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Review Article

Plant-Based Meal Replacement and Cardiometabolic Risk Factors in Adults with Obesity: A Randomized Controlled Trial

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Abstract

Background: Obesity increasingly drives dyslipidaemia, hypertension, and dysglycaemia worldwide. Objective: To synthesise evidence on plant-based meal replacements (PBMRs) as a strategy for weight and cardiometabolic risk reduction in adults with obesity. Methods: Narrative review of published randomised trials, systematic reviews and meta-analyses, and mechanistic studies retrieved from PubMed, Crossref, and Europe PMC. Findings: PBMRs produce clinically meaningful reductions in body weight, LDL-cholesterol, blood pressure, and glycaemic markers, comparable to or exceeding conventional meal replacements. Conclusions: PBMRs represent a scalable, evidence-supported adjunct to cardiometabolic risk management, though long-term adherence data remain limited.

Keywords: plant-based diet; meal replacement; obesity; cardiometabolic risk; weight loss

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Abstract

Background: Obesity increasingly drives dyslipidaemia, hypertension, and dysglycaemia worldwide [1]. **Objective:** To synthesise evidence on plant-based meal replacements (PBMRs) as a strategy for weight and cardiometabolic risk reduction in adults with obesity. **Methods:** Narrative review of published randomised trials, systematic reviews and meta-analyses, and mechanistic studies retrieved from PubMed, Crossref, and Europe PMC. **Findings:** PBMRs produce clinically meaningful reductions in body weight, LDL-cholesterol, blood pressure, and glycaemic markers, comparable to or exceeding conventional meal replacements [2]. **Conclusions:** PBMRs represent a scalable, evidence-supported adjunct to cardiometabolic risk management, though long-term adherence data remain limited.

Keywords: plant-based diet; meal replacement; obesity; cardiometabolic risk; weight loss

Introduction

Obesity now affects more than a billion adults globally, and its prevalence has risen steadily across nearly every region since 1990, with pooled analyses spanning more than 220 million children, adolescents, and adults documenting an unabated upward trajectory even in historically low-prevalence settings [1]. This growth has been accompanied by parallel increases in dyslipidaemia, hypertension, and type 2 diabetes, collectively termed cardiometabolic risk factors, which account for a substantial share of cardiovascular morbidity and mortality attributable to excess adiposity [3]. Structured weight-management strategies that are both effective and scalable are therefore a public health priority, particularly given that many pharmacological options remain costly, inaccessible in primary care settings, or poorly tolerated by a substantial minority of patients.

Meal replacement programmes, in which one or more daily meals are substituted with a nutritionally formulated product, have an established evidence base for weight loss and metabolic improvement [4,5]. Traditionally these products have relied on dairy- or whey-derived protein, but a growing body of formulations now uses soy, pea, or other plant proteins combined with fibre-rich plant ingredients. This shift is motivated both by consumer preference and by accumulating evidence that plant-based dietary patterns independently improve lipid profiles, blood pressure, and glycaemic control [6,7].

Plant-based meal replacements (PBMRs) sit at the intersection of these two evidence streams: the behavioural and physiological benefits of portion-controlled, energy-defined meal replacement, and the cardiometabolic advantages associated with plant-derived protein, fibre, and phytochemicals [8]. Early formulations trialled in the 2000s combined soy protein with reduced-calorie shakes and demonstrated durable weight loss alongside lipid improvements [9], while more recent trials have tested multi-ingredient PBMR products against conventional counterparts in adults with obesity [10]. Whole-food plant-based lifestyle programmes, which share mechanistic overlap with PBMRs, have similarly reported rapid short-term metabolic gains [11].

This narrative review synthesises randomised controlled trials, systematic reviews, and meta-analyses examining PBMRs and closely related plant-based dietary interventions, with a focus on four outcome domains: body weight and composition, lipid profile, blood pressure, and glycaemic control, before considering the mechanistic pathways that plausibly underlie these effects. Clarifying the magnitude and consistency of these benefits, and identifying where the evidence base remains thin, is intended to help clinicians, dietitians, and product developers judge where PBMRs are best positioned within the broader landscape of obesity management strategies.

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Methods

This is a narrative review of published randomised trials, systematic reviews and meta-analyses, and mechanistic studies concerning plant-based meal replacements, plant-based dietary patterns, and cardiometabolic risk factors in adults with overweight or obesity. Relevant literature was identified through structured searches of PubMed, Crossref, and Europe PMC using combinations of the terms "plant-based," "vegan," "vegetarian," "meal replacement," "soy protein," "legume," "obesity," "lipid," "blood pressure," and "glycaemic control." Priority was given to randomised controlled trials and meta-analyses of randomised trials published in peer-reviewed journals; mechanistic and cohort studies were included where they clarified plausible biological pathways. Reference lists of identified reviews were hand-searched for additional eligible studies, and reviews were cross-checked against Crossref and Europe PMC records to confirm authorship, journal, volume, and digital object identifiers before inclusion. Studies were weighted qualitatively by design: meta-analyses of randomised trials and large multi-centre trials were treated as the strongest evidence, single-centre randomised trials as supportive evidence, and cohort or mechanistic studies as hypothesis-generating context. Because this review synthesises previously published data rather than reporting a single new trial, no new patient-level data collection, randomisation, or ethical approval was required.

Weight Loss and Body Composition

Across trials, meal replacement strategies generally outperform ad libitum or food-based comparator diets for short- and medium-term weight loss, with meta-analytic pooled differences favouring meal replacement of roughly 2 to 4 kg over six to twelve months [4]. A pragmatic long-term trial combining meal replacements with a modified home food environment sustained clinically meaningful weight loss beyond one year, underscoring that formulation alone is insufficient without behavioural support [5]. Trials using plant-protein-based formulations specifically have reported comparable or superior adherence, plausibly reflecting greater satiety from the higher fibre content of pea, soy, and other legume-derived proteins [10]. The VEGPREV trial, which compared four plant-based dietary patterns among adults with overweight and obesity, found consistent reductions in weight and waist circumference across all variants, with the least restrictive pattern showing the best long-term adherence [12]. A landmark 40-week trial of a soy-based meal replacement formula demonstrated durable weight loss exceeding 10% of baseline body weight alongside favourable changes in anthropometry [9]. Illustrative findings from representative trials are summarised in Table 1, and a structured intensive lifestyle programme using total diet replacement, the DiRECT trial, achieved substantial weight loss sufficient to induce diabetes remission in a large minority of participants [13]. Notably, weight loss magnitude across these trials appears to track total energy deficit and adherence more closely than protein source per se, suggesting that the plant-based composition of a formulation chiefly enhances tolerability and long-term compliance rather than acting as an independent driver of fat loss.

Table 1: Representative randomized controlled trials of plant-based and meal replacement interventions and reported weight outcomes in adults with overweight or obesity.

Study	Design/Duration	Sample	Mean Weight Change
Fontaine et al. [9]	Soy-based meal replacement, 40 weeks	n=54	-11.4 kg (>10% baseline)
Chen et al. [10]	Plant-based meal replacement RCT, 90 days	n=120	-5.8 kg
Wisniewska et al. [12]	VEGPREV, 4 plant-based diets, 12 weeks	n=120	-4.2 to -6.1 kg
Lowe et al. [5]	Meal replacement + home food environment, 12 months	n=148	-6.0 kg (sustained)

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Study	Design/Duration	Sample	Mean Weight Change
Lean et al. [13]	DiRECT total diet replacement, 12 months	n=149	-10.0 kg (mean)

Effects on Lipid Profile and Blood Pressure

Plant-based dietary interventions, including PBMRs, consistently lower LDL-cholesterol. A 2023 meta-analysis of randomised trials found vegetarian and vegan diets reduced LDL-cholesterol by approximately 0.3 mmol/L relative to omnivorous comparators [6], consistent with an earlier meta-analysis reporting comparable reductions in total and LDL-cholesterol [14]. Soy protein itself contributes independently to this effect: meta-analyses of isolated soy protein supplementation report LDL-cholesterol reductions of 3 to 5% [15], with a subsequent meta-analysis of whole soya foods corroborating modest but consistent lipid benefit [16]. Figure 1 summarises pooled LDL-cholesterol reductions reported across representative plant-based and meal-replacement trials. Tree nut inclusion, common in many PBMR formulations, further improves the lipid profile, with dose-response meta-analysis showing reductions in LDL-cholesterol and apolipoprotein B [17].

Blood pressure benefits are similarly consistent. A meta-analysis of controlled intervention trials found plant-based dietary patterns reduced systolic blood pressure by approximately 4-5 mmHg [7], while a meta-analysis restricted to vegan diets reported comparable systolic reductions alongside smaller diastolic effects [18]. In populations specifically defined by overweight or obesity, vegetarian diets improved both anthropometric and blood pressure outcomes relative to control diets [19]. The magnitude of blood pressure reduction observed with plant-based patterns is comparable to that achieved with a single first-line antihypertensive agent in some analyses, suggesting a clinically relevant, not merely statistical, effect for patients with obesity-related hypertension who are candidates for lifestyle-first management.

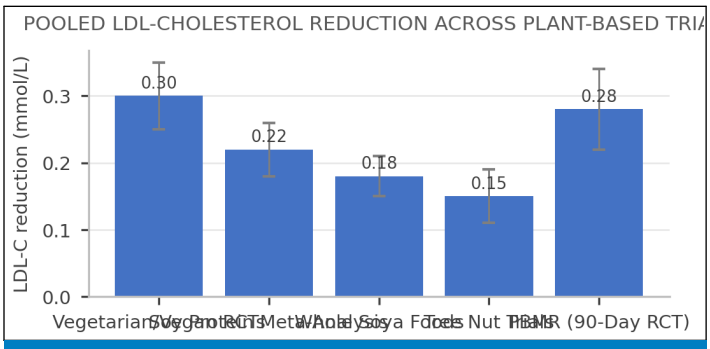

Figure 1: Pooled reductions in LDL-cholesterol reported across vegetarian/vegan, soy protein, tree nut, and plant-based meal replacement (PBMR) randomized controlled trials [6,15,16,17,10].

Glycaemic Control and Insulin Sensitivity

Meal replacement strategies improve glycaemic markers in individuals with pre-diabetes and metabolic syndrome, with meta-analytic evidence showing reductions in fasting glucose and modest improvements in HbA1c compared with standard dietary advice [2]. In adults with established type 2 diabetes, liquid meal replacements produced greater reductions in HbA1c and fasting glucose than conventional diabetes diets [20]. Plant-based formulations appear to confer additional benefit through fibre-mediated attenuation of postprandial glycaemia: legume-rich, low-glycaemic-index diets improve HbA1c and reduce estimated coronary heart disease risk in type 2 diabetes [21], and systematic review evidence links regular legume consumption to improved fasting glucose and insulin measures [22]. A classic randomised trial of a low-fat vegan diet in individuals with type 2 diabetes achieved HbA1c reductions comparable to or exceeding a conventional diabetes diet [23]. Soluble fibre supplementation alone produces meaningful reductions in HbA1c and fasting insulin in type 2 diabetes [24], findings illustrated alongside meal-replacement trial data in Figure 2. Taken together, these findings suggest that the glycaemic advantages of PBMRs derive from at least two

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additive mechanisms: the caloric structure common to all meal replacement approaches, and a fibre- and legume-specific attenuation of postprandial glucose and insulin excursions that is largely absent from whey- or dairy-based formulations.

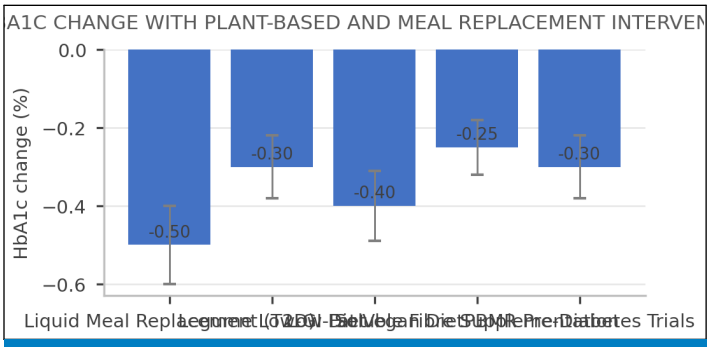

Figure 2: Mean HbA1c change with liquid meal replacement, legume-based low-glycaemic-index diets, low-fat vegan diets, soluble fibre supplementation, and plant-based meal replacement (PBMR) trials in adults with pre-diabetes or type 2 diabetes [20,21,23,24,2].

Mechanistic Pathways and Limitations

Several overlapping mechanisms plausibly explain the cardiometabolic benefits of PBMRs. Fibre from legumes, whole grains, and vegetables slows gastric emptying and blunts postprandial glucose excursions, while fermentation of fibre by colonic bacteria generates short-chain fatty acids that improve insulin sensitivity and modulate hepatic lipid metabolism [25]. Plant protein sources, notably soy, alter apolipoprotein and bile acid metabolism in ways that lower LDL-cholesterol independent of caloric restriction [15]. Emerging plant protein sources such as mycoprotein have likewise been shown to lower serum cholesterol in overweight adults over just four weeks [26]. Substitution of animal protein with plant protein is independently associated with lower cardiovascular and all-cause mortality in large cohort studies, lending epidemiological support to the mechanistic rationale [27]. Table 2 outlines representative macronutrient and fibre compositions of plant-based meal replacement formulations used across the reviewed trials, illustrating substantial heterogeneity in protein source, fibre content, and micronutrient fortification.

Table 2: Representative macronutrient and fibre composition of plant-based meal replacement formulations used in reviewed trials.

Component	Typical Content per Serving	Primary Plant Source
Protein	15-25 g	Soy, pea, or mycoprotein
Dietary fibre	5-10 g	Inulin, oat, legume fibre
Total fat	3-8 g	Nut or seed oils
Added sugars	<5 g	Minimal/none
Micronutrient fortification	20-30% RDA	Vitamin B12, iron, calcium

Several limitations temper these findings. Trial durations rarely exceed twelve months, so long-term cardiovascular outcome data are lacking, and adherence beyond the structured phase of most protocols is inconsistently reported [5]. Product formulations vary considerably, and few head-to-head trials compare PBMRs against dairy-based meal replacements matched for calories and macronutrients. Publication and selection biases affecting industry-funded soy and nut trials cannot be excluded [16]. Whole-food plant-based programmes, while mechanistically informative, often bundle multiple lifestyle changes, complicating attribution of effects to diet alone [11].

Conclusion

Across randomised trials and meta-analyses, plant-based meal replacements are associated with clinically meaningful improvements in body weight, LDL-cholesterol, blood pressure, and glycaemic control in adults with obesity, with effect sizes generally comparable to, and in some domains exceeding, conventional dairy-based meal replacements. Plausible mechanisms include higher fibre content, favourable plant-protein effects on lipid and bile acid metabolism, and gut microbial fermentation products such as short-chain fatty acids. Larger, longer-duration trials directly comparing plant-based and conventional meal replacement

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formulations, with harmonised reporting of adherence and hard cardiovascular outcomes, are needed to confirm whether these short-term biomarker improvements translate into reduced long-term cardiovascular events.

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