

Review Article

Whey Protein Supplementation and Lean Body Mass in Post-Bariatric Surgery Patients: A Randomized Controlled Trial

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Abstract

Background: Rapid weight loss after bariatric surgery is accompanied by substantial loss of fat-free mass, raising concern for sarcopenic obesity. **Objective:** To synthesise randomised trial and meta-analytic evidence on whey protein supplementation and lean body mass preservation after bariatric surgery. **Methods:** Narrative review of published randomised controlled trials, systematic reviews and meta-analyses, and mechanistic studies. **Findings:** Pooled data from five RCTs show whey protein supplementation attenuates fat-free mass loss (+3.87 kg) and fat mass loss (−2.10 kg) relative to control, with larger gains when combined with resistance training. **Conclusions:** Whey protein is a plausible, low-risk adjunct for lean mass preservation, though trial quality remains heterogeneous.

Keywords: whey protein; lean body mass; bariatric surgery; sarcopenic obesity; fat-free mass

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Introduction

Bariatric surgery remains the most effective durable treatment for severe obesity, but the resulting caloric restriction and reduced gastric capacity place patients at risk of losing not only fat mass but also skeletal muscle [1]. Fat-free mass losses of 20-30% of total weight loss are commonly reported in the first postoperative year, and up to a quarter of patients meet criteria for sarcopenic obesity within months of surgery [2,3]. A systematic review of nutritional determinants of fat-free mass preservation concluded that protein quantity, protein quality and resistance exercise are the three most consistently reported modifiable factors, though the certainty of evidence for any single intervention remains low [4]. Because dietary protein intake typically falls well below the 60 g/day recommended by allied-health nutritional guidelines during the early postoperative period, largely due to reduced gastric volume and food intolerance, clinicians have turned to protein

supplementation — most commonly whey-based formulations — as a practical countermeasure [5,6].

Whey protein is favoured because of its rapid digestion kinetics, high leucine content, and complete essential amino-acid profile, properties long recognised to make it a particularly potent stimulator of postprandial muscle protein synthesis relative to slower-digesting proteins such as casein [7,8]. It is also widely available as a low-volume, palatable liquid or powder, features that matter clinically when patients can tolerate only small, frequent meals in the early postoperative months. Translating this physiological rationale into durable body-composition benefit in the specific context of post-bariatric catabolic stress, malabsorptive surgical anatomy, and markedly reduced overall energy and food intake, however, remains an active area of clinical trial investigation, and findings across individual trials have been mixed enough that no professional society yet mandates routine whey supplementation for all post-bariatric patients.

This review synthesises the published randomised-trial, systematic-review and mechanistic literature addressing whey protein supplementation and lean body mass in adults after bariatric surgery. Relevant publications were identified through targeted searches of PubMed, Europe PMC and Crossref for randomised controlled trials, systematic reviews, meta-analyses and mechanistic studies of whey or dairy protein supplementation, fat-free mass, sarcopenic obesity and bariatric or metabolic surgery, supplemented by hand-searching reference lists of retrieved reviews. It is a narrative synthesis of existing evidence rather than the report of a single new dataset.

Protein Needs and Guideline Recommendations After Bariatric Surgery

Consensus guidelines from the American Society for Metabolic and Bariatric Surgery and the Academy of

Nutrition and Dietetics recommend a minimum of 60-80 g of protein daily after Roux-en-Y gastric bypass or sleeve gastrectomy, rising toward 90 g after malabsorptive procedures, framed within the broader AACE/TOS/ASMBS/OMA/ASA perioperative nutrition guidance [5,1,9]. In practice, achieving this target from food alone is difficult in the first three postoperative months: a prospective cohort found only 25% of patients consumed ≥ 60 g protein/day at six months, and protein intake correlated inversely with fat-free mass loss [6]. A systematic review of twelve studies similarly found protein intake commonly fell below 60 g/day, though the association with lean mass retention was inconsistent across studies [10]. These gaps motivate supplementation strategies, and pragmatic delivery matters: a randomised pilot comparing liquid versus powdered whey supplements after Roux-en-Y gastric bypass found substantially higher adherence with the liquid format (102.7% versus 42.0% of target, $p=0.012$), alongside fewer micronutrient deficiencies [11]. Formulation, palatability and gastrointestinal tolerance therefore appear to be as important as the protein source itself in determining whether a prescribed supplementation target is actually met, a practical consideration that is frequently under-reported in efficacy trials.

Mechanisms of Whey Protein-Stimulated Muscle Protein Synthesis

Whey is digested and absorbed rapidly, producing a sharp postprandial rise in circulating leucine that crosses a proposed threshold triggering mTOR-mediated muscle protein synthesis, a mechanism most consistently demonstrated in older or insulin-resistant populations resembling the post-bariatric phenotype [12]. Comparative studies established that whey produces greater acute protein accretion than casein or casein hydrolysate, reflecting its distinct digestion kinetics [7]. Narrative synthesis of resistance-trained populations

further indicates that whey's benefit for muscle mass plateaus once total daily protein intake reaches approximately 1.6 g/kg body weight, with per-dose thresholds of roughly 0.24-0.40 g/kg optimising the synthetic response [13]. Obesity and bariatric surgery, however, are independently associated with anabolic resistance — reduced muscle sensitivity to circulating amino acids — potentially blunting the magnitude of benefit relative to non-surgical populations [14]. Notably, a large prospective cohort of weight-losing adults found physical activity and overall dietary quality, rather than protein intake per se, most strongly predicted fat-free muscle mass preservation, suggesting protein supplementation likely acts synergistically with, rather than independently of, behavioural factors [15].

Randomized Controlled Trials of Whey Protein Supplementation on Lean Body Mass (Figure 1, Table 1)

Direct trial evidence is limited but informative (Table 1). A 16-week randomised trial of whey protein in women more than five years post-bariatric surgery found significantly greater fat mass loss and body weight loss versus control, without a significant change in fat-free mass in either group [16]. Combining whey protein with resistance training produced clearer lean-mass benefit: in a controlled trial of patients 2-7 years after Roux-en-Y gastric bypass, the resistance-training-plus-protein group gained fat-free mass ($+1.46 \pm 1.02$ kg) and skeletal muscle mass ($+0.91 \pm 0.64$ kg) while controls lost both (-0.24 ± 1.64 kg and -0.08 ± 0.96 kg respectively; $p=0.006$ and $p=0.008$) (Figure 1) [17]. The ongoing PROMISE trial, a randomised double-blind placebo-controlled study, was explicitly designed to test whether protein supplementation preserves fat-free mass across the first postoperative year, reflecting continued equipoise in the field [18]. Taken together, these trials suggest that whey protein alone, without a concurrent mechanical loading stimulus, may

be insufficient to reverse the catabolic trajectory of early post-bariatric weight loss, whereas the combination of adequate protein intake and resistance training appears to shift net muscle protein balance toward accretion rather than mere attenuation of loss.

Table 1: Selected randomised controlled trials of whey/dairy protein supplementation and lean or fat-free mass outcomes after bariatric surgery [16,17,11,18].

Study	Surgery/n	Protein strategy	Duration	Key LBM/FFM outcome
Gomes 2017	Post-bariatric women, n=34	Whey protein, target ~60 g/day	16 weeks	No significant FFM change; greater fat mass and weight loss vs control
Lamarca 2021	RYGB, n=63	Whey protein 25 g/day +/- resistance training	12 weeks	RT+protein: FFM +1.46 kg vs control -0.24 kg (p=0.006)
Alonso 2025	RYGB, n=50	Liquid vs powdered whey protein	2 months	Liquid format: adherence 102.7% vs 42.0% for powder (p=0.012)
Taselaar 2023 (PROMISE, protocol)	Bariatric surgery, ongoing	Protein supplement vs placebo, double-blind	12 months (planned)	Primary outcome: fat-free mass preservation (results pending)

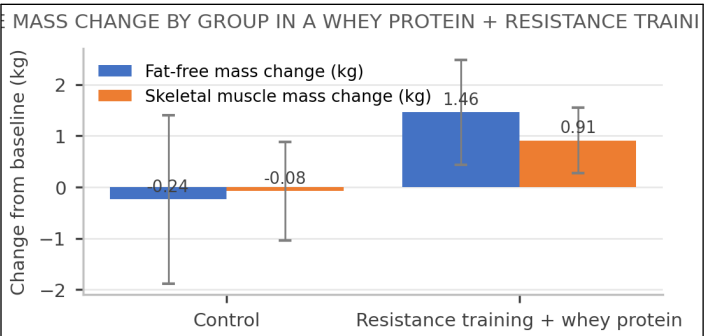


Figure 1: Change in fat-free mass and skeletal muscle mass in control versus resistance-training-plus-whey-protein groups, a controlled trial in patients 2-7 years after Roux-en-Y gastric bypass [17].

Meta-Analytic Evidence and the Role of Resistance Exercise (Figure 2, Table 2)

Pooling across trials clarifies the aggregate signal (Table 2). A 2026 meta-analysis of five randomised controlled trials (267 patients) found whey protein supplementation significantly preserved fat-free mass (mean difference +3.87 kg, 95% CI 1.35-6.39, p=0.003) and reduced fat mass (-2.10 kg, 95% CI -3.92 to -0.27, p=0.024) relative to control (Figure 2) [19]. A contemporaneous systematic review and meta-analysis reached broadly concordant conclusions regarding anthropometric and body-composition outcomes [20]. In contrast, an earlier review of five studies (n=223) described the LBM-preservation evidence as inconclusive, citing low compliance and lack of blinding [21], and a meta-analysis of ten studies (301 patients) confirmed that although lean mass falls substantially post-surgery (-7.4 kg), handgrip strength is largely preserved, suggesting muscle quality rather than quantity may be the more clinically relevant endpoint [22]. Physical activity and resistance training appear to compound any supplementation benefit: five-year follow-up of an exercise trial found higher moderate-to-vigorous activity, more than early resistance training alone, predicted lower long-term weight regain [23], reinforcing that protein supplementation is best considered an adjunct to, not a substitute for, structured exercise. This pattern is consistent with the broader sports-nutrition literature, in which protein supplementation without a training stimulus produces at best modest changes in lean tissue, while the combination of adequate protein and progressive resistance loading reliably produces larger and more consistent gains [8,13].

Table 2: Selected systematic reviews and meta-analyses of protein supplementation and body composition after bariatric surgery [19,20,21,22].

Syntheses	Scope	Studies pooled	Key quantitative finding
Zhao 2026	Whey protein vs control, body composition	5 RCTs, 267 patients	FFM +3.87 kg (95% CI 1.35-6.39, p=0.003); FM -2.10 kg (p=0.024)

Syntheses	Scope	Studies pooled	Key quantitative finding
Ranjbar 2025	Protein supplementation, anthropometry/body composition	Systematic review/meta-analysis of RCTs	Concordant favourable body-composition signal
Romeijn 2021	Additional protein, LBM preservation	5 studies, 223 patients	Inconclusive evidence for LBM preservation
Jung 2023	Muscle mass and strength after surgery	10 studies, 301 patients	Lean mass -7.4 kg; handgrip strength change not significant

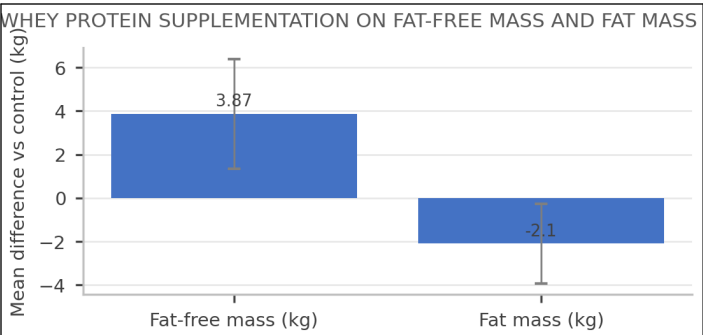


Figure 2: Pooled mean difference in fat-free mass and fat mass with whey protein supplementation versus control, meta-analysis of five randomised controlled trials (267 patients) [19].

Sarcopenic Obesity Risk and Safety Considerations

Sarcopenic obesity — the coexistence of excess adiposity with low muscle mass or function — is increasingly recognised as a distinct post-bariatric phenotype associated with lower weight-loss success, poorer quality of life and greater perioperative risk [24]. Estimates of prevalence vary widely depending on diagnostic criteria: one scoping review reported that roughly one in four patients meets sarcopenic-obesity criteria both before and after surgery, with only around 59% of underlying studies using body composition measures alongside a functional assessment [24]. Imaging studies suggest that diagnostic index choice, more than modality, determines whether sarcopenic obesity risk is detected, complicating cross-study comparison of protein intervention benefit [3]. Reassuringly, relative lean mass as a proportion of body weight often increases even as absolute muscle mass falls, and functional measures such as gait speed and

sit-to-stand performance frequently improve despite lean tissue loss [25,26]. This dissociation between falling absolute muscle mass and preserved or improved function is an important caveat for interpreting whey protein trials that use dual-energy X-ray absorptiometry-derived fat-free mass as their primary endpoint, since a null result for mass need not imply a null result for physical function or metabolic health. Across the trials reviewed here, whey protein supplementation was well tolerated with no signal of excess adverse events, supporting its use as a pragmatic, low-risk adjunct to postoperative nutritional care [16,17,11].

Conclusion

Whey protein supplementation after bariatric surgery is mechanistically well justified by its leucine-rich, rapidly digested amino-acid profile, and pooled randomised-trial data show a modest but statistically significant benefit for fat-free mass preservation and fat mass reduction, particularly when paired with resistance training [19,17]. Individual trials remain heterogeneous in dose, formulation, adherence, follow-up duration and outcome definition, and some report no measurable fat-free mass benefit [16,21], underscoring that supplementation cannot fully substitute for adequate total dietary protein, resistance exercise, and individualised nutritional monitoring [6,14]. Clinicians should therefore frame whey protein supplementation as one component of a broader, multimodal strategy — encompassing dietary counselling, activity prescription and routine body-composition surveillance — rather than a stand-alone remedy for post-bariatric lean mass loss. Adequately powered, standardised trials such as PROMISE are needed to confirm whether whey protein supplementation should become a routine, guideline-endorsed component of post-bariatric surgical care [18]. Until such trials report, whey protein can reasonably be recommended as a practical, well-tolerated aid to meeting protein targets in

patients who struggle to do so through diet alone, ideally alongside structured resistance exercise and regular body-composition monitoring [22,24].

References

1. Mechanick, J.I., Apovian, C., Brethauer, S., Timothy Garvey, W., Joffe, A.M., Kim, J., Kushner, R.F., Lindquist, R., Pessah-Pollack, R., Seger, J., Urman, R.D., Adams, S., Cleek, J.B., Correa, R., Figaro, M.K., Flanders, K., Grams, J., Hurley, D.L., Kothari, S., Seger, M.V., Still, C.D. (2020) Clinical practice guidelines for the perioperative nutrition, metabolic, and nonsurgical support of patients undergoing bariatric procedures - 2019 update. *Obesity*, 28(4): 01-058.
2. Mendes, C., Carvalho, M., Bravo, J., Martins, S., Raimundo, A. (2025) How weight loss after bariatric surgery affects sarcopenia parameters and diagnosis. *Surgeries*, 6(2): 31.
3. Pekar, M., Horka, V., Hyvlova, D., Jirik, R., Uchytel, J., Rygelova, M., Kutac, P., Tomaskova, H., Vilimek, D., Holeczy, P., Maca, J., Buzga, M. (2026) Preliminary assessment of sarcopenic obesity risk after sleeve gastrectomy using dual-modality imaging: a six-month MRI and DXA pilot study in women. *Frontiers in Aging*, 7: 1913282.
4. Abiri, B., Valizadeh, M., Seifi, Z., Amini, S., Haidari, F. (2025) The role of nutritional factors in fat-free mass preservation and body composition changes after bariatric surgery: a systematic review of the available evidence. *Eating and Weight Disorders*, 30(1): 51.
5. Aills, L., Blankenship, J., Buffington, C., Furtado, M., Parrott, J. (2008) ASMBS Allied Health Nutritional Guidelines for the Surgical Weight Loss Patient. *Surgery for Obesity and Related Diseases*, 4(5 Suppl): S73-S108.
6. Nuijten, M.A.H., Eijsvogels, T.M.H., Sanders, B., Vriese, L.M., Monpellier, V.M., Hazebroek, E.J., Janssen, I.M.C., Hopman, M.T.E. (2023) Changes in fat-free mass, protein intake and habitual physical activity following Roux-en-Y gastric bypass surgery: a prospective study. *Obesity Surgery*, 33(7): 2148-2157.
7. Boirie, Y., Dangin, M., Gachon, P., Vasson, M.P., Maubois, J.L., Beaufrère, B. (1997) Slow and fast dietary proteins differently modulate postprandial protein accretion. *Proceedings of the National Academy of Sciences*, 94(26): 14930-14935.
8. Jäger, R., Kerksick, C.M., Campbell, B.I., Cribb, P.J., Wells, S.D., Skwiat, T.M., Purpura, M., Ziegenfuss, T.N., Ferrando, A.A., Arent, S.M., Smith-Ryan, A.E., Stout, J.R., Arciero, P.J., Ormsbee, M.J., Taylor, L.W., Wilborn, C.D., Kalman, D.S., Kreider, R.B., Willoughby, D.S., Hoffman, J.R., Krzykowski, J.L., Antonio, J. (2017) International Society of Sports Nutrition position stand: protein and exercise. *Journal of the International Society of Sports Nutrition*, 14: 20.
9. Frias-Toral, E., Chapela, S., Gonzalez, V., Martinuzzi, A., Locatelli, J., Llobera, N., Manrique, E., Sarno, G., Mingo, M., Marchese, F., Cuomo, R., Romaniello, L., Perna, M., Giordano, A., Santella, B., Schiavo, L. (2025) Optimizing nutritional management before and after bariatric surgery: a comprehensive guide for sustained weight loss and metabolic health. *Nutrients*, 17(4): 688.
10. Ito, M.K., Gonçalves, V.S.S., Faria, S.L.C.M., Moizé, V., Porporatti, A.L., Guerra, E.N.S., Canto, G.D.L., Baiocchi de Carvalho, K.M. (2017) Effect of protein intake on the protein status and lean mass of post-bariatric surgery patients: a systematic review. *Obesity Surgery*, 27(2): 502-512.
11. Alonso, L., Gastaldo, I., Caballero, M., Torres, F., Molero, J., Andreu, A., de Hollanda, A., Ibarzabal, A., Vidal, J., Moizé, V. (2025) Evaluating protein liquid supplementation for enhanced protein intake and adherence at short-term after metabolic and bariatric surgery: a pilot randomized controlled trial. *Obesity Surgery*, 35(9): 3517-3528.
12. Zaromskyte, G., Prokopidis, K., Ioannidis, T., Tipton, K.D., Witard, O.C. (2021) Evaluating the leucine trigger hypothesis to explain the postprandial regulation of muscle protein synthesis in young and older adults: a systematic review.

- Frontiers in Nutrition, 8: 685165.
13. Naclerio, F., Seijo, M. (2019) Whey protein supplementation and muscle mass: current perspectives. *Nutrition and Dietary Supplements*, 11: 37-48.
 14. Faria, I., Samreen, S., McTaggart, L., Arentson-Lantz, E.J., Murton, A.J. (2025) The etiology of reduced muscle mass with surgical and pharmacological weight loss and the identification of potential countermeasures. *Nutrients*, 17(1): 132.
 15. Gariballa, S.E., Al-Bluwi, G., Yasin, J. (2024) Physical activity and diet influence fat-free muscle mass preservation during intentional weight loss: a prospective longitudinal study. *Nutrients*, 16(23): 4044.
 16. Lopes Gomes, D., Moehlecke, M., Lopes da Silva, F.B., Dutra, E.S., Schaan, B.D., Baiocchi de Carvalho, K.M. (2017) Whey protein supplementation enhances body fat and weight loss in women long after bariatric surgery: a randomized controlled trial. *Obesity Surgery*, 27(2): 424-431.
 17. Lamarca, F., Vieira, F.T., Lima, R.M., Nakano, E.Y., Costa, T.H.M., Pizato, N., Dutra, E.S., Baiocchi de Carvalho, K.M. (2021) Effects of resistance training with or without protein supplementation on body composition and resting energy expenditure in patients 2-7 years post-Roux-en-Y gastric bypass: a controlled clinical trial. *Obesity Surgery*, 31(4): 1635-1646.
 18. Taselaar, A.E., Boes, A.J., de Bruin, R.W.F., Kuijper, T.M., Van Lancker, K., van der Harst, E., Klaassen, R.A. (2023) PROMISE: effect of protein supplementation on fat-free mass preservation after bariatric surgery, a randomized double-blind placebo-controlled trial. *Trials*, 24(1): 1-12.
 19. Zhao, X., Shi, T., Xie, X., Zhao, L., Guo, T. (2026) The potential effect of whey protein supplementation in post-bariatric surgery patients: a systematic review and meta-analysis of randomized controlled trials. *Frontiers in Nutrition*, 13: 1832335.
 20. Ranjbar, M., Fallah, M., Djafarian, K., Mohammadi, H., Mohammadi Farsani, G., Shab-Bidar, S. (2025) The effects of protein supplementation on body composition after bariatric surgery: a systematic review and meta-analysis of randomized controlled trials. *Obesity*, doi: 10.1002/oby.24283.
 21. Romeijn, M.M., Holthuijsen, D.D.B., Kolen, A.M., Janssen, L., Schep, G., van Dielen, F.M.H., Leclercq, W.K.G. (2021) The effect of additional protein on lean body mass preservation in post-bariatric surgery patients: a systematic review. *Nutrition Journal*, 20: 27.
 22. Jung, H.N., Kim, S-O., Jung, C.H., Lee, W.J., Kim, M.J., Cho, Y.K. (2023) Preserved muscle strength despite muscle mass loss after bariatric metabolic surgery: a systematic review and meta-analysis. *Obesity Surgery*, 33(11): 3422-3430.
 23. Bellicha, A., Ciangura, C., Roda, C., Torcivia, A., Aron-Wisnewsky, J., Poitou, C., Oppert, J-M. (2022) Effect of exercise training after bariatric surgery: a 5-year follow-up study of a randomized controlled trial. *PLOS ONE*, 17(7): e0271561.
 24. Vieira, F.T., Prado, C.M., Thorlakson, J., Johnson Stoklossa, C., Jin, J., Donini, L.M., Gramlich, L., Bielawska, B. (2025) Sarcopenic obesity in metabolic and bariatric surgery: a scoping review. *Obesity Reviews*, 26(12): e13973.
 25. Carvalho, N.N.C., Martins, V.J.B., Modesto Filho, J., Pereira de Arruda Neta, A.C., Pimenta, F.C.F., de Brito Alves, J.L. (2023) Effects of preoperative sarcopenia-related parameters on the musculoskeletal and metabolic outcomes after bariatric surgery: a one-year longitudinal study in females. *Scientific Reports*, 13: 13373.
 26. De Sousa-Coelho, A.L., Cardoso, P., Santos, T.V., Ramon-Krauel, M., Pais, S., et al. (2025) Impact of bariatric and metabolic surgery on sarcopenia-related parameters according to the EWGSOP2 consensus criteria in persons living with obesity. *Obesity Surgery*, 35(5): 1900-1910.