 1
Special populations: dietetic prescriptions during GLP-1 therapy.

Population	Protein target (g/kg/day)	Per-meal target (g/kg & leucine)	Key adaptations/notes	Monitoring focus	References
Older adults (≥65 y)	≥1.2–1.5	≈0.4 g/kg/meal (~2.5–3.0 g leucine)	RT 2–3 × /wk; add brief power work; prioritize protein at first meal; nutrient-dense pattern	Vitamin D; iron status; periodic grip strength/SPPB	[17,22,23,28,29]
Type 2 diabetes	≥1.2 (up to 1.6 as appropriate)	~0.3–0.4 g/kg/meal (~2.5–3.0 g leucine)	Distribute protein to aid satiety/glycemia; watch hypoglycemia if insulin/secretagogues; monitor B12 with metformin	B12 (metformin); glucose trends	[12,22]
CKD G3–G5 (non-dialysis)	~0.8 (avoid >1.3 unless indicated)	Individualized (aim for anabolic dosing when feasible)	Coordinate with nephrology; plant-forward proteins; manage phosphorus/sodium; avoid indiscriminate supplements	Vitamin D per renal guidelines; iron management; renal function	[18,26]
Vegetarian/vegan	≥1.2	~0.3–0.4 g/kg/meal (~2.5–3.0 g leucine)	Leucine-dense plant proteins (soy/tempeh); fortified foods; consider essential amino acids (EAA) if intake low	B12; consider iron & zinc if symptomatic/risk	[9,10,12,22,23]
Sarcopenic obesity/low strength	≥1.2–1.5	≈0.4 g/kg/meal (~2.5–3.0 g leucine)	Start RT at initiation; frequent function checks (q4–8 wk); maintain energy floors	Grip strength; SPPB; LM trends (BIA/DXA)	[17,28,29]
Athletes/highly active*	1.6–2.2	~0.3–0.4 g/kg/meal (~2.5–3.0 g leucine)	Ensure energy restriction does not outpace recovery; post-exercise protein feeding; periodize training	Performance markers; injury/overreach signs	[9,22,31]

All protein prescriptions shown in g/kg/day and g/kg/meal refer to adjusted body weight in adults with obesity unless otherwise stated. *In athletes with obesity, targets should also be individualized according to sport demands, energy availability, and tolerability; adjusted body weight may still be preferable for initial prescribing in clinical obesity care.

2.3. Eligibility criteria

We included adult (≥18 y) studies in people with overweight/obesity receiving GLP-1RAs or dual GIP/GLP-1 agents for weight management (with or without type 2 diabetes) reporting at least one of: (i) changes in ad libitum energy intake, appetite or eating control; (ii) body-composition outcomes (DXA/BIA-derived fat mass or LM); (iii) protein intake requirements and distribution during energy deficit; (iv) micronutrient status or monitoring; or (v) integration of progressive resistance training. Study types prioritized were systematic reviews/meta-analyses, randomized controlled trials, large cohorts, and authoritative guidelines/consensus statements. We excluded pediatric and pregnancy populations, peri-operative bariatric protocols (unless mechanistically informative), animal studies, and non-English texts.

2.4. Study selection and data handling

One reviewer screened titles/abstracts and full texts against the criteria. To reduce selection bias in a single-reviewer process, inclusion/exclusion rules were specified a priori and applied consistently; uncertainties were resolved by revisiting criteria and triangulating with guideline statements. From included records, we extracted population, intervention (agent/dose/duration), comparator, outcomes (energy intake, appetite metrics, DXA/BIA, functional measures), key effect estimates, and safety/micronutrient signals.

2.5. Evidence appraisal and synthesis

Given heterogeneity in designs and outcomes, no quantitative meta-analysis was attempted. Instead, we applied an evidence hierarchy (SR/MA > RCT > large cohort > mechanistic/feeding studies > narrative reviews) and synthesized results narratively. Practice recommendations emphasize convergence across high-quality trials and contemporary guidelines (ADA 2025 for B12 monitoring with metformin; KDIGO 2024 for CKD protein limits; ESPEN clinical nutrition in obesity; PROT-AGE protein guidance in older adults) [12,15,17,18]. Where GLP-1-specific data were sparse, we explicitly note extrapolations from adjacent literature (e.g., weight-loss and bariatric nutrition) and identify these as research priorities. Where direct GLP-1-specific evidence was limited, recommendations were cautiously extrapolated from broader literature on energy restriction, obesity treatment, sarcopenia prevention, and clinical nutrition, and are presented as pragmatic rather than definitive GLP-1-specific standards. Some principles discussed in this review are not unique to GLP-1-based therapy, but reflect broader physiology of energy restriction and weight loss. Their relevance in the GLP-1 setting lies in the added effects of appetite suppression, delayed gastric emptying, reduced meal volume, and treatment-related tolerability issues, which may amplify challenges in achieving adequate protein, energy, and micronutrient intake.

2.6. Energy & macronutrient dynamics under GLP-1 therapy

GLP-1–based therapies lower ad libitum energy intake in a dose-dependent manner through central appetite pathways and, at least transiently, delayed gastric emptying [1–7,19]. Controlled-feeding and laboratory buffet studies consistently show fewer calories per eating occasion and improved control of eating with semaglutide and liraglutide versus placebo [4,19]. With higher-dose or oral formulations, absolute daily intake reductions can approach one quarter of baseline in short-term trials [20,21]. In real-world practice, these changes translate into rapid energy deficits that drive early weight loss.

Shifts in macronutrient selection under GLP-1 therapy are generally small but directionally favorable for weight control (lower energy density, fewer discretionary foods) [4]. Nevertheless, spontaneous intake suppression can inadvertently depress protein intake below levels needed to preserve LM, especially when meal frequency drops or when nausea and early satiety limit portion size [1,2,4,7]. Because micronutrient adequacy depends on total energy available to "carry" vitamins and minerals, aggressive caloric restriction raises the risk that customary diets fail to meet requirements without careful food selection or supplementation.

Dietetic implications are therefore twofold. First, establish pragmatic energy "floors" that help preserve micronutrient adequacy while allowing continued weight loss. Approximate thresholds of ~1200 kcal/day for many women and ~1500 kcal/day for many men may serve as useful clinical reference points when appropriate; however, these values are not universal prescriptions and should be individualized according to age, body size, physical activity, rate of weight loss, and comorbidities. Nutrient-dense dietary patterns emphasizing vegetables, fruit, legumes, low-fat dairy, lean proteins, whole grains, nuts, and seeds should be prioritized. Second, protect LM by anchoring each eating occasion with high-quality protein and distributing intake across the day. Pragmatic meal-level tactics include targeting approximately 0.3–0.4 g/kg protein per eating occasion, providing approximately 2.5–3 g leucine, and front-loading protein in the first meal to counter morning anorexia [22–24]. However, these meal-based protein and leucine targets are based largely on extrapolation from broader muscle protein synthesis, sarcopenia, and weight-loss literature, as direct GLP-1-specific trial evidence remains limited. High-protein oral nutrition supplements may be considered when solid food is poorly tolerated or when whole-food intake alone is insufficient to achieve daily protein and meal-based leucine targets. These strategies may help many patients maintain protein and micronutrient adequacy despite reduced appetite and gastrointestinal symptoms. However, nutritional rescue should not rely exclusively on counseling when pharmacotherapy tolerability is the limiting factor. In patients with persistent low intake despite dietetic optimization and oral nutrition support, multidisciplinary review with the prescribing clinician may be necessary to optimize dose progression and protect nutritional status.

Management of tolerance is integral to maintaining nutrient density. Dietary pacing (smaller, slower meals), temporary texture modification (e.g., soft/semisolid options), and avoidance of high-fat, very sweet, or strongly odorous foods during nausea can preserve intake. For patients with persistent vomiting or very low intake, clinicians should consider thiamine deficiency early and treat empirically while arranging laboratory confirmation [11]. As energy intake stabilizes after dose adjustments, reassess protein adequacy and micronutrient "coverage," and titrate meal structure accordingly.

2.7. Practice points

- Expect ~15–30% reductions in ad libitum intake early in therapy; plan nutrient-dense substitutions proactively [1,2,4,7,20,21]. Reported reductions in energy intake are most evident during the early phase of treatment and dose escalation, and may attenuate over time as gastrointestinal tolerance improves, dosing stabilizes, and behavioral adaptation occurs.
- Use energy floors to maintain micronutrient adequacy and anchor each eating occasion with high-quality protein [22–24].

- Anticipate and manage GI symptoms to protect intake; escalate to thiamine repletion if vomiting persists [11].

2.8. Body-composition outcomes

Across randomized trials with body-composition substudies, fat mass accounts for the majority of weight lost on GLP-1–based therapy, while a non-trivial component is absolute LM [1,2,7,8]. In the tirzepatide SURMOUNT-1 DXA substudy, approximately three quarters of total weight loss was fat mass and roughly one quarter LM, indicating favorable but not exclusive fat loss [4]. Exploratory analyses with semaglutide show a similar qualitative pattern: large absolute losses in fat mass accompanied by smaller, yet clinically relevant, reductions in LM; percent LM may increase even as absolute LM decreases, reflecting disproportionate fat loss [1,8].

Why this matters clinically is twofold. First, LM contributes to strength, physical function, and metabolic health; excessive LM loss during weight reduction is associated with reduced functional reserve and potentially greater frailty risk in older adults [17]. Second, LM is a key determinant of resting energy expenditure; preserving LM likely supports weight-loss maintenance and glycemic control. These considerations are particularly salient for patients with sarcopenic obesity or those with low baseline muscle strength. Importantly, lean mass is not equivalent to skeletal muscle mass alone; it also includes organs, total body water, and other fat-free compartments, so changes in lean mass should not be interpreted as a direct one-to-one marker of muscle loss. Emerging magnetic resonance imaging-based evidence also suggests that reductions in muscle volume during GLP-1-based therapy may be broadly commensurate with the degree of weight loss and underlying clinical context, and may coexist with adaptive improvements in muscle quality, including improved insulin sensitivity and reduced muscle fat infiltration. Accordingly, muscle-related changes during treatment should not be interpreted as uniformly detrimental, although caution remains warranted in older adults and other vulnerable populations [25].

Magnitude and modifiers of LM change. The proportion of LM lost tends to rise when energy deficits are large, protein intake is inadequate, meal frequency is reduced, or resistance training is absent. Conversely, higher protein intakes and resistance training may attenuate LM loss and improve functional outcomes. In clinical practice, early dietitian-led countermeasures, including protein distribution, meal structuring, and exercise support, should begin at or before pharmacotherapy initiation.

2.9. Practice points

- Expect favorable fat-dominant weight loss but plan for some absolute LM reduction; guard LM proactively [1,2,7,8].
- Older adults and patients with low baseline strength are priority groups for LM-preservation strategies [17].
- The clinical importance of LM change should be interpreted in relation to function, baseline risk, and overall treatment context, rather than from body weight alone [17,25].

2.10. Protein strategies

2.10.1. Goals and daily targets

To mitigate LM loss during GLP-1–based weight reduction, daily protein should generally be $\geq$ 1.2 g/kg in adults without CKD, with 1.6 g/kg appropriate for many during active training or aggressive energy deficit when tolerated [17,18,22]. Older adults require higher intakes ($\geq$1.2–1.5 g/kg/day) to overcome anabolic resistance and support function [17,22,23]. For CKD stages G3–G5 (non-dialysis), a target near ~0.8 g/kg/day is appropriate, individualized with nephrology input; avoid sustained intakes >1.3 g/kg/day unless specifically indicated [26]. Protein requirements should be individualized according to age, sex, physical activity, baseline LM, rate of weight loss, and comorbidities, rather than interpreted as a one-size-fits-all target.

2.10.2. Per-meal distribution and leucine threshold

Distribute protein across 3–4 eating occasions, aiming for ~0.3–0.4 g/kg per meal to reach the leucine threshold that maximizes muscle protein synthesis—approximately ~2.5–3.0 g leucine per meal for most adults, and closer to the upper end in older adults [22,23]. Front-loading protein at the first meal can counter morning anorexia; a pre-sleep casein option may be considered in physically active or sarcopenia-risk patients [22].

2.10.3. How to calculate in people with obesity

In adults with obesity, we propose using adjusted body weight (AjBW) as the default basis for protein prescriptions expressed as g/kg, unless a specific clinical reason justifies another approach. This helps avoid overestimation that may occur with actual body weight while remaining more practical than ideal body weight alone in many patients. A pragmatic formula is: AjBW = ideal body weight (IBW) + 0.25 $\times$ (Actual Body Weight $-$ IBW). Ideal body weight may be used as a more conservative alternative in selected cases, but the same approach should be applied consistently across visits and across daily and meal-based protein prescriptions.

2.10.4. Quality, sources, and patterns

Prioritize high-quality proteins (dairy, eggs, soy, lean meats, mixed legumes + grains) while preserving overall diet quality. For vegetarian/vegan patterns, emphasize leucine-dense plant sources (e.g., soy foods) and consider fortified foods or supplemental essential amino acids to reach per-meal thresholds [22,23]. Pair protein with progressive resistance training for additive effects on LM preservation (see Exercise Integration).

2.10.5. Implementation tips

- Anchor each meal with a known protein portion (e.g., 25–40 g per eating occasion for many adults; tailor by body size using 0.3–0.4 g/kg) [22].
- High-protein oral nutrition supplements, protein modulars, or essential amino acid blends may be considered early when whole-food intake alone is insufficient to achieve daily protein and meal-level leucine targets. These products may be particularly useful during dose escalation, low appetite, reduced meal frequency, or poor tolerance to solid foods. Their selective use in this context should be viewed as a pragmatic clinical strategy, supported primarily by nutritional rationale and clinical experience rather than by an extensive GLP-1-specific trial base [27].
- Reassess protein adequacy whenever GLP-1 dose changes or GI symptoms affect intake.
- In CKD, coordinate with nephrology; emphasize plant-forward options and avoid chronic excess [26].

2.11. Micronutrient monitoring

2.11.1. Rationale and risk profile

People living with obesity often present with suboptimal micronutrient status at baseline—most commonly vitamin D and iron, with variable shortfalls in folate, vitamin B12, and zinc [9,10].

Although current evidence does not strongly establish GLP-1–based therapy as an independent direct cause of micronutrient deficiency, reduced ad libitum energy intake, nausea, early satiety, or vomiting may lower diet quality and "micronutrient carrying capacity," thereby increasing risk in susceptible individuals if intake is not actively managed [1,2,4,7]. In particular, prolonged vomiting or very low intake should trigger early consideration of thiamine deficiency because of the potential for rapid neurological sequelae [11]. Oral nutrition supplements or targeted micronutrient support should therefore be used selectively and, in most cases, temporarily, with reassessment once oral intake and food tolerance improve.

2.11.2. Monitoring panel and cadence

A pragmatic, dietitian-led panel focuses on the most prevalent and actionable risks.

- 25-hydroxy-vitamin D (25-OH-D) — baseline, recheck at 3–6 months if low or if risk persists, then annually.
- Iron status (ferritin, transferrin saturation) + CBC — baseline; repeat at 3–6 months if symptomatic or if prior deficiency; at least annually thereafter.
- Vitamin B12 — baseline and periodic monitoring in patients with type 2 diabetes treated with metformin, and in those with symptoms/signs suggestive of deficiency [12].
- Folate — baseline or when macrocytosis/megaloblastic anemia is suspected; repeat if dietary risk continues.
- Zinc (± copper if prolonged high-dose zinc is used) — symptom-triggered (alopecia, dermatitis, poor wound healing) with follow-up as indicated.
- Thiamine (vitamin B1) — assess promptly in the setting of persistent vomiting or very low intake; if deficiency is suspected, treat empirically while arranging laboratory confirmation [11].

2.12. Special situations and diet patterns

Vegetarian/vegan patterns require proactive B12 planning (fortified foods or supplements) and attention to iron and zinc bioavailability [9,10]. Older adults may need closer vitamin D surveillance due to lower cutaneous synthesis and higher fracture risk. In CKD (stages G3–G5, non-dialysis), coordinate micronutrient decisions (e.g., vitamin D analogues, iron management) with nephrology and avoid indiscriminate supplementation outside guideline-based indications [26].

2.13. Interpretation and action

Interpret values against local laboratory reference ranges and clinical context; correct identified deficiencies using guideline-concordant regimens and re-test to document recovery [11,12,26]. Where intake remains low despite counseling (e.g., during dose escalation), consider short-term use of higher-protein, micronutrient-fortified oral nutrition supplements to meet daily requirements while solid food tolerance improves.

2.14. Practice points

- Start with a focused baseline panel; repeat at 3–6 months for abnormal/at-risk findings and annually for stable patients [9–12].
- Maintain high suspicion for thiamine deficiency when vomiting persists; do not delay empiric treatment while arranging tests [11].
- Align B12 monitoring with metformin use and symptomatology; integrate diet pattern and age-related risks into the monitoring cadence [9,10,12].

2.15. Body-composition & function monitoring

2.15.1. Purpose

Monitoring body composition together with simple functional measures can help identify patients who are losing disproportionate LM or developing functional decline during GLP-1–based therapy [1,2,7,8,17,18].

What to measure and how.

DXA is the preferred research-grade method for assessing total and regional fat mass and LM in this context [1,4,5]. In routine practice, multi-frequency bioimpedance analysis (BIA) may be used to monitor trends when DXA is unavailable, although results should be interpreted cautiously because they are influenced by hydration status, device type, prediction equations, and measurement protocols [18]. Functional measures such as hand-grip strength and the Short Physical Performance Battery (SPPB) complement body-composition assessment and may help detect clinically meaningful decline that is not evident from body weight alone [28].

2.15.2. Suggested cadence

- Baseline (before or at initiation): DXA (if available) or BIA; hand-grip strength; SPPB (or gait speed if time is limited); document recent weight history and activity pattern.
- Early follow-up: During dose escalation or rapid weight loss, reassess symptoms and intake at each visit; repeat BIA every 4–8 weeks if needed to monitor LM trends; repeat hand-grip strength if low intake, fatigue, or weakness emerges.
- Medium-term: Repeat DXA at 6–12 months when feasible, or earlier if there is substantial performance decline, repeated BIA-indicated LM decrease, or high-risk status such as older age or sarcopenic obesity.
- Long-term: Annual DXA may be considered where feasible; otherwise, continue BIA plus functional testing to guide nutrition and exercise adjustments.

2.15.3. Interpreting change and acting

Converging signals such as repeated LM decline on DXA/BIA, falling grip strength, or worsening SPPB scores should prompt reassessment of protein intake, meal distribution, exercise participation, energy adequacy, and tolerability barriers. Because repeated DXA is often impractical in routine care, functional testing, dietary review, and selective use of BIA may represent more feasible alternatives in many health systems. Older adults, individuals with low baseline strength, sarcopenic obesity, or CKD may require earlier reassessment and closer multidisciplinary follow-up [17,18,26,28].

2.15.4. Practice points

- Use DXA where feasible; use BIA pragmatically to follow trends when DXA is unavailable or impractical [1,7,8,18].
- Pair body-composition assessment with functional measures such as grip strength and SPPB to detect clinically meaningful decline early [28].
- Escalate nutrition and exercise countermeasures promptly when LM or strength falls, especially in older adults or those with sarcopenic obesity [17,18,28].

2.16. Exercise integration

2.16.1. Rationale

Resistance training is an important adjunct to nutritional care during GLP-1–based therapy because it may help attenuate lean-mass (LM) loss and support strength and functional capacity during energy deficit, particularly when combined with adequate protein intake [9,23]. In this context, exercise should be viewed as a core supportive component of care rather than an optional add-on.

2.16.2. General principles

For most adults, a pragmatic goal is to encourage resistance training 2–3 times per week, with exercises that involve the major muscle groups and that can be progressed gradually according to baseline fitness, symptoms, tolerance, and clinical status [29,30]. The specific mode of exercise may vary depending on individual preference, equipment access, joint limitations, and prior training experience. In previously inactive individuals, starting with simple, supervised, or low-complexity exercises may improve adherence and safety. The primary aim is to maintain or improve muscle function and preserve LM during weight loss, rather than to pursue highly optimized athletic training adaptations.

2.16.3. Older adults and those at risk of sarcopenia

In older adults and other patients at risk of sarcopenia, resistance training remains important, but exercise plans should place particular emphasis on safety, function, and progression according to tolerance [28,29]. When appropriate, balance, mobility, and functional movement elements may be incorporated alongside resistance exercise to support physical performance and reduce the risk of decline. More individualized planning may be beneficial for people with low baseline strength, frailty, functional limitations, or complex comorbidities, ideally with input from an exercise physiologist, physiotherapist, or similarly qualified professional when available.

2.16.4. Integration with protein strategies

Exercise support should be paired with practical protein strategies. Patients should be encouraged to distribute protein intake across the day and to consume a high-quality protein-containing meal after training when feasible, while still aiming to meet overall daily protein targets [22,23]. On days of poor appetite, nausea, or reduced meal volume, high-protein oral nutrition supplements may help support both protein and micronutrient adequacy.

2.16.5. Safety and tailoring

Exercise advice should be individualized according to age, baseline function, comorbidities, and treatment tolerance. In people with type 2 diabetes, clinicians should remain attentive to glucose trends and hypoglycemia risk when other glucose-lowering therapies are used. In CKD, resistance training is generally feasible with appropriate clinical tailoring, although coordination with nephrology may be warranted in more complex cases [26]. Musculoskeletal pain, joint disease, or functional limitation may necessitate adapted or supported exercise formats.

2.16.6. Practice points

- Encourage resistance training as a routine supportive component of GLP-1 care to help preserve LM and physical function [9,23,28–30].
- Favor simple, feasible, and progressive exercise plans over highly technical prescriptions, especially in previously inactive or symptomatic patients [29,30].
- In older adults and sarcopenia-risk groups, emphasize safety, functional capacity, and individualized progression, with referral to qualified exercise professionals when needed [28,29].

2.16.7. Special populations

Special populations require tailored protein dosing, monitoring cadence, and exercise integration during GLP-1 therapy. Table X summarizes pragmatic prescriptions and red-flag monitoring priorities for common clinical scenarios.

2.17. Clinical algorithm & follow-up schedule

2.17.1. Overview

The practical implementation of this framework depends substantially on access to dietetic care, which remains variable across health systems. In routine practice, many patients receiving GLP-1-based therapy may have little or no structured nutrition follow-up despite reduced appetite, smaller meal volumes, and questions about protein quality, portion size, and symptom management. Accordingly, clinicians prescribing GLP-1-based therapy should consider referral for dietetic support whenever feasible, while simplified patient education strategies may be needed where specialist follow-up is limited.

The dietetic care pathway during GLP-1–based therapy should be protocolized to (i) safeguard micronutrient adequacy despite reduced intake, (ii) preserve LM via protein distribution and resistance training, and (iii) detect problems early through scheduled monitoring [1,2,4,7,8,12–17,17,18,18–24,26,28–30].

Step 1 — Baseline assessment (at or before initiation)

- History & symptoms: appetite/tolerance, prior deficiencies, vomiting risk, co-therapies (e.g., metformin), comorbid CKD/T2D [1,2,4,7,11,12,26].
- Anthropometry, function, and composition: weight, BMI, and waist circumference; hand-grip strength and SPPB or gait speed for all patients at baseline; dual-energy X-ray absorptiometry where available, or bioelectrical impedance analysis for interim trend monitoring. When body-composition tools are unavailable, a function-first pathway should be used rather than postponing surveillance [17,18,28].
- Laboratory panel: 25-OH-vitamin D; iron studies (ferritin, transferrin saturation) + CBC; vitamin B12 (especially with metformin); folate; zinc (± copper if prolonged zinc); thiamine if vomiting/very low intake [9–12].
- Education: nausea/early satiety strategies; protein-anchored meals; warning signs for thiamine deficiency [11].

Step 2 — Set targets (prescriptions)

- Energy floors to maintain micronutrient adequacy: ~1200 kcal/day (most women) and ~1500 kcal/day (most men), individualized to body size and activity [24].
- Daily protein: adults without CKD $\geq$1.2 g/kg (consider 1.6 g/kg with structured training/greater deficits); older adults $\geq$1.2–1.5 g/kg; CKD G3–G5 ~0.8 g/kg with nephrology input [17,18,22,23,26].
- Per-meal distribution: ~0.3–0.4 g/kg/meal aiming for ~2.5–3.0 g leucine (upper end in older adults) [22,23].

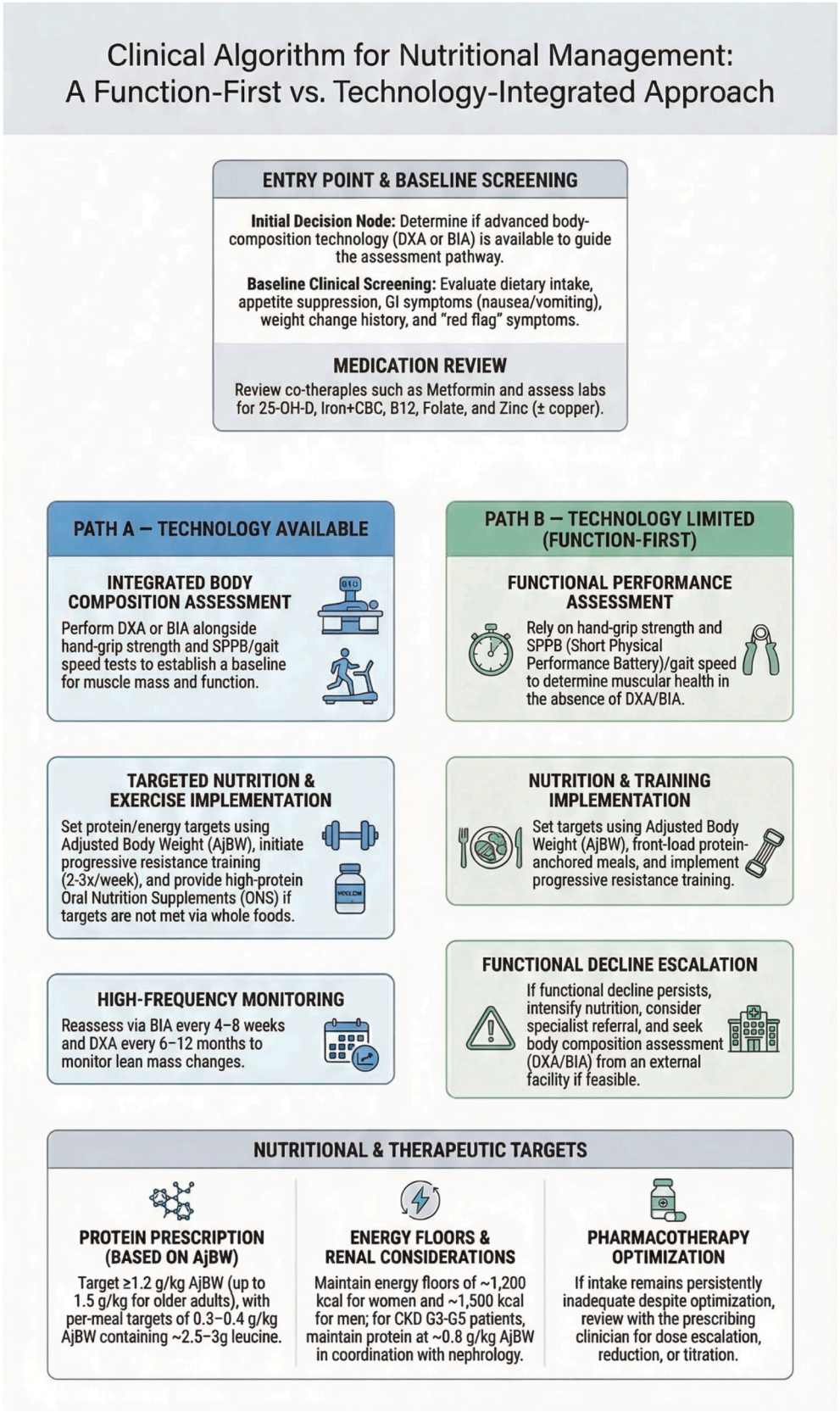

Fig. 1. Clinical algorithm for lean-mass preservation during GLP-1–based obesity treatment: technology-enabled and function-first pathways.

- Calculation in obesity: may use Adjusted or Ideal Body Weight where appropriate; document the scalar (AjBW = IBW + 0.25–0.33 × [Actual−IBW]) and apply consistently [18,27].
- Exercise: prescribe progressive resistance training (RT) 2–3 × / week; introduce simple power drills in older adults once technique is safe [28–30].

Step 3 — Implement (first 4–8 weeks; during dose escalation)

- Meal structure: 3–4 eating occasions; anchor each with high-quality protein; front-load protein at the first meal to counter morning anorexia [22,23].
- Tolerance management: pacing, smaller portions, temporary soft textures; avoid high-fat/very sweet/strong odors during nausea; consider higher-protein ONS/EAA when solids are poorly tolerated [1,2,4,7,22,23].
- Education refreshers: label reading for protein/leucine; micronutrient-dense choices within energy floors.

If whole-food intake is insufficient to achieve protein goals, introduce high-protein oral nutrition supplements or protein modulars early rather than waiting for severe intake deterioration.

Step 4 — Monitor (scheduled surveillance)

- Visits: at ~4–8 weeks and at each dose change; then at ~12, 24, and 52 weeks, adjusting by risk.
- Composition & function: BIA every 4–8 weeks during early weight loss; DXA at 6–12 months (earlier if functional decline); repeat grip strength/SPPB when intake is low or weakness appears [17,18,28].
- Laboratory panel: repeat targeted tests at 3–6 months if low/risk; annual recheck when stable; B12 periodically with metformin; assess thiamine immediately with persistent vomiting (do not delay empiric repletion if suspected) [9–12].

Step 5 — Troubleshoot (red flags & actions)

- Persistent vomiting/very low intake → empiric thiamine repletion and urgent evaluation [11].
- Signs of inadequate protein/LM loss: falling grip strength or repeated BIA-indicated LM decline; intensify protein to the higher end of the range (+0.2–0.3 g/kg/day if tolerated), reinforce per-meal distribution, and progress RT volume/intensity [17,22,23,28–30].
- CKD or intolerance to higher protein: maintain ~0.8 g/kg/day, prioritize plant-forward sources, and coordinate with nephrology [26].
- Micronutrient deficiency on labs: treat per guideline and re-test to document correction [9–12,26].

If energy intake remains persistently below the practical energy floor, or if protein and micronutrient adequacy cannot be maintained despite optimized counseling and oral nutrition support, the patient should be reassessed with the prescribing clinician for pharmacotherapy optimization, including delayed dose escalation, temporary dose reduction, or individualized titration.

Step 6 — Long-term maintenance (after ~6–12 months)

- Reaffirm energy floors and protein distribution as appetite stabilizes; transition to weight-maintenance protein (often ≥1.2 g/kg/day) with continued RT 2–3 × /week [17,22,29,30].
- Annual check: composition (DXA if feasible), selected labs, and functional tests; earlier if symptoms emerge [17,18,28].

Practice points.

- Expect sizable intake reductions early; pre-empt nutrient shortfalls with energy floors and protein distribution [1,2,4,7,22–24].
- Pair RT with per-meal leucine-informed dosing to preserve LM and function [22,23,28–30].
- Use a focused, repeatable lab panel; escalate rapidly when vomiting persists or function declines [9–12,17,28]. A practical overview of the proposed monitoring and intervention pathway is summarized in Fig. 1.

3. Future directions

GLP-1–based pharmacotherapy creates a unique nutritional milieu—large appetite suppression with mostly fat-dominant weight loss yet measurable lean-mass (LM) reduction [1,2,7,8]. To translate this into robust clinical pathways, several priorities warrant prospective evaluation.

1) Protein prescription trials in GLP-1 users. Randomized, titratable protein targets (e.g., ≥1.2 vs 1.6 g/kg/day) with standardized per-meal distribution (~0.3–0.4 g/kg and ~2.5–3 g leucine) should test effects on LM, strength, and physical performance, ideally alongside structured resistance training (RT) [17,18,22,23,28–30].
2) Combined nutrition–exercise protocols. Pragmatic, multicenter trials comparing usual care vs protocolized energy floors + high-protein distribution + RT (2–3 × /week) on LM preservation, functional outcomes, glycemia, and weight-loss maintenance [22,23,28–30].
3) Micronutrient monitoring strategies. Frequency, thresholds, and cost-effectiveness of a focused laboratory panel (25-OH-vitamin D, iron studies/CBC, B12—especially with metformin, folate, zinc; thiamine in high-risk vomiting) require prospective validation with patient-important outcomes [9–12].
4) Special populations. Trials tailored to older adults, sarcopenic obesity, CKD stages G3–G5, vegetarian/vegan patterns, and highly active individuals to define safe upper/lower protein bounds, leucine thresholds, and RT progressions [17,18,22,23,26,28–31].
5) Body-composition and functional endpoints. Harmonized DXA protocols and complementary functional measures (grip strength, SPPB) should be embedded as co-primary endpoints to capture clinically meaningful change beyond weight alone [17,28].
6) Implementation science. Evaluation of dietitian-led, algorithm-based care pathways within obesity clinics and primary care—including digital follow-up, adherence supports, and equity considerations.

Collectively, these studies can refine dosing, monitoring cadence, and care delivery to preserve LM, prevent deficiencies, and optimize long-term outcomes during GLP-1 therapy.

4. Conclusion

GLP-1–based pharmacotherapy reliably reduces ad libitum energy intake and produces fat-dominant weight loss, yet a clinically relevant fraction of total weight loss is absolute LM. This creates clear dietetic imperatives: safeguard micronutrient adequacy despite reduced intake, set pragmatic energy floors, prescribe sufficient daily protein with deliberate per-meal distribution to

reach leucine thresholds, and integrate progressive resistance training. A focused laboratory panel (25-OH-vitamin D, iron studies/CBC, vitamin B12—especially with metformin, folate, zinc; and thiamine in high-risk vomiting) coupled with scheduled reassessment enables early detection and correction of problems. Using adjusted body weight as the default basis for protein prescriptions in adults with obesity, with ideal body weight reserved for selected conservative applications (older adults, CKD, vegetarian/vegan patterns, sarcopenic obesity, and highly active individuals) improves feasibility and safety. The clinical algorithm and tables presented here translate a dispersed literature into a practical, clinician-ready pathway designed to preserve LM, prevent deficiencies, and optimize the long-term outcomes of GLP-1 therapy.

Disclosure of interest

The author reports there are no competing interests to declare.

Data availability statement

No new data were generated or analyzed in this study.

Ethics

Narrative review—no studies with human participants or animals.

Consent

Not applicable.

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