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Effects of vegan diets and lifestyle on adult body composition: a narrative review

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The health benefits of vegan diets are well documented, though achieving nutritional adequacy requires careful planning, as is the case with any well-designed diet. Vegan diets effectively address obesity, with emerging evidence suggesting that body composition analysis offers a more accurate assessment of body weight management than traditional body mass index (BMI) calculations. This narrative review evaluates the impact of vegan diets on adult body composition based on 16 human interventional studies (published between 01/2014–10/2024), sourced from the PubMed/Medline database across various countries, including the USA, Canada, Brazil, Chile, and several European countries. Findings indicate that vegan diets can lead to greater reductions in body weight and more favourable changes in body composition compared to control diets, including high carbohydrate lacto-ovo, traditional and vegan-type Mediterranean, animal-based ketogenic, portion-controlled, therapeutic omnivorous and Western-type diets. However, some studies report significant muscle mass loss. Strategies to mitigate this include regular physical activity, particularly resistance training, ensuring sufficient protein intake and applying modest energy restrictions without compromising nutrient adequacy. Individual factors such as baseline BMI and health status also influence outcomes. This review further addresses critical real-world questions and dilemmas to deepen understanding of the relationship between vegan diet, body composition, and overall health, thus contextualizing the theme. Future research should explore whether a well-designed vegan diet, combined with customized lifestyle interventions, can further improve muscle mass preservation and overall body composition outcomes compared to other dietary lifestyles.

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1. Introduction

The World Obesity Federation identifies obesity as a progressive, relapsing chronic noncommunicable disease (NCD).[1] Affecting over 2.5 billion adults, including 650 million obese, obesity and overweight present major public health issues. Since 1990, obesity rates have more than doubled, with rates quadrupling.[2] This trend elevates NCD risks, such as coronary heart disease, dyslipidaemia, hypertension, type 2 diabetes and certain cancers through metabolic dysregulation, systemic inflammation and hormonal imbalances that compromise cardiovascular, endocrine and immune functions.[2–4] Over the next three decades, individuals classified as overweight are projected to contribute to 60% of diabetes cases, 18% of cardiovascular disease (CVD) cases, 11% of dementia cases and 8% of cancer cases globally.[5,6] A systematic review of 19 studies highlights obesity's economic impact, contributing 0.05% to 2.42% of GDP, with 0.7% to 17.8% of health expenditures from direct costs.[7] The global economic cost of preventable lifestyle-associated NCDs (*e.g.*, physical inactivity, poor nutrition, tobacco use and excessive alcohol intake) is projected to reach 44 trillion euros by 2030.[8] Reducing the projected prevalence of overweight and obesity by 5% annually from current trends or maintaining it at 2019 levels could save $429 billion annually, totalling approximately $2.2 trillion from 2020 to 2060 across 161 countries.[9]

Body weight (BW) management is challenging due to environmental factors like the availability of "obesogenic

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foods", media advertising, social influences and chronic stress.[3,10–13] Losing BW is vital for those with obesity to improve metabolic risk factors linked to diabetes, coronary artery disease and obesity-related cancers.[14] However, in their review, Dabas *et al.*, found that a few studies indicate that BW loss eventually slows down, stagnates, or reverses in 85% of cases.[15] A *meta*-analysis of 29 long-term BW loss studies revealed that more than half of the BW lost was regained within two years, and by the five-year mark, over 80% of the initial BW loss had been regained.[16] This issue stems from biological, medical, interventional, lifestyle and environmental factors beyond individual differences.[15] Long-term obesity management requires sustained behavioural changes and ongoing support systems to reinforce positive behaviours and meet individual expectations.[17,18]

The World Health Organization (WHO) classifies individuals into six obesity categories based on height and BW.[19] However, the body mass index (BMI) does not distinguish between fat-free mass (FFM), lean body mass (LBM) and body fat mass (BFM),[20] leading to potential inaccuracies. For instance, a study from the USA found that BMI may not indicate cardiometabolic disease risk in about 30% of adults.[21] Body composition, unlike BMI, offers crucial insights for BW management, disease and mortality risks.[22–25] Technologies used for quantitative assessment of the body include bioelectrical impedance analysis (BIA), dual-energy X-ray absorptiometry (DXA), magnetic resonance imaging (MRI) and spectroscopy (MRS), computed tomography (CT) and ultrasound imaging (US).[26,27] BW loss usually results in reduced muscle mass, identified as FFM, LBM or skeletal muscle mass (SMM), which enables body movements. The body comprises BFM and FFM, including bone, water, organs and SMM. LBM is calculated as total BW minus BFM and bone mineral content, while SMM is more accurately measured by MRI and often estimated through LBM and FFM.[28] A key limitation in the existing literature is that most BW loss often uses FFM or LBM as proxies without directly measuring SMM. Accurate SMM assessment requires advanced imaging techniques, like whole-body MRI or D3-creatine dilution, not commonly used in BW loss studies.[29]

In overweight and obese individuals, diet-induced BW loss usually results in 20–40% FFM/LBM loss, with the rest from BFM reduction.[14,30,31] A decrease in LBM can cause adverse health effects such as lower resting energy expenditure, fatigue, impaired neuromuscular function, higher injury risk and increased appetite.[31,32] Low muscle mass and unintentional BW loss are linked to illness but differ from intentional BW loss aimed at improving obesity-related health outcomes.[29] Obese individuals typically have greater absolute muscle mass due to higher musculoskeletal loads compared to those with normal BMI, but some may develop sarcopenic obesity, marked by the coexistence of obesity and poor muscle health.[14,33] Sarcopenia involves an age-related decline in SMM and strength, commonly affecting vulnerable populations such as postmenopausal women and older adults.[14,34] It is associated with significant health risks like falls, fractures, frailty and mortality. Sarcopenic obesity features reduced SMM and impaired function coupled with excessive adipose tissue. Its incidence is rising with global ageing, obesity, inflammation and inactivity or poor diet.[35,36]

To prevent muscle mass loss during BW reduction, strategies focus on optimizing body composition and muscle quality. This involves improving the FFM/LBM-to-BFM ratio, reducing the accumulation of triglycerides in muscles, increasing insulin sensitivity and enhancing muscle strength relative to mass. Preserving muscle mass is clinically beneficial, particularly for those with low baseline muscle mass.[14,29,37,38] Muscle loss may lead to unfavourable BW regain following intentional BW loss. In addition, unintentional muscle mass loss may influence appetite regulation, potentially contributing to this phenomenon.[31,32,39] The loss of muscle mass during diet-induced BW loss can be primarily attributed to excessive energy restriction, which suppresses postprandial muscle protein synthesis. In contrast, moderate and prolonged energy restriction combined with controlled BW loss has been shown to stimulate muscle protein synthesis. For individuals with obesity experiencing hypocaloric BW loss, regular physical activity (PA), particularly resistance training, along with adequate protein intake, is crucial to mitigate muscle mass loss. This is crucial, especially on very low-energy diets (800–1200 kcal day^{-1}).[14,34,40] When consumed *ad libitum*, a vegan diet, particularly the one based on a whole-food vegan (WFV) dietary pattern, tends to reduce both energy and protein intake due to the high satiety effects of fibre-rich unprocessed foods.[41,42] Unless well-designed or supplemented with vegan protein sources, such diets may especially compromise protein adequacy.[43–47] Therefore, well-designed vegan diets that incorporate sufficient vegan protein in the overall diet are essential for preserving muscle mass during BW loss, which, however, is true for any kind of diet, too.[48]

While there are diverse opinions on the most effective dietary patterns for BW loss and overall health, experts generally agree that a healthy diet should prioritize whole, minimally processed, plant-dominant foods.[49–54] Vegetarian diets, especially vegan diets, and their associated healthy lifestyles are increasingly studied for their potential to address global environmental concerns, food-system sustainability[50,55–57] and public health challenges, including NCDs such as obesity, CVD, type 1 and type 2 diabetes, prostate cancer, various autoimmune diseases, Alzheimer's disease and healthy ageing.[58–76] While both vegan and non-vegan diets can raise concerns about nutritional adequacy, since either can be nutritionally inadequate without proper planning.[77–85] However, the main global issue is not the type of diet, but rather the individual's knowledge of nutrition, meal preparation skills, and commitment to choosing and preparing healthy, nutrient-rich meals, primarily from whole foods.

Research on vegan diets mainly examines BW loss only, given the prevalence of obesity-related diseases.[6,86] For example, an RCT on a WFV diet for adults in pre-obesity and obese BMI categories with ischaemic heart disease or type 2 diabetes showed significant BW loss: an average of 8.6 kg at three months, 12.1 kg at six months and 11.5 kg at twelve months. However, the study did not report changes in BFM, FFM, or LBM during body weight loss and lacked detailed dietary intake and physical activity PA data. Physical activity was assessed solely using the Borg Rating of Perceived Exertion scale, which does not allow for a precise definition of the type, duration, frequency, or intensity of the activity performed.[87] The omission of detailed data on body composition changes, PA, and incomplete dietary intake information complicates the interpretation of study outcomes. Further, the relationship between PA and its effects on BW loss and body composition is influenced by various dietary factors and continues to be a subject of ongoing research. An umbrella review indicates that PA positively influences BW loss and body composition by decreasing BFM and visceral adipose tissue (VAT). Although the effects are modest, various PA types offer unique benefits: aerobic training effectively reduces BW and BFM, while resistance training is crucial for maintaining LBM during BW loss.[88] Regardless, there is substantial evidence indicating that effective BW loss is best achieved through a combination of dietary modifications and PA rather than through interventions focused solely on diet or PA.[14,30,33,89–93] An additional challenge in such studies is the potential for inadvertent increases in PA in diet-only studies due to participants' awareness of being monitored, a phenomenon known as the Hawthorne effect.[94,95] Historically, studies have rarely explored the combined effects of multiple interventions on health outcomes, such as a vegan diet and PA. However, recent research is increasingly integrating lifestyle interventions, allowing for a more comprehensive and generalized understanding of their effects rather than attributing results solely to dietary changes.[46,60,71,96,97]

This narrative review aimed to assess the impact of vegan diet interventions on body composition, especially BFM and muscle mass during BW loss. We hypothesize that (i) a well-designed vegan diet combined with resistance training can preserve fat-free mass FFM or LBM, and (ii) that interventional studies predominantly promote WFV diets. Moreover, this narrative review addresses important real-world questions of urgent relevance and dilemmas of pressing concern to enhance the understanding of the relationship between a vegan diet (leaving vegan ideology aside), body composition, and overall health, providing context for the theme.

2. Search strategy and structure of a review flow procedure

This narrative review includes English-language interventional studies that investigated the effects of vegan diets on body composition changes in adults (≥18 years). Relevant studies were identified through a comprehensive search of the PubMed/Medline databases. Search terms and filters were applied to refine the review results, and the complete syntax is available in Appendix A. The database screening process was conducted by an independent investigator from the Information Forwarding and Search Service of the Central Medical Library, University of Ljubljana, Slovenia (in acknowledgement). In addition, reference lists of included articles were screened to identify potential articles for inclusion that were not identified by the comprehensive database search. The review process followed a structured procedure and flow (Fig. 1) to ensure systematic and seamless identification, screening and selection of eligible studies for analysis.

Notably, the present investigation focused exclusively on studies published within the inclusion date range (January 2014 to October 2024), with a particular emphasis on those that may have been classified in the PubMed/Medline database at a later stage. The 10-year timeframe was implemented to address the review's priority of analysing quality evidence published most recently in the last decade. Additionally, the end date of October 2024 aligns with the timeline for searching, analysing, and writing this publication. The inclusion criteria specified that the study investigated intervention studies involving a vegan diet, without limitations regarding study design, participants' BMI, or health status. The use of dietary sup-

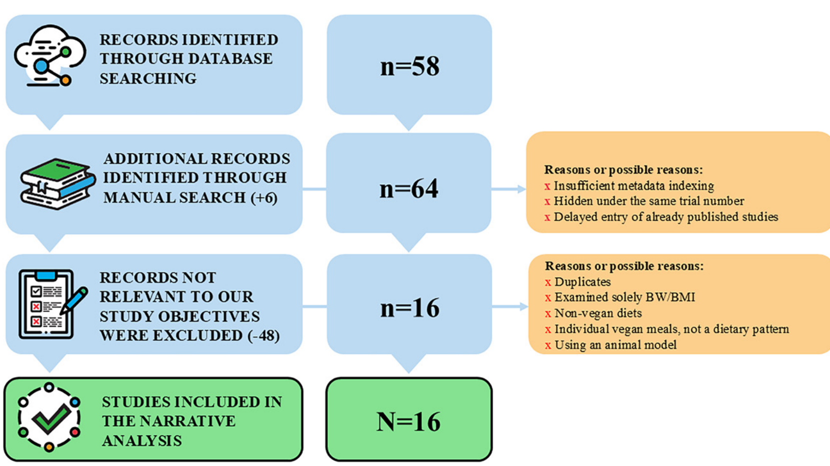

Fig. 1 An overview and flow of the narrative review process.

plements like vegan meal replacements (MR) or vegan protein powders was also not a criterion for exclusion.

Additionally, considering confusion in the literature regarding "vegan" and "plant-based" diets, which are often used interchangeably, a vegan diet was considered in this review in line with the leading scientific standards as one that entirely excludes all animal products, differentiating it from traditional (lacto-, ovo-) vegetarian diets.[77,98,99] Moreover, the Western dietary pattern is characterised by high caloric density, predominantly comprised of red meat and a significant proportion of ultra-processed foods (UPF), such as processed meats, sugar-sweetened beverages (SSB), baked goods and confections. This diet is notably deficient in fruits, vegetables, whole grains and dietary fibre. Conversely, an (balanced) omnivorous diet, historically referred to as a balanced mixed or healthy diet, is continuously evolving in definition but generally aligns more closely with the dietary guidelines recommended by health and nutrition authorities.[100–102] Therefore, in review of the analysed studies, control diets that either did not specify dietary changes or instructed participants to adhere to their usual eating habits—including the baseline diet in single-arm studies—were categorized as adhering to a Western-type dietary pattern.

Exclusion criteria were applied to remove study duplicates, studies focused solely on BW loss or BMI changes without further measures of body composition, non-vegan diets, individual vegan meals (*i.e.*, rather than a full vegan dietary pattern) and studies involving animal models. Fig. 1 presents an overview and flow of the inclusion process. For studies with multiple publications, the article reporting the primary research findings rather than those based on a smaller subset of participants was prioritized for inclusion.

To ensure the accurate identification of duplicated studies, the primary reference for interpretation was the "ClinicalTrials.gov" NCT number or the "International Clinical Trial Registry Platform" identifier. Ethical approval details, including the institutions that approved the study protocol (*e.g.*, multiple ethical boards for different studies under the same trial registration number), were also reviewed to confirm the integrity and uniqueness of the included studies. Additionally, this review cross-referenced previously published study protocols, study dates, inclusion criteria and the identification of the control group to prevent duplication of study results in the analysis.

Body composition was evaluated mainly through simultaneous changes in BW and BMI. Studies that reported changes only in waist circumference without providing data on BF in kilograms (mass), percentages (%) or FFM/LBM were categorized as reporting anthropometric measures rather than body composition metrics and were excluded from detailed analysis. For descriptive interpretation, studies conducted by the same research group/led by a common principal investigator that employed similar BW loss interventions across diverse demographic populations or as secondary analysis were included if they provided complementary body composition data or compared popular diet patterns (even if they did not meet the formal inclusion criteria). This descriptive inclusion aimed to supplement the dataset and facilitate a more comprehensive understanding of the factors influencing the observed outcomes.

3. Results

3.1. Characteristics of the studies included in the review

The initial database search identified 58 potentially relevant publications. An additional six articles were identified through manual search and reference lists of included studies. In this review, we examined and evaluated 16 interventional studies that met the inclusion criteria, focusing on the impact of a vegan diet and lifestyle on body composition. These studies were conducted across the USA,[41,42,103–106] Canada,[107] Brazil,[46] Chile[108] and various European countries such as the UK,[109] the Netherlands,[110,111] Slovenia,[44,112] Spain[113] and Germany.[114] Among the 16 studies, nine were RCTs; the rest were non-randomized, including three single-arm trials. Table 1 (diet only, n = 8) and Table 2 (combined diet and PA, n = 8) provide an overview of the studies, including all relevant details.

To assess body composition, ten studies utilized DXA,[41,42,46,103–106,109–111] whereas the remaining studies employed BIA technology.[44,107,108,112–114] However, nine studies (60%) employed control diets that represented high-quality dietary patterns as described in the scientific literature.[41,42,46,104,107,108,112–114] These control diets included high-carbohydrate lacto-ovo-vegetarian,[107] traditional Mediterranean,[42] vegan-type Mediterranean,[113] animal-based ketogenic,[104] portion-controlled omnivorous,[112] therapeutic omnivorous,[41] non-supervised omnivorous diet[108] and omnivorous diets supervised by dietitians.[46,114] In four studies, control diets were either unspecified or instructed participants to maintain their usual eating habits,[103,105,110,111] termed in the methods section as Western-type diets. We also included the baseline diets from three single-arm studies in this category.[44,106,109] In this review, eight studies (50%) incorporated PA as part of their lifestyle interventions,[44,46,106,108,110–112,114] with most focusing on resistance training; three studies included both resistance and aerobic-type training.[106,110,111] The remaining eight studies did not include PA as part of the intervention,[41,42,103–105,107,109,113] but it may have been maintained prior to the study period. Three studies evaluated participants with a normal BMI, which comprised three distinct groups of lean, muscular individuals: one untrained group,[46] one generally physically active group[113] and one fitness-oriented group.[114] The remaining participants' BW was classified as pre-obesity,[44,104,110,112] obese class I[42,103,105–109,111] or obese class II,[41] according to the WHO's BMI classification.[19]

A total of ten studies examined a WFV diet.[41,42,44,103–106,110–112] Among these, two studies utilised a vegan MR in the otherwise WFV diet (≥90% of energy intake).[44,112] However, in the other studies categorized as

Table 1 Changes in body composition with a vegan diet only

First author (year of publication)	Country of study	Study design	Subjects in intervention/control groups (n/n)	Study duration (w/m)	Type, quality of intervention and control diet	Type, frequency, duration of PA/No PA	Method of assessment (DXA/BIA)	Results	Other outcomes in the intervention group	Special features
Jenkins *et al.*, (2014)[107]	Canada	RCT	10/13	6 m	Low-carbohydrate vegan *vs.* high-carbohydrate lacto-ovo-vegetarian diet	No PA was prescribed but it was recorded	BIA	−6.8 kg *vs.* −5 kg of BW, −4.2% *vs.* −3.9% of BF%	↓ Total cholesterol, LDL cholesterol, ApoB, triglycerides	*Ad libitum* eating was recommended. No FFM was measured. The total PA level was constant (24 METs). Participants with hyperlipidemia were classified as class I obese based on BMI.
Kahleova *et al.*, (2018)[103]	USA	RCT	37/35	16 w	Low-fat WFV *vs.* control diet (no change)	No PA was prescribed but it was recorded	DXA	−6.4 kg *vs.* −0.6 kg of BW, −2.3 kg (36%) *vs.* −1 kg of LBM, −3.9 kg (61%) *vs.* +0.4 kg of BFM	↓ Total cholesterol, LDL cholesterol, HDL cholesterol, HOMA-IR, fasting insulin resistance, fasting and postprandial plasma glucose concentration and VAT ↑ Beta-cell sensitivity	Intervention group: *Ad libitum* eating was recommended, and unannounced by telephone calls, the dietitians assessed participants' dietary adherence. The total PA remained unchanged. The initial BMI was classified as obese class I.
Kahleova *et al.*, (2020)[105]	USA	RCT	117/106	16 w	Low-fat WFV *vs.* control diet (no change)	No PA was prescribed but it was recorded	DXA	−6.4 kg *vs.* −0.5 kg of BW, −2.1 kg (33%) *vs.* −0.6 kg of LBM, −4.1 kg (64%) *vs.* +0.01 kg of BFM	↓ Total cholesterol, LDL cholesterol, HDL cholesterol, HOMA-IR, hepatocellular lipid and VAT ↑ Thermic effect of food	Intervention group: *Ad libitum* eating was recommended, and weekly lectures and cooking demonstrations were included. The total PA decreased (from 2719 METs to 2114 METs). The initial BMI was classified as obese class I.
Hall *et al.*, (2021)[104]	USA	RCT, cross-over	20	2 w (each)	Low-fat WFV *vs.* animal-based ketogenic diet	No PA was prescribed but was recorded (no change)	DXA	−1.09 kg (vegan) *vs.* −1.77 kg (keto) of BW, −0.16 kg *vs.* −1.61 kg of FFM, −0.67 kg *vs.* −0.18 kg of BFM	↑ Glucose, insulin levels and muscle mass preservation ↓ LDL cholesterol, ApoB, hs-CRP, BP, energy intake NS difference in VAT	Participants classified as pre-obese based on their BMI were admitted as inpatients to the National Institutes of Health Clinical Centre. *Ad libitum* eating was recommended (all food was provided).

Table 1 *(Contd.)*

First author (year of publication)	Country of study	Study design	Subjects in intervention/control groups (n/n)	Study duration (w/m)	Type, quality of intervention and control diet	Type, frequency, duration of PA/No PA	Method of assessment (DXA/BIA)	Results	Other outcomes in the intervention group	Special features
Argyridou *et al.*, (2021)[109]	UK	Single-arm	23	8 w	Vegan diet	No PA was prescribed (asked to maintain), but was recorded (total PA was comparable)	DXA	−2.6 kg of BW, −1.2 kg (46%) of LBM, −1.5 kg of BFM, −0.08 kg of VAT	↓ Plasma TMAO, postprandial glucose, total cholesterol, LDL cholesterol and markers of renal function	Individualised follow-up by telephone between face-to-face visits over 10–14 days. *Ad libitum* eating was recommended. The participant with dysglycemia had a BMI classified as obese class I.
Barnard *et al.*, (2022)[42]	USA	RCT, cross-over	62	16 w (each)	Low-fat WFV *vs.* Mediterranean diet	No PA was prescribed but it was recorded	DXA	−6 kg *vs.* 0 kg of BW, −2.5 kg (42%) *vs.* −0.2 kg of LBM, −3.6 kg *vs.* −0.2 kg of BFM	↓ Total cholesterol, LDL cholesterol, HOMA-IR, systolic and diastolic BP (in the Mediterranean diet more), ↑ OGIS	Weekly lectures and cooking demonstrations were included. The total PA level was 2585 METs and 2952 METs at baseline and week 16. The baseline BMI was classified as obese.
Turner-McGrievy *et al.*, (2023)[41,115]	USA	RCT	77/82	24 m	WFV *vs.* therapeutic omnivorous diet	PA was not prescribed or recorded	DXA	−2.5 kg *vs.* −2 kg of BW, −1.5 kg (60%) *vs.* −1.3 kg of LBM (65%), −0.3% *vs.* −0.3% of BFM	No difference in total cholesterol, LDL cholesterol and BP changes between the groups	*Ad libitum* eating was recommended, and nutrition classes were offered (weekly for 6 months, biweekly for 6 months, and monthly for 12 months). The participant's BMI was in the obese class II category.
López-Moreno *et al.*, (2024)[113]	Spain	RCT, cross-over	14	3 w/4 w	Traditional Mediterranean *vs.* vegan-type Mediterranean diet	They maintained their PA routines	BIA	NS difference in body composition indices after the baseline period for both diets	↓ LDL cholesterol, triglycerides, BP and mean arterial pressure, improved immune status, but NS differences in cardiorespiratory fitness	Participants were physically active, healthy males with a normal BMI, monitored by registered dietitians through weekly follow-ups.

RCT: randomized controlled trial, n: number, w: weeks, m: months, BIA: bioelectrical impedance analysis, DXA: dual-energy X-ray absorptiometry, WFV: whole-food vegan, ↓: decreased, ↓: increased, PA: physical activity, DXA: dual X-ray absorptiometry, BIA: bioimpedance analysis, USA: United States of America, UK: United Kingdom, FFM: fat-free mass, LBM: lean body mass, BFM: body fat mass, LDL cholesterol: low-density lipoprotein cholesterol, ApoB: apolipoprotein B, BMI: body mass index, METs: metabolic equivalents, HOMA-IR: homeostatic model assessment for insulin resistance, VAT: visceral adipose tissue, hs-CRP: high-sensitivity C-reactive protein, TMAO: trimethylamine-*N*-oxide, BP: blood pressure, OGIS: oral glucose insulin sensitivity, NS: non-significant.

Table 2 Changes in body composition with combined vegan diet and PA

First author (year of publication)	Country of study	Study design	Subjects in intervention/control groups (n/n)	Study duration (w/m)	Type, quality of intervention and control diet	Type, frequency, duration of PA/No PA	Method of assessment (DXA/BIA)	Results	Other outcomes in the intervention group	Special features
Jakše *et al.*, (2017)[112]	Slovenia	Non-RCT	241/84	10 w	Low-fat WFV diet with MR *vs.* portion control (own judgement)	Resistance training: 2–3 times weekly for 45 min	BIA	−5.6 kg *vs.* −1.2 kg of BW, −0.3 kg (5%) *vs.* −0.4 kg (33%) of FFM, −4.3% *vs.* −0.4% of absolute BF% change	A subgroup of BMI ≥30 kg m^{-2}: −7.3 kg *vs.* −1.9 kg of BW, −0.9 kg (12%) *vs.* −0.7 kg (37%) of FFM, −3.8% *vs.* −0.5% of absolute BF% change	Intervention group: *Ad libitum* eating was recommended, and MR was used. Weekly lectures were included for both groups. The participants' BMIs were in the pre-obesity category.
Jakše *et al.*, (2019)[44]	Slovenia	Single-arm	36 (phase 1) 18 (phase 2)	9 m	Low-fat WFV diet with MR	Resistance training: 2–3 times weekly for 45 min	BIA	End phase 1: −2.6 kg of BW, −0.1 kg of FFM (4%), −4% of BF% End phase 1 *vs.* end phase 2: −3 kg of BW, −0 kg of FFM, −1.9% of BF%	↓ Total cholesterol, LDL, non-HDL and HDL cholesterol, IGF-1 regressed toward the mean	*Ad libitum* eating was recommended, and MR was used. Weekly lectures were included in phase 1. The participants' BMIs were in the pre-obesity category.
Hevia-Larrain *et al.* (2021)[46]	Brazil	Non-RCT with parallel group	19/19	12 w	Vegan *vs.* omnivorous diet	Lower-limb resistance training 2 times weekly as an intervention with added protein: soy for VEG and whey for OMN	DXA	VEG *vs.* OMN: +1.8 kg *vs.* +2 kg of BW, +1.9 kg *vs.* +1.5 kg of LBM, −0.1 kg *vs.* +0.6 kg of BFM	↑ LBM and strength in both groups, with no differences	Participants were untrained, physically active males. Protein intake was set at 1.7 g per kg of BW, and the researcher studied how resistance training affected body composition and strength in lean, muscular participants who were either vegans or omnivores with normal BMI.
Bernhart *et al.*, (2022)[106]	USA	Non-RCT	45/25	12 w	WFV *vs.* control diet (not specified)	Resistance training: 2–3 times weekly, moderate-to-vigorous aerobic activities: 2–3 times weekly for 45–60 min	DXA	−1.9 kg m^{-2} *vs.* −1.4 kg m^{-2} of BMI, −1.8% *vs.* −1.9% of BF%	↓ DII	Intervention group: *Ad libitum* eating was recommended. Weekly and monthly lectures covered topics such as anti-inflammatory WFV diets, PA, and stress management techniques. The participants' BMIs were in the obese class 1 category. They received financial compensation upon completion of the study.

Table 2 *(Contd.)*

First author (year of publication)	Country of study	Study design	Subjects in intervention/control groups (n/n)	Study duration (w/m)	Type, quality of intervention and control diet	Type, frequency, duration of PA/No PA	Method of assessment (DXA/BIA)	Results	Other outcomes in the intervention group	Special features
Walrabenstein *et al.*, (2023)[110]	Netherlands	RCT with parallel design	40/37	16 w	WFV *vs.* control (no change) diet	Resistance training: 2 times weekly, aerobic activities: 150 min weekly of moderate intensity	DXA	−3.5 kg *vs.* +1 kg of BW, −2.9 kg (83% of BW loss) *vs.* +0.5 kg of BFM	↓ LDL cholesterol and HbA1c, improved DAS28	Intervention group: Weekly meetings were included. The participants' BMIs were in the pre-obesity category. They had a high risk for RA or MSOA.
Walrabenstein *et al.*, (2023)[111]	Netherlands	RCT with parallel design	32/32	16 w	WFV *vs.* control (no change) diet	Resistance training: 2 times weekly, aerobic activities: 150 min weekly of moderate intensity	DXA	−6.4 kg *vs.* −0.1 kg of BW, −3.9 kg (61%) *vs.* −0.1 kg (0.2%) of BFM	↓ LDL cholesterol, hs-CRP, HbA1c and fasting glucose Improved WOMAC, PROMIS (fatigue and pain interference)	Intervention group: Weekly meetings were included. The participants with MSOA had BMIs in the obese category.
Cárcamo-Regla *et al.*, (2024)[108]	Chile	Non-RCT	49/34	16 w	Vegan *vs.* omnivorous diet	Both groups with and without resistance training	BIA	VEG-TR *vs.* VEG-C: −0.2 kg *vs.* +1.3 kg of BW, −0.7 kg (−1.2%) *vs.* +0.6 kg (−0.2%) of BFM, +0.4 kg *vs.* +0.2 kg of LBM	OMN-TR gained BW (0.4 kg), lost BFM (−0.5 kg) and gained LBM (0.25 kg), while OMN-C gained BW (2.3 kg), gained BFM (1.6 kg) and lost LBM (−0.3 kg)	The gender ratio between groups was not comparable. The BMI of both control groups and OMN-TR was in the pre-obesity category, with the BMI of VEG-TR being 22.7 kg m^{-2}. The participants performed resistance training using their own BW only. There were differences in age between groups. The study does not provide information on dietary intake or the characteristics of the diets.
Isenmann *et al.*, (2024)[114]	Germany	Single-arm	9	1 + 4 w/8 w	Omnivorous *vs.* vegan diet	All phases included two weekly sessions of resistance and endurance training	BIA	−0.65 kg *vs.* +0.83 kg of BW, −0.2 kg *vs.* −0.05 kg of SMM, −0.24 kg *vs.* +0.61 kg of BFM (NS)	NS differences in strength tests (elastic power and maximum strength)	Participants were recreationally fitness-oriented females, supervised by a sports dietitian for the entire study. The study included three dietary phases: habitual omnivores, omnivores supervised by sports dietitians, and a vegan diet.

RCT: randomized controlled trial, n: number, w: weeks, m: months, BIA: bioelectrical impedance analysis, DXA: dual-energy X-ray absorptiometry, WFV: whole-food vegan, BMI: body mass index, MR: vegan meal replacement, FFM: fat-free mass, LBM: lean body mass, BFM: body fat mass, LDL cholesterol: low-density lipoprotein cholesterol, HDL cholesterol: high-density lipoprotein cholesterol, IGF-1: insulin-like growth factor-1, USA: United States of America, RA: rheumatoid arthritis, DII: dietary inflammation index, DAS28: disease activity score 28 for RA, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index, PROMIS: patient-reported measurement information system, hs-CRP: high-sensitivity C-reactive protein, HbA1c: glycated haemoglobin, MSOA: metabolic syndrome-associated osteoarthritis, VEG-TR: vegan diet group with resistance training, VEG-C: vegan diet control group, OMN-TR: omnivorous diet group with resistance training, OMN-C: omnivorous diet control group, ISSN: International Society of Sports Nutrition, SMM: skeletal muscle mass, NS: non-significant.

vegan diets,[46,107–109,114] the exact proportion of the WFV food groups remains unclear. Within studies characterized by a vegan diet, one was a low-carbohydrate vegan diet,[107] six were low-fat vegan diets,[42,44,103–105,112] one was a vegan-type Mediterranean diet,[113] and another was a vegan diet supplemented with soy protein.[46] Notably, the soy protein-enriched vegan diet study was the only one in which participants were identified as vegan or omnivorous prior to the intervention. In this study, the researchers investigated the differential effects of resistance training on body composition, providing valuable insights into the interaction between diet and exercise. Except for one study conducted in an inpatient setting, where all meals were provided by the research,[104] the remaining studies were conducted in real-world conditions.

Most studies offered various types of participant support, such as guidance on dietary adherence, educational lectures on healthy lifestyle habits, cooking and shopping workshops and newsletters. However, most studies lacked detailed data on dietary intake. The duration of the studies showed considerable variability. Specifically, three studies were conducted over a period of six months or longer,[41,44,107] with one study extending for two years.[41] The remaining studies varied in duration, comprising six studies that lasted 16 weeks,[42,103,105,108,110,111] three studies completed in either 12[46,106] or 13 weeks,[114] one study lasting 10 weeks,[112] one study lasting 8 weeks,[109] and two studies with a duration of four weeks.[104,113]

3.2. Summary and details of the studies included in the review

3.2.1. Intervention-related effects by diet only. In a six-month RCT conducted in Canada, researchers assessed the effect of a low-carbohydrate vegan diet (10 participants completing the intervention) compared to a high-carbohydrate lacto-ovo-vegetarian diet (13 participants completing the control) in adults with obesity and hyperlipidaemia. The intervention group showed a greater reduction in BW and BF% compared to the control group, with changes of 6.8 kg *vs.* 5 kg and 4.2% *vs.* 3.9%, respectively, as measured by BIA. While changes in FFM were not reported, waist circumference reduction decreased more in the intervention group (6.1 cm) compared to the control group (5.4 cm). Furthermore, the average daily energy intake for participants adhering to the following low-carbohydrate vegan diet experienced a significant reduction in average daily energy intake, from 1840 kcal to 1388 kcal, representing a 33% decrease alongside an increase in relative protein intake from 20% to 23%. The analysis of dietary intake, body composition, and other outcomes encompassed all participants who initiated the study, comprising 20 individuals in the intervention group and 19 in the control group, noting a significant dropout rate. We maintain the possibility that the authors may have made an error in the table concerning the number of participants included in the final analysis. Notably, the nutritional profile of the low-carbohydrate vegan diet indicated a substantial dietary cholesterol content of 117 mg per 1000 kcal, a value that may reflect a typographical error.[107]

A 16 week RCT conducted in the United States involved 37 participants who adhered to a low-fat WFV diet, while 35 participants maintained a control diet without modifications, referred to as a Western-type diet. All participants were classified as obesity class I, with a baseline BMI averaging 33 kg m^{-2}. Body composition changes were assessed using DXA. Participants assigned to the intervention group demonstrated a more significant change in body composition, achieving an average BW reduction of 6.4 kg, which included a decrease in LBM of 2.3 kg, accounting for 36% of the total BW loss. Additionally, those following the low-fat WFV diet exhibited a notable decline in average daily energy intake, reducing from 1851 kcal to 1450 kcal, representing a 28% decrease. There was also a reduction in relative protein intake, decreasing from 17% to 12% of total energy intake. Physical activity levels did not show a significant change; however, the study did not specify the types or intensities of PA. Furthermore, the authors did not report the use of a support system.[103]

In another 16 week RCT conducted in the USA from the same research team, 117 participants followed a low-fat WFV diet, while 106 participants maintained a control diet with no changes, referred to as a Western-type diet. The participants were initially classified as obesity class I, with a baseline BMI of 33 kg m^{-2}. Body composition changes were assessed using DXA. Participants in the intervention group experienced greater body composition change, with an average BW loss of 6.4 kg, accompanied by a reduction of 2.1 kg in LBM, representing 33% of the total BW loss. Furthermore, participants adhering to the low-fat WFV diet experienced a significant reduction in average daily energy intake, from 1834 kcal to 1344 kcal, representing a 36% decrease, along with a decrease in relative protein intake from 16% to 13% of energy intake.[116] Baseline PA levels averaged 2719 METs, but these decreased to 2114 METs (down by 29%) by week 16. However, the study did not specify the types or intensities of PA undertaken.[105]

A cross-over RCT at the National Institutes of Health Clinical Centre in the USA assessed the effects of a low-fat WFV diet compared to an animal-based ketogenic diet in 20 adults classified as pre-obese with a baseline value of 29.9 kg m^{-2}. Each diet was consumed *ad libitum* over two weeks, and body composition changes were assessed using DXA and MRS. Participants consumed meals provided by the research team and were instructed to maintain habitual PA levels throughout the intervention. Both diets resulted in comparable BW loss and reductions in VAT. However, notable differences emerged in body composition changes: the low-fat WFV diet led to greater BFM loss (0.67 kg *vs.* 0.18 kg) and better preservation of FFM (0.16 kg *vs.* 1.61 kg) compared to the ketogenic diet. Notably, during the low-fat WFV diet phase, there was a substantial decrease in daily energy and protein intake compared to baseline. Notably, during the low-fat WFV diet phase, participants experienced a significant decrease in their daily energy and protein intake compared to the baseline measurements. Specifically, those following the low-fat WFV diet consumed 550 to 700 fewer calories each day than when they were on the animal-based ketogenic diet. Additionally, daily protein intake was lower during the low-fat WFV diet in both absolute terms (down by 135 kcal) and as a percentage of total energy consumed (down by 1.5%). Despite this significant difference in calorie intake, participants reported no variations in hunger, meal enjoyment, or feelings of fullness between the two diets.[104]

A single-arm, eight-week trial conducted by UK researchers assessed the effects of a vegan diet on adults with a BMI classified as obesity class I with a baseline value of 32.6 kg m^{-2} and dysglycemia. Body composition was assessed using DXA, revealing a modest BW reduction of 2.6 kg, accompanied by a significant loss of LBM of 1.2 kg, accounting for 46% of the total BW loss. Participants were instructed to maintain their pre-existing PA levels, which were not part of the intervention, with moderate to vigorous activity reported to average 20–25 minutes daily. Daily energy and protein intake on a vegan diet decreased from 1807 kcal to 1576 kcal (down by 15%) and from 17% to 13% of total energy. This decline in protein intake was particularly pronounced in participants classified as severely obese, where intake decreased from 0.8 g per kg BW to 0.5 g per kg of BW.[109] Notably, given that this is a single-arm study, the comparison with the baseline diet refers to what we described as a Western-type diet.

In a 16 week crossover RCT conducted in the United States, researchers assessed the effects of low-fat WFV and Mediterranean diets on 62 adults diagnosed with class I obesity, characterized by a baseline BMI of 34.3 kg m^{-2}. The researchers encouraged participants on the WFV diet to enjoy well-designed meals and *ad libitum* without strict portions or energy control. Body composition changes, assessed using DXA, revealed that the low-fat WFV diet led to more pronounced improvements in body composition. Participants on the WFV diet experienced a total BW loss of 6.0 kg, with 2.5 kg (42%) of the loss attributed to LBM. PA was not a recommended intervention component, but the total PA was recorded at 2952 METs, with no specific details on type, intensity, frequency or duration provided. Participants following the WFV diet significantly reduced their daily energy intake, from 1815 kcal at baseline to 1315 kcal, representing a 38% decrease. Protein intake on the WFV diet decreased from 18% to 12% of total energy intake. From the standpoint of contextualizing health outcomes, a low-fat WFV diet demonstrated significant improvements in BW, lipid profiles and insulin sensitivity when assessed from baseline and in comparison to a Mediterranean diet. While both dietary approaches resulted in reductions in BP, the decrease was more pronounced in individuals following the Mediterranean diet.[42]

In a two-year RCT conducted in the USA, researchers compared the effects of a WFV diet with a therapeutic omnivorous "soul food" diet in 159 individuals classified as obese class II, with an average baseline BMI of 37 kg m^{-2}.[41,115] The study did not mandate nor record participants' PA levels. Using DXA, the study found no significant difference in BW loss between the two dietary groups. Over the one-year intervention period, participants experienced modest BW loss, averaging 2.5 kg, with a 1.5 kg reduction in LBM, accounting for 60% of the total BW loss.[41] The vegan diet group's daily energy intake decreased from 1953 to 1518 kcal (down by 29%), while protein intake dropped from 84 g (17% of energy) to 50 g (13% of energy). After one year, 34% of the energy in the vegan diet came from fat. Both groups initially presented low calcium intake, recording 776 mg d^{-1} for participants prior to commencing the WFV diet and 822 mg d^{-1} for those starting the omnivorous diet. These values remained inadequate throughout the duration of the study, with intakes recorded at 811 mg d^{-1} for the WFV diet and 699 mg d^{-1} for the omnivorous diet. Fibre intake showed a notable increase, rising from a baseline of 17 g d^{-1} to 27 g d^{-1} for participants adhering to the WFV diet and 19 g d^{-1} for those on the omnivorous diet. Iron intake was sufficient for both groups at baseline and on both diets, at 13 mg d^{-1} each.[115]

Spanish researchers conducted an 8 week crossover RCT known as the OMNIVEG study, involving fourteen recreationally active young males with a normal BMI who initially followed a baseline Western-type diet (details not specified). The protocol included an isocaloric regimen with equivalent macronutrient distribution, consisting of a 3 week traditional omnivorous Mediterranean diet, a 7 day washout period and a subsequent 4 week vegan Mediterranean diet phase. Both diets provided a daily energy intake of about 2600 kcal, with over 30% of energy derived from fat, a characteristic feature of the Mediterranean diet. The primary differences between the two diets were the sources of protein (animal and plant *vs.* plant only) and daily fibre intake, with the vegan-type Mediterranean diet group consuming higher amounts of fibre (41 g *vs.* 31 g). Participants maintained their usual PA levels, but specifics regarding type, intensity, frequency and duration were not provided. The study found no significant differences in body composition between the two Mediterranean diets, as assessed *via* BIA. However, the vegan-type Mediterranean diet demonstrated significant improvements in cardiorespiratory fitness, cardiometabolic health and immune status.[113] The study's limitations include the short intervention periods, the small sample size (n = 14) and the inclusion of only men with a low BF% (approximately 15%) and a normal BMI (23 kg m^{-2}). However, there is no information on energy and protein intake for the baseline period before the study. Instead, the authors use the dietary intake and characteristics of the traditional Mediterranean diet as the baseline.

3.2.2. Intervention-related effect that combined diet and PA. Slovenian researchers conducted a 10 week study that demonstrated the efficacy of a low-fat WFV diet supplemented with MR in reducing BW while preserving FFM, as measured by BIA. The study included 241 participants in the vegan diet group and 84 participants in a control group, both of whom adhered to regular PA, including resistance training with a minimum of two weekly sessions of 45 minutes of moderate-intensity exercise. The baseline BMI was classified in the pre-obesity category with a baseline value of 27.9 kg m^{-2}. The intervention group successfully maintained FFM; with a loss of 5.6 kg in BW, only 5% was due to FFM. Among a subgroup of participants classified as obese class I based on BMI, FFM loss was minimal, with only 0.9 kg (12% of total BW loss) lost despite an average BW reduction of 7.3 kg. The estimated daily energy intake from the prescribed diet is 1450 kcal, consisting of 15% protein, which amounts to 54 g per day.[112]

Slovenian researchers also conducted a 36 week prospective single-arm interventional study comprising two phases: an initial 10 week intervention followed by an additional 26 week maintenance phase. The intervention involving 36 individuals with a baseline BMI categorized as pre-obesity included a low-fat WFV diet supplemented with MR and regular PA, including resistance training. Body composition was assessed using BIA. Participants achieved significant FFM preservation, with only a 4% reduction, and no further FFM loss was observed during the subsequent 26 weeks. Participants had a baseline BMI of 26.5 kg m^{-2}, which decreased to 25.2 kg m^{-2} by the end of phase one. Those who continued further reduced their BMI from 24.7 kg m^{-2} to 23.4 kg m^{-2} by the end of phase two. Similarly, baseline body fat percentage declined from 30.3% to 26.3% by the end of phase one, with those who continued achieving an additional decrease from 26.5% to 24.6%. In phase two, the dietary intervention provided an estimated daily energy intake of 1700 kcal, with 20% of energy derived from protein.[44] Notably, given that this is a single-arm study, the comparison with the baseline diet refers to what we described as a Western-type diet.

A study carried out in Brazil evaluated 38 untrained young adults with normal BMI, comprised of both vegan and omnivorous participants prior to the intervention. The study involved a 12 week program that included resistance training, specifically focusing on leg press exercises, conducted bi-weekly, alongside protein supplementation—soy protein for the vegan group and whey protein for the omnivorous group. Body composition changes measured by DXA showed similar improvements in both groups, including increased LBM, decreased BFM and enhanced strength. Notably, the average daily energy intake of vegans remained consistent throughout the study, ranging from 2251 to 2359 kcal. However, their protein intake nearly doubled compared to baseline, increasing from 65 g day^{-1} (0.9 g per kg BW or 11.5% of energy intake) to 120 g day^{-1} (1.7 g per kg BW or 20% of energy intake). Omnivorous individuals initially derived 16% of their energy from protein intake, which likely contributed to a higher initial BMI, LBM and BFM compared to vegans; however, the observed differences were not statistically significant.[46]

A 12 week non-RCT conducted in the USA demonstrated that adherence to a vegan diet, combined with aerobic and resistance training, in 70 participants with obesity class I significantly reduced BMI and BF%, as measured by DXA. The recommended dietary pattern primarily consisted of a WFV diet, which excluded all animal products. However, it permitted up to three servings of seafood each week. In contrast, a control diet was not specified and was referred to as a Western-type diet. The outcomes were comparable to those of a control group of non-dieters, despite the control group being, on average, 11.9 years younger and engaging in higher daily levels of moderate-to-vigorous PA at baseline (61 min day^{-1} *vs.* 32 min day^{-1}) and follow-up (55 min day^{-1} *vs.* 39 min day^{-1}). The control group only received general follow-up through newsletters, with no additional dietary or PA interventions.[106] In addition, the intervention group showed greater improvements in their dietary inflammatory index scores after three months (but not at 12 months). However, there were no significant differences in the main inflammation and lipid outcomes between the two groups. Dietary intake was evaluated using three unannounced 24 hour dietary recalls, covering 43 parameters, including nutrient composition, phytochemicals and specific spices, herbs and teas. Importantly, a comparison of the usual dietary intake reports between the intervention group and the baseline data was not performed.[117]

Researchers from the Netherlands conducted a 16 week RCT known as the ‘plants for joints’ study to assess the effectiveness of a WFV diet compared to a control diet with no changes, referred to as a Western-type diet. The study involved 77 individuals with pre-obesity BMI who were at high risk for rheumatoid arthritis or metabolic syndrome-associated osteoarthritis (MSOA). Body composition, assessed using DXA, revealed that 83% of the total BW loss in the intervention group was attributed to BFM, with a mean BW loss of 3.5 kg. The PA levels increased from 154 minutes to 205 minutes per week; however, resistance training remained limited to 24–31 minutes per week. Daily energy intake remained stable with baseline values (~ 1750 kcal), but protein consumption decreased from 0.9 g per kg BW (66 g d^{-1} or 15% of energy intake) to 0.8 g per kg BW (58 g d^{-1} or 13% of energy intake). Furthermore, the WFV diet group began with lower BMI and BFM compared to the omnivorous group (27.1 kg m^{-2} *vs.* 30.6 kg m^{-2} and 25.5 kg *vs.* 27.7 kg, respectively), which resulted in less potential for improvement and greater challenges in physical activity due to co-morbidities; nevertheless, they still demonstrated progress.[110]

The same research team later conducted a separate 16 week RCT on 64 individuals classified as obese I in the BMI category and with osteoarthritis or MSOA. This study also assesses the effectiveness of a WFV diet compared to a control diet with no changes, referred to as a Western-type diet. DXA analysis showed that 61% of the total BW loss in the intervention group was derived from BFM, corresponding to a mean BW loss of 6.4 kg. Total PA averaged 202 minutes per week, consistent with their previous findings, but resistance training increased slightly to 39 minutes per week, which may still be insufficient for more extensive LBM preservation. Energy intake decreased modestly from 1755 kcal to 1638 kcal day^{-1}, while protein intake dropped from 0.8 g per kg BW (74 g day^{-1} or 17% of energy intake) to 0.7 g per kg BW (57 g day^{-1} or 14% of energy intake).[111] The study compared to the one mentioned above from the same research team[110] indicates that subjects with MSOA and additional comorbidities in obese class 1 with a baseline BMI of 33 kg m^{-2} experienced a lower percentage of BFM loss.

Chilean researchers conducted a 16 week non-RCT involving 70 participants in four groups: a vegan diet with resistance training, an omnivorous diet with resistance training and corresponding control groups for each diet. Body composition changes were assessed using BIA. Participants following a vegan diet alongside resistance training achieved better outcomes, including reductions in BW and BF% as well as increases in LBM, compared to those on an omnivorous diet with resistance training. Researchers found no significant differences in LBM among the various dietary groups. While a vegan diet was associated with greater BW reduction and improvements in body composition, combining this diet with an active lifestyle and regular PA was found to be a more effective strategy for reducing body fat mass than relying on diet alone, regardless of the specific type of diet followed. Importantly, the study did not include information about the dietary intake or characteristics of these diets. The BMI of both the vegan group and the omnivorous control groups, which included those on a diet only and those in an omnivorous intervention that combined diet with resistance training, was classified as pre-obesity. In contrast, the vegan intervention group, which incorporated diet with resistance training, exhibited a BMI of 22.7 kg m^{-2}.[108]

German researchers conducted a 12 week, single-arm, three-phase study involving nine recreationally active young adult females. The protocol included a 1 week familiarization phase with a habitual omnivorous diet, followed by a 4 week phase involving a registered dietitian's omnivorous diet and then an 8 week vegan diet phase. Participants maintained their usual exercise regimen, averaging four weekly training sessions, which included two resistance and two endurance sessions. During the vegan phase, participants experienced a significant SMM loss of 0.05 kg. Daily energy intake remained stable at approximately 2000 kcal throughout both phases, but protein intake decreased significantly during the vegan diet phase. Protein intake dropped from an average of 94 g day^{-1} (1.4 g per kg BW or 17% of energy intake) at baseline to 85 g day^{-1} (1.2 g per kg BW or 14% of energy intake) during the omnivorous diet phase and further to 72 g day^{-1} at the end (1.1 g per kg BW) in the vegan diet phase. Researchers attributed the decline in SMM to the reduction in protein intake. The study, not designed as a cross-over trial, investigated the sequential transition from an omnivorous diet to a dietitian-supervised diet, and finally to a vegan diet. However, the study cannot provide insights into the effects of switching from a vegan diet back to an omnivorous diet.[114] Notably, given that this is a single-arm study, the comparison with the baseline diet refers to what we described as a Western-type diet.

4. Discussion

The narrative review aimed to assess the impact of vegan diet interventions on body composition, especially BFM and muscle mass during BW loss. A total of 16 human intervention studies were included in this assessment, spanning multiple countries: the USA, Canada, Brazil, Chile and several European nations—namely the UK, Netherlands, Slovenia, Spain and Germany. Among the 16 studies reviewed, nine were RCTs, while the remainder consisted of non-randomized designs, including three single-arm trials. For body composition assessment, ten studies utilized DXA, whereas the others employed BIA technology. Notably, nine studies implemented control diets that reflected high-quality dietary patterns as outlined in scientific literature. These control diets included high-carbohydrate lacto-ovo-vegetarian, traditional Mediterranean, vegan-type Mediterranean, animal-based ketogenic, portion-controlled omnivorous, therapeutic omnivorous and omnivorous diets. All, except one, were supervised by study dietitians. In contrast, the other control diets were either unspecified or described as unchanged dietary patterns, which we referred to as a Western-type diet. In the review, eight studies included PA as part of their lifestyle interventions, predominantly focusing on resistance training; only one study incorporated both resistance and aerobic-type training. The remaining seven studies did not include PA as a component of the intervention, although participants may have maintained their PA levels prior to the study period. The key findings can be summarized as follows:

Key #1: The findings indicate that vegan diets may result in more significant (1a) BW loss and (1b) body composition change compared to other dietary methods. The extent of BW loss and body composition change primarily depends on the baseline BMI and body composition status.

Key #2: A vegan diet combined with PA, especially resistance training, is effective in preserving FFM or LBM compared to other diets. This preservation is affected by baseline BMI, particularly in individuals in the obese class category, as well as energy and protein intake. While only one study directly compared a vegan diet with PA, indirect findings from other research conditionally support initial hypotheses.

Key #3: The dietary intake data in the studies analysed are incomplete or missing. However, limited reports on specific nutrients show that both vegan and non-vegan diets have several nutritional inadequacies.

Key #4: In this review, 60% of the studies used a WFV diet as the intervention, while the remaining studies labelled their interventions as vegan diets. This suggests that our second hypothesis—regarding researchers and dietitians primarily promoting WFV diets—is at least partly confirmed. While we can't give a definite position regarding the quality of vegan diets in other studies, we believe researchers and dietitians primarily advocate for adherence to WFV diets.

Key #5: Most studies in our review included a support system, which may have played a key role in the outcomes of both intervention and control diets, particularly regarding adherence to dietary plans.

Key #6: The analysed studies have limitations that require discussion; the validity of conclusions depends on context. Additionally, supporting data from other publications by the same authors on the same dietary pattern can help mitigate individual study limitations.

4.1. Key findings #1

4.1.1 Vegan diet and BW change (#1a). This narrative review focused on the effect of a vegan diet and its associated lifestyle, especially PA, on body composition, specifically on

BFM loss, which is also accompanied by BW change. All studies examined included BW loss as an important outcome, except for three studies that primarily assessed body composition changes in physically active individuals.[46,113,114] Obesity is a critical global health issue associated with over 50 diseases and a substantial global burden on healthcare systems.[6,86]

Achieving sustainable BW management cannot depend exclusively on personal willpower or generalized generic dietary guidance, such as "consume less and increase PA", "practice moderation", "reduce carbohydrate intake", or "follow common sense".[118–122] Such BW loss strategies often fail in environments saturated with highly palatable and energy-dense foods. The terms "small quantities", "healthful" and "unhealthful" are often used to describe generic advice for improving BW management within habitual omnivorous or plant-based diets; however, these terms are imprecise and inconsistently defined, which can lead to potential misinterpretation[119,123–125] and, consequently, BW loss failure.

Evidence suggests that vegan diets are effective in promoting BW loss across various populations.[65,126–129] A systematic review conducted by Spanish researchers evaluated 13 RCTs examining the BW loss effects of WFV diets. Their review suggested that an *ad libitum* WFV diet is more effective for BW loss than other dietary interventions, including portion-controlled omnivorous diets. However, sustaining portion-controlled omnivorous diets is often challenging due to the prevalence of unhealthy food options and diverse eating habits.[63] One RCT included in the review studied postmenopausal women in the pre-obesity BMI category for 14 weeks, with follow-up BW loss data collected one and two years after the intervention. This trial compared a low-fat WFV diet to a low-fat omnivorous diet based on the National Cholesterol Education Program (NCEP). The results showed that women following the WFV diet experienced greater BW at both the one-year and two-year follow-ups compared to those on the NCEP diet.[130,131] Furthermore, this narrative review highlighted a 16 week RCT involving 117 overweight adults on a low-fat WFV diet compared to 106 participants following a control Western-type diet without any changes.[105] The findings showed that participants who replaced animal products with vegan foods, including ultra-processed options like soy milk and vegan meats, experienced significant BW loss. This evidence supports the idea that even processed plant-based foods can contribute positively to BW management. Additionally, participants who adopted a low-fat WFV diet also improved their metabolism and cardiometabolic risk factors, while the control group saw no significant changes. Therefore, key predictors of BW loss, according to the report, included reducing processed, unprocessed, and ultra-processed animal foods, which resulted in lower calorie and fat intake, higher fibre intake and an increase in calorie burn from post-meal metabolism.[105,132]

The researchers performed a secondary analysis of an RCT involving 68 adults that addressed the long-awaited question of the validity of the ABO blood-type diet regarding BMI, body composition, blood lipid concentrations and glycaemic control. This topic often ties into personalized nutrition, particularly concerning dietary patterns. Half of the participants followed a low-fat WFV diet, while the other half continued their usual Western-type diet. In this context, the intervention diet resembled the dietary recommendations for blood type A, whereas the comparison diet was similar to those suggested for blood type O. The study found that participants across various blood types[133] and races (*i.e.*, Black and White)[134] who followed the low-fat WFV dietary intervention showed similar results in body composition metrics such as BMI, BFM, LBM, and VAT.[133,134] In summary, two systematic reviews, one of which included a *meta*-analysis, indicate that a diet based on ABO blood types does not have a significant impact on BW, BFM or cardiovascular health,[135,136] contrary to what is sometimes suggested.

A crossover RCT studied the impact of reducing extra virgin olive oil EVOO in participants with obesity following otherwise a WFV diet. Those who cut EVOO from 4 tablespoons to less than one teaspoon daily for 4 weeks lost more BW and had lower total and LDL cholesterol. The low-EVOO group had a significantly lower energy intake (1338 *vs.* 1822 kcal) and consumed less total fat (32% *vs.* 49%) and saturated fat (7 g per 1000 kcal *vs.* 9 g per 1000 kcal), but more protein (14% *vs.* 10%), carbohydrates (57% *vs.* 43%) and fibre (21 g per 1000 kcal *vs.* 17 g per 1000 kcal). In addition, PA levels remained similar. These results suggest that reducing EVOO intake, along with energy restriction and higher protein intake, supports greater BW loss and improves LDL cholesterol levels.[137] Although EVOO is an energy-dense processed food, its low nutrient density may limit the health benefits of WFV diets.

In our review, in comparison to other diets, a vegan diet is more effective for BW loss, though the extent of BW loss varies based on the individual's baseline BMI, the duration of the intervention and the level of support received.

4.1.2 Vegan diet and body composition change (#1b). The key finding of our review suggests that a vegan diet effectively improves body composition, though muscle mass preservation varies. Methodological differences complicate comparisons, but evidence shows that FFM and LBM preservation are influenced by baseline body composition status, energy and protein intake and resistance training. Obese individuals have a greater potential for BW loss and changes in body composition. However, they may face higher risks of FFM or LBM loss, especially if they undergo energy or protein restrictions, along with challenges in adhering to resistance exercise. In this regard, MR or vegan protein supplements favourably reduce FFM or LBM loss;[44,46,112] however, muscle mass losses from vegan diets were generally less severe than those from other dietary patterns. While improvements in body composition from vegan diets were observed, the clinical significance of FFM or LBM loss associated with sustained BW loss and maintenance of body composition remains uncertain.

To enhance understanding of FFM dynamics during BW loss interventions across different BMI categories, a Slovenian research group conducted a retrospective analysis of 217 participants following a low-fat WFV lifestyle. Those with a normal BMI gained 0.9 kg of FFM while losing 2.4 kg of BFM, resulting in a BW loss of 1.2 kg. Participants with pre-obesity lost 3.9 kg of BW, including a reduction of 0.3 kg of FFM (8%) and a 3.6 kg decrease in BFM. Individuals with obesity experienced a BW loss of 7.5 kg, with a 1.5 kg loss of FFM (20%) and a 5.6 kg decrease in BFM. Notably, those losing at least 5 kg of BW had an average reduction of 8.8 kg, with 25% attributed to FFM.[96] In our review, we examined one study by Hall *et al.*,[104] in a metabolic ward that provides insights into BW loss mechanisms associated with two diets: a low-fat WFV diet and an animal-based ketogenic diet. The WFV diet greatly favours body composition outcomes. This is relevant since an earlier study by the same lead author compared an animal-based ketogenic diet to a high-carbohydrate omnivorous diet in men with pre-obesity, also in a metabolic ward. That study indicated no significant difference in BFM reduction, suggesting that BW loss on the ketogenic diet was mainly due to water, glycogen and possibly FFM rather than BFM loss.[138]

The mechanism of striving to preserve muscle mass during BW loss is closely related to the resting metabolic rates of SMM and adipose tissue. Although these rates are lower than those of vital organs, SMM plays a much more significant role in overall resting energy expenditure compared to adipose tissue.[139,140] Preserving muscle mass during BW loss is crucial, as it supports a higher metabolic rate, increases energy expenditure during PA and aids in effective body composition management. Maintaining muscle mass reduces the risk of BW regain (the "yo-yo" effect), supports functional health and improves body image.[14,141–143] To enhance understanding of BW loss strategies and muscle mass preservation, it's important to conduct studies on individuals within similar BMI categories and assess other health outcomes for a comprehensive view of the impact of a particular diet on body composition changes.

The measurement of muscle mass is influenced by changes in BFM, depending on the assessment method used. Techniques like BIA and DXA are affected by BFM changes due to their reliance on tissue conductivity and segmentation assumptions.[144,145] BFM loss can alter hydration and soft tissue distribution, leading to inaccuracies in LBM estimates. Although imaging methods such as MRI and CT provide more precise assessments, they can still be impacted by changes in intramuscular and intermuscular fat.[146] This relationship is exemplified by a randomized controlled trial by Kahleova *et al.*.[105] The study analyzed in this narrative review found that BW loss from a low-fat WFV diet resulted in significant reductions in intramyocellular and hepatocellular lipid levels. This occurred despite no explicit energy restriction, which led to a 36% energy reduction compared to the baseline diet, resulting in 34% and 10% reductions in hepatocellular and intramyocellular lipid levels, respectively. These reductions correlated with changes in BFM and improved HOMA-IR but were accompanied by a significant loss of LBM (down by 33% of BW loss).[105] This indicates that lipid content shifts within the muscle can occur alongside BFM loss and can influence LBM measurements, particularly with sensitive techniques. Thus, considering body composition assessment methods and lipid redistribution is crucial in interpreting FFM or LBM changes during BW loss interventions as it affects body composition assessments and metabolic outcomes.

Overall, the review results suggest that vegan diets may lead to more significant changes in body composition compared to other dietary methods. It is important to note that a Western-type diet was designated as the control in six studies, representing 40% of our analysis. This was especially pertinent in scenarios where no dietary modifications were specified (20%) or in single-arm studies (20%). We reasonably speculate that any studied alteration in this unhealthy diet contributes to improved BW and body composition management. Regardless, the extent of FFM or LBM loss primarily depends on initial BMI, health status, energy and protein restriction and participation in PA, especially resistance training.

4.2 Key finding #2: vegan diet combined with PA

In this review, eight studies combined a vegan diet with PA, while the remaining seven focused on diet intervention only. However, PA may have been included in these studies, not as a change but maintained from before the study period.

A vegan diet is associated with a holistic health-promoting lifestyle, including regular PA, restorative sleep, effective stress management, emotional well-being and avoidance of substances like smoking and alcohol and environmental pollutants.[97,147,148] These components, based on a whole-food, plant-dominant diet, are central to lifestyle medicine, which promotes evidence-based changes to prevent and manage common NCDs.[149,150] Such lifestyle choices, along with natural movement, purpose, community engagement and supportive relationships, are associated with increased longevity, as shown in studies of centenarians in "Blue zone" regions.[150,151] Epidemiological research should use these factors to ensure accurate health outcome interpretations. Additionally, regarding the effect of a vegan diet on sports performance, a vegan diet in physically active individuals does not adversely impact athletic performance, strength, power or body composition despite a reduction in BMI.[152–154]

In our review, we found that a vegan diet combined with PA, particularly resistance training, helps participants preserve their FFM or LBM more effectively. The preservation of muscle mass is likely affected, in addition to energy and protein intake, by the type, intensity, duration and frequency of resistance PA, which were not consistently detailed in the analysed studies. Additionally, the individual's baseline BMI and any PA limitations faced by individuals with obesity and comorbidities may play a significant role.

4.3. Key finding #3: vegan diet and dietary intake

The limited reports on dietary intake in the analysed review prevent us from drawing definitive conclusions about the nutritional adequacy of both the intervention and control diets. While it is widely acknowledged that vegan diets can pose a risk for nutrient deficiencies, it's important to note that non-vegan diets also commonly result in inadequate nutrient intake.[82,83,155–161]

A 22 week RCT with 99 patients with type 2 diabetes compared the nutrient intake of a low-fat vegan diet to the 2003 American Diabetes Association omnivorous diet. Nutrient intake was assessed through 3 day weighted food records. At baseline, both groups had inadequate fibre, calcium, vitamin C, vitamin D and potassium, along with excessive sodium and saturated fat intake. Post-intervention, deficiencies in vitamin D, calcium, potassium and potentially zinc remained in both diets, with continued excess sodium. The vegan diet showed a vitamin B12 deficiency, while the omnivorous diet was still low in fibre and vitamin C.[162]

Obviously, specific nutritional inadequacies are more commonly associated with vegan diets.[163] These include vitamin B12, EPA and DHA, calcium, iron (particularly in females), zinc and iodine.[82,163–165] Cross-sectional studies identified these deficiencies, often linked to suboptimal adherence to dietary guidelines, inadequate meal planning, limited access to fortified foods (particularly outside the USA) and the exclusion of dietary supplements in the diet and/or in the assessment method.[43,47,166] A cross-sectional study by Jakše *et al.*, involved 151 participants in a long-term WFV lifestyle program. This program included a WFV vegan diet that featured MR and dietary supplements. The researchers used 3 day weighed food records to demonstrate that this supplemented WFV diet was nutritionally adequate. However, the findings emphasized that full nutritional adequacy without supplementation was unlikely, particularly for vitamins B12 and D.[47,166] Similarly, an RCT conducted as part of the Prostate Cancer Lifestyle Trial found that a low-fat vegan diet generally met nutritional adequacy for most essential nutrients but reported deficiencies in calcium, vitamin B5 and vitamin D. However, adequacy in this study was largely attributed to the inclusion of fortified soy protein supplements (providing also vitamins, minerals and trace elements), fish oil (providing EPA and DHA) and iron-free multivitamins.[43,60,167] A study by Karlsen *et al.*, examined theoretical 30 day WFV diet meal plans formulated based on USA dietary guidelines without supplements. The findings revealed that these meal plans failed to provide sufficient amounts of vitamins B12 and D.[79] Calcium adequacy for females varied depending on the reference values used.[79,168] Although iodine intake was not considered in this study, adequate iodine intake can be achieved through sources such as seaweed (nori, wakame, kelp), iodized salt, and, to a lesser extent, potatoes with peels, berries and legumes.

This narrative review does not confirm a direct link between favourable body composition changes and the nutritional adequacy of vegan diets due to limited dietary intake data. However, the review included studies that indicated both the intervention and control diets demonstrated nutritional adequacy. In addition, we highlight the established principle of nutritional sufficiency as found in other research. To achieve nutritional adequacy in vegan diets, it is essential to consume a diverse array of whole-food plant-based groups in a planned manner. Supplementing with vitamins B12 and D is essential, with vitamin D being particularly important during the autumn and winter months due to reduced UV exposure. While it's theoretically possible to obtain enough vitamin B12 from a varied diet that includes non-animal sources,[169] regular supplementation is still recommended to prevent deficiency and insufficiency.[77] It is important to note that the adequacy of vitamin D intake within a healthy dietary pattern is not solely determined by an individual's dietary choices. Meeting specific physiological needs may also necessitate sufficient EPA and DHA levels, especially due to the limited endogenous conversion of alpha-linolenic acid (ALA) to EPA and DHA.[81,170–173] To successfully adopt a nutritionally adequate vegan diet that addresses challenges related to calcium, iron, iodine, and selenium intake and absorption,[77,171,174,175] especially at the beginning, an extensive support system is essential.[171] This system should encompass education and skills in meal planning, grocery shopping, and food preparation to effectively navigate lifestyle challenges.[47,171]

4.4. Key finding #4: vegan, low-fat vegan, WFV and predominantly WFV diets

In this review, nine studies implemented a WFV diet as the dietary intervention, while the remaining six studies designated the intervention as vegan. Although we cannot make a definitive judgment on the quality of the vegan diets in the other studies, we believe that researchers and registered/sports dietitians primarily support adherence to WFV diets.

A vegan diet can be further categorized by fat content. A "low-fat" vegan diet generally comprises 10–20% of energy from fat,[42,47] with 10% sometimes labelled as "very-low-fat".[60,176] The WFV diet is predominantly characterized by a high fibre content, recommending a daily intake of 35 to 90 grams, with carbohydrates comprising 60 to 75% of total energy.[42,47,167] In contrast, a low-carbohydrate vegan diet analyzed in one RCT as a part of this review consists of 26% of energy from carbohydrates and is considered high-fat at 43% of energy.[107] Additionally, a carefully structured vegan ketogenic diet exists, albeit with a lower fibre content. However, the current scientific literature on the vegan ketogenic diet is still practically non-existent. While the traditional ketogenic diet is high in animal products, a vegan version can potentially be created using plant-based fats like avocados, nuts, seeds, and vegetable oils.[177]

A WFV diet focuses on whole-food, plant-based sources or minimally processed options. In contrast, a vegan diet excludes all animal-derived foods but may include UPFs, which are often high in sugars, fats, salt and refined flour. Therefore, a vegan diet doesn't necessarily prioritize whole foods or healthy preparation methods. Researchers may label a diet as vegan while considering it WFV, but inconsistent definitions complicate the understanding of the dietary framework. Typically, a vegan diet includes fruits, vegetables, grains, legumes, nuts and seeds.[172,173] It also includes certain non-plant foods such as fungi, mushrooms, algae and bacteria (*e.g.*, in fermented foods), which are not biologically strict plants[178] that are often included due to their nutritional advantages. These sources can provide essential nutrients that are scarce in purely plant-based diets. Enhancing nutritional quality involves prioritizing whole-foods and minimizing UPFs. When UPFs are selected, those with lower total and saturated fats, sugars and sodium are chosen, while options that are higher in fibre and protein are preferred. However, not all UPFs are harmful; some vegan burgers, tofu and meat alternatives, unsweetened vegan yoghurts and whole-grain bread can be beneficial if chosen wisely.[179–188]

Notably, the term "predominantly WFV diet" lacks consensus on the specific proportion of UPFs or energy from whole-food, plant-based sources. We define it as primarily whole-food, plant-based, excluding animal products but potentially including some UPFs that still provide dietary fibre from whole-food, plant-based sources in amounts to meet recommended levels. Saturated fats and free sugars are kept within established limits. Studies suggest that a predominantly WFV diet should derive at least 80%, ideally 90%, of total energy from whole food sources,[47,166,171] a numbered concept to enhance public understanding.

The studies included in this review demonstrate that vegan diets can vary widely in macronutrient composition, being low in fat,[42,44,104,105,112] low in carbohydrates[107] or even aligned with Mediterranean dietary patterns.[113] It is important to encourage individuals to adopt a nutritionally adequate vegan diet that closely resembles the WFV diet and is sustainable for them in the long term.

4.5. Key finding #5: the importance of a support system

In eleven studies, participants had an extensive support system. In one study, they stayed at a research centre with all meals provided, and in two studies, they underwent training processes with trainers, which could further aid in dietary and PA adherence.

Long-term compliance, adherence to dietary plans, and maintenance of BW loss are critical challenges in BW loss interventions.[189,190] A *meta*-analysis found that 57% of individuals starting to participate in commercial BW loss programs achieved less than a 5% reduction of their initial BW,[191] with failure rates reported in some studies as high as 99.8% among individuals with obesity.[189,192] Common lapses in adherence often occur at eating out of home, at home during evenings and on weekends that frequently involve the consumption of unhealthy foods.[193,194] The quality of the support system is a key factor influencing adherence to interventions and improving outcomes.[131]

Adherence and acceptability are crucial for a diet's long-term success. Research, including RCTs and qualitative reviews, shows that adherence to vegan diets can be equal to or greater than non-vegan diets.[115,195–197] A systematic review of 121 RCTs found that BW loss often diminished at 12 months across various diets, except for the Mediterranean diet. In a 14 week RCT with follow-ups at 1 and 2 years, both a low-fat WFV diet and a moderate-fat omnivorous diet had high acceptability among well-educated postmenopausal women, with no significant differences.[131,198] These findings highlight the need to tailor dietary interventions to individual preferences, ensuring support systems enhance adherence and long-term success.

Adopting a vegan diet or any structured eating pattern can be challenging due to individual differences in dietary responses. Our review highlighted the existence of extensive support systems, including educational resources, cooking classes and community support, in helping participants improve their understanding and motivation to adopt and maintain new dietary habits.[44,60,64,97,130,131,199,200] However, the effect size of support systems on outcomes related to body composition remains unclear.

4.6. Other contextual aspects of the topic

4.6.1. PA and body composition and body image. Maintaining a healthy body composition, defined as a balanced BFM-to-LBM/FFM ratio, is essential for overall health. An umbrella review of 44 systematic reviews confirmed that resistance training increases SMM, strength and physical function compared to inactivity. Research highlights the role of PA and dietary changes in BW reduction.[201] A review of 12 systematic review studies found that PA positively affects BW loss and body composition by reducing BFM and VAT. Aerobic exercise is effective for lowering BW and BFM, while resistance training helps preserve LBM during BW loss.[88]

This distinction aligns with biological and social perspectives, as humans benefit from both aerobic and resistance training, reflecting WHO's PA recommendations for optimizing body composition.[202] Body dissatisfaction, especially among those with obesity and women, highlights the psychological aspect of body composition management.[203] Improved body composition is associated with better body image satisfaction, which is essential for maintaining motivation in long-term BW and body composition management strategies.[141–143,204]

By emphasising the physiological and psychological advantages of PA, a synergistic approach that combines aerobic and resistance training not only enhances BW management and body composition but also promotes overall well-being and fosters adherence to healthy lifestyle practices.

4.6.2. Diet or PA for BW loss. Our review identified one non-RCT study comparing a vegan diet group alone to one that combined the vegan diet with PA, showing superior body composition changes with the latter.[108] Other studies indicated that including PA, especially resistance training, preserved FFM and LBM more effectively than diet alone. However, additional research is necessary to validate these findings across various intervention and control diets.

The effectiveness of diet and PA for BW loss and body composition management has garnered significant interest. Studies show that dietary interventions are usually more effective than PA alone for BW loss and improving body composition. However, the most effective results come from combining resistance and endurance training,[205,206] especially with a moderate hypocaloric diet,[14,30,33,89–93,207] as seen in most vegan diet interventions. A systematic review of 78 RCTs indicates that combining energy restriction with exercise leads to the most effective results for BW loss, reducing BFM and maintaining LBM, making it the optimal method for enhancing body composition.[208]

Further, evidence suggests a synergistic relationship between PA and dietary habits, where healthier eating often leads to increased PA and active individuals tend to adopt better dietary practices.[209,210] Moreover, integrating diet and PA is essential for long-term success in BW management. This synergy fosters a sustainable, healthier lifestyle by promoting lasting health improvements. Additionally, motivation can wane over time, so setting progressive, achievable goals is key to maintaining commitment and driving continued success.[14,92,93]

Regular PA also significantly influences appetite control. Research shows that higher habitual PA enhances sensitivity in the appetite control system, improving responses to energy density and food content variations.[211–213] Encouraging both habitual and structured exercise is crucial, especially during holidays, to counteract indulgent eating. This tendency may lead to a gap between BW loss and gain, highlighting the importance of consistent PA.[214]

Dietary interventions are more effective for BW loss and body composition change than exercise alone. However, combining a structured exercise program with healthy eating offers the best sustainable benefits for BW and body composition management.

4.6.3. Physical (in)activity and public health. In our analysis of the studies, we observed that the majority of participants reported low levels of PA, indicating physical inactivity, with the notable exception of three studies that involved participants who were already physically active.[46,113,114]

Physical inactivity is a major public health issue, with nearly 1.8 billion adults at risk of developing NCDs due to insufficient PA. Addressing this could reduce major NCD prevalence by 6% to 10%, improving life expectancy.[215] The "Exercise is Medicine" initiative by the American College of Sports Medicine aims to raise awareness of the importance of PA in health management.[216] The American Heart Association emphasizes resistance training, alone or with aerobic exercise, to reduce CVD risk factors.[217] Systematic reviews and meta-analyses indicate that resistance training reduces the risk and mortality associated with common NCDs.[218]

A dose–response meta-analysis shows an inverse non-linear relationship between non-occupational PA and risks of CVD, cancer and all-cause mortality. Small increases in PA can significantly protect inactive individuals from NCDs, highlighting the impact of minor behavioural changes. Exercise, particularly high-intensity resistance training, is also an effective treatment for depression.[219] A recent prospective twin study suggests that meeting WHO recommendations for PA is sufficient for lifespan benefits, and more intense training may not provide additional advantages.[220] Promoting PA is crucial due to its broad implications for public health, with the economic cost of physical inactivity estimated at $50 billion annually.[221,222] Initiatives focusing on education, community engagement and access to PA resources are vital for improving health outcomes globally.

Consistent, organized and habitual physical activity is a powerful strategy for preventing and treating NCDs, including obesity, and for achieving and maintaining a healthy body composition.

4.6.4. BW loss, BW regains and lasting benefits. We reviewed four studies lasting six months or longer, including one that spanned two years,[41] one for a year,[106] one for nine months[44] and another for six months.[107] We aim for long-term outcomes that involve consistent BW loss and the maintenance of body composition, which can be assessed using BMI and BF% according to WHO classifications.[19,223] Therefore, the primary challenge in treating obesity and obesity-related type 2 diabetes is maintaining long-term BW loss.[18,224,225]

Research consistently shows that individuals who lose 5% of their BW typically regain it within two years, and approximately 80% of those losing 10% or more regain it within one year.[189] Sustaining the dietary and PA behaviours necessary for BW loss is a crucial and demanding task,[189,190,226] raising questions about the value of BW loss given the high likelihood of BW regain.

The amount of BW loss needed for health benefits varies with specific comorbidities.[227] A review of 24 trials showed that behavioural BW management improved cardiometabolic risk factors for at least five years, but benefits decreased with BW regain. Trends for CVD and diabetes are similar, though data is limited.[228] A recent review of 155 trials confirmed that BW loss offers long-term health benefits, even with some BW regain.[229] The Diabetes Remission Clinical Trial (DiRECT) found lasting remission benefits for individuals with pre-obesity and type 2 diabetes after five years, with lower BW regain linked to greater benefits. After one year, 46% of participants achieved remission; this decreased to 36% after two years and 23% after five years, with those in the low-intensity support group showing higher remission rates.[225]

These findings highlight that while BW regain is common, the health benefits of initial BW loss often persist. The extent to which BW regains impacts long-term outcomes, emphasizing the need for strategies that encourage sustained behaviour change for effective BW and body composition management.

4.6.5. Motives and barriers to adopting a vegan diet. Our review did not address the reasons behind a vegan diet. However, understanding these motives is important because they are associated with long-term lifestyle changes that can facilitate overcoming the challenges of transitioning to a vegan diet. Slovenian researchers, from which we included two intervention studies in our review, conducted a cross-sectional survey on the same dietary sample (supplemented WFV lifestyle), assessing motives in 151 long-term vegan participants. They found that health benefits, BW management and eating to satiety were the primary reasons for adopting a vegan diet.[97]

Vegan diets positively impact various health aspects, including decreased NCD rates and improved overall well-being.[58,59,61–73,230] However, the scientific literature reveals ambiguities and inconsistencies regarding their effects. For instance, diverging positions exist on the impact of vegan diets on bone mineral density,[171,231–233] dementia types and Alzheimer's disease,[71,234,235] environmental sustainability,[50,55–57,236] athletic performance,[152–154,237–240] nutritional adequacy and supplementation needs,[81–83,241] protein quality[171,242–245] and perceived dietary costs.[246–252] An integrative review in this field recommends a low-fat WFV diet minimizing UPFs as the most health-promoting dietary pattern throughout life. Such a diet can mitigate nutrition-related NCDs, reduce healthcare costs and promote environmental sustainability and animal welfare.[49] Supporting this view, complementary meta-analyses suggest that an optimal diet for human health consists of a low-fat, high-fibre regimen comprising at least 90% plant-based foods.[50]

Despite these advantages, barriers hinder the adoption of vegan diets, stemming from perceptions and practical difficulties. Key obstacles include limited knowledge of vegan options, entrenched dietary habits and concerns about nutrient adequacy.[171,253,254] A recent review in high-income countries highlighted a lack of awareness of appealing vegan foods as a major issue.[255] Motivations for adopting a vegan diet vary, driven by health, ethical concerns about animal welfare and environmental factors, but are influenced by cultural and economic contexts, complicating generalizations.[97]

Addressing these barriers requires targeted education, improved access to diverse vegan foods and clear guidance on achieving nutritional adequacy. Utilizing individual motivations for adopting vegan diets can enhance their acceptance and practice, countering prejudice based on personal beliefs rather than evidence.[256]

4.6.6. Vegan diet and health professionals. Health professionals are pivotal in promoting vegan diets and their associated health benefits.[257,258] However, a notable deficiency in nutrition education remains a significant barrier across regions,[259–261] including Europe[262–265] and medical schools in the USA.[266–268] Numerous studies highlight that health professionals often lack adequate knowledge about plant-based diets, particularly vegan diets,[269,270] limiting their ability to provide evidence-based nutritional guidance.[260,269,271–275] Without proper training in clinical nutrition, knowledge and skills, physicians around the globe are generally unprepared to initiate informed lifestyle discussions about nutrition with their patients.[259,276]

Nutrition is fundamental to health, influencing both quality of life and overall longevity.[277] The primary goal of medicine is to enhance well-being, making the integration of diet a key health determinant. However, four barriers impede this integration for physicians: (i) lack of nutrition education in medical training; (ii) Underappreciation of nutrition science in primary care; (iii) limited financial incentives for nutritional counselling; and (iv) resistance to change due to outdated beliefs about nutrition's role in NCDs management, despite evidence like the WHO's classification of processed meats as a carcinogen.[258] In addition, the phrase "more hippocrates, less hypocrisy" emphasizes that health professionals should model healthy behaviours. Health professionals should promote and implement healthier options in hospitals and schools. Despite discussions, these initiatives are often poorly implemented in practice.[278] Physicians who are overweight or obese, physically unfit, inadequately informed about plant-based diet, or unconsciously biased by personal beliefs or financial conflicts of interest are less likely to counsel patients on BW loss or deliver optimal care, partly due to lower self-efficacy. Consequently, patients may perceive such providers as less credible, leading to diminished trust, reduced adherence to medical advice, and potentially poorer health outcomes.[279–281] A survey of registered dietitians in the UK and Ireland showed positive views on WFV diets but revealed notable knowledge gaps. For instance, 75% believed plant proteins were incomplete. Concerns included risks of malnutrition, micronutrient deficiencies and eating disorders during the transition to WFV diets. Barriers for dietitians included lack of education, unsupportive environments and challenges of excluding certain food groups. Patients faced difficulties with cooking skills and the perceived cost of plant-based foods.[269] Virtual culinary medicine interventions offer a promising solution to overcome barriers like a lack of plant-based cooking skills, enhancing dietary behaviours, food literacy, and perceived control over health outcomes.[282]

Despite these challenges, successful vegan dietary initiatives have emerged across various public institutions, including kindergartens, primary schools, universities, hospitals and workplaces in various countries, such as Portugal,[283] Italy,[284–286] the United Kingdom,[287] France,[288] Finland,[289] Spain,[290] Sweden,[291] the USA[292–301] and Brazil.[302] Additionally, the Strategic Council for Nutrition in Slovenia has recommended the implementation of similar programs.[80] These programs demonstrate the potential for systemic adoption of vegan meals at the institutional level.

Promoting plant-based diets, including vegan diets, in healthcare and educational settings can support healthier populations and help address the growing impact of diet-related diseases, as well as overcome resistance and misinformation.

4.6.7. Influencers on social media. Social media has become a significant platform for diet-related discussions, heavily shaped by the influence of social media personalities. These influencers wield considerable promotional power, impacting an individual's body image and food choices.[303] Similar to traditional media, social media influencers can have both positive and negative effects on health outcomes.[304–306] The rise of influencers is partly driven by societal dissatisfaction with body image,[307] scepticism toward traditional health and nutrition authorities[308] and a persistent human fascination with health, beauty and longevity.[309–311]

However, many influencers often build credibility in one area and exploit that trust to endorse food products or diets in unrelated fields,[312] often without the qualifications necessary to provide evidence-based nutritional advice. This practice often results in misleading information that is contrary to public health guidelines. Drawing from observations in direct practice, we can identify several characteristics of unqualified influencers that present significant challenges for society in making informed decisions: (i) misinformation risk from unverified claims; (ii) financial incentives leading to biased endorsements; (iii) misuse of credibility for unrelated products; (iv) promotion of unhealthy dietary choices; (v) unrealistic health promises that undermine evidence-based practices. In contrast, this does not apply to qualified experts who, through their expertise and evidence-based contributions, gain influence and credibility in their respective fields.

In today's information-rich era, nutrition practitioners, clinician-scientists, researchers and food experts must engage on social media. By promoting critical thinking, they can counter misinformation and provide reliable, evidence-based guidance.[308] This engagement is vital for navigating social media diet-related discussions and encouraging informed decision-making among users.

4.6.8. Real-world environment and contagious obesity. A food environment, often described as "obesogenic" or "toxic", promotes the widespread availability and consumption of inexpensive, high-energy, processed foods. This situation is compounded by inadequate regulatory measures, such as ineffective food taxes, subsidies and unregulated marketing and advertising. These factors contribute to excessive energy intake and increasing obesity rates.[11,313–315] Research indicates that urban areas with a prevalence of UPF outlets experience increased obesity risks, particularly among vulnerable socioeconomic groups.[313] Social influences, including family and friends, significantly shape dietary habits and behaviours. Social networks—and, increasingly, social media—play a crucial role in shaping behaviours related to obesity within communities.[10,11] Evidence suggests that obesity can spread within social networks, functioning as a "contagious" phenomenon.[316,317] It appears that the closer the relationship, the more similar their diet paths were.[318] This indicates that traditional BW management programs that primarily target individual BW loss may be less effective without addressing the broader social and environmental contexts that influence behaviour. Peer and family support in BW loss initiatives has been shown to enhance motivation, improve adherence to dietary changes and foster sustainable health outcomes.[319–322]

Strategies to combat obesogenic environments should improve access to healthy, affordable foods, limit unhealthy marketing and promote collaboration among schools and policymakers for healthier eating. Inclusivity is essential, as social, physiological, cultural and economic factors complicate many populations' shift to a plant-based diet.[323] A range of dietary alternatives focusing on whole-food dietary patterns should be encouraged to lower the risk of NCDs.[324,325] Information, diverse food options, strong political and professional support and leading by example are essential for promoting healthier lifestyle changes. These efforts are crucial in tackling global public health issues like the rise of NCDs. For example, studies in the UK suggest that adhering to dietary guidelines for healthy omnivorous diets could reduce CVD risk by one-third among healthy middle-aged and older adults.[326]

Social media and dietary trends today lead many to overly control their diets, increasing the risk of eating disorders such as orthorexia nervosa. It is crucial to differentiate between orthorexia, a pathological obsession with healthy eating, and a non-pathological interest in health-conscious diets.[327] Studies indicate that vegans and omnivores show similar eating attitudes, with vegans often exhibiting healthier behaviours overall.[328–330] A major concern is the Düsseldorf Orthorexia Scale (DOS), which may conflate dietary conscientiousness with pathology. Some DOS items reflect Western norms, potentially stigmatizing non-mainstream diets like veganism. This risks misdiagnosis and pathologizing healthy behaviours. To enhance diagnostic validity, researchers should clarify the distinction between normative eating practices and true eating disorders.[331]

Such findings highlight the importance of implementing multi-faceted, inclusive strategies to combat obesity and eating disorders and improve public health outcomes globally.

5. Limitations and strengths of this narrative review

This narrative review has limitations to consider when interpreting its findings. The review is not systematic, but its flexibility allows for a broader overview and holistic conceptual synthesis. Key limitations of the studies include a small number of overall studies, varied study designs, with a mere nine RCTs. Additionally, the quality of control diets varied, and many studies lacked complete dietary intake assessments. Other significant limitations were the absence of PA measures in half of the studies and the reliance on different body composition assessment technologies, with six studies using BIA. Further limitations included short study durations in most studies, lack of control groups in three studies, small sample sizes, and a focus on single-gender populations and overly restrictive protein or energy intake. There were also variations in baseline BMI statuses, both among different studies and within the compared groups of individual studies. Additionally, not all studies assessed every body composition variable. The overall narrative review highlights the benefits of the low-fat WFV diet on body composition changes, though LBM preservation may be compromised without adequate resistance training or excessive energy and protein restrictions. However, further studies that address the aforementioned study limitations are necessary to confirm this trend. Lastly, the two RCTs included in this review (with 75 and 233 participants, respectively) were conducted from October 2016 to June 2017[48,103] and January 2017 to February 2019[105] under the same NCT number assigned by ClinicalTrials.gov.[332] Considering certain similarities in the data, it is important to acknowledge the possibility of partial data overlap.

Despite these limitations, the narrative review contributes by analysing studies with clear criteria and considering their characteristics and control diets. It synthesizes secondary analyses and relevant studies from the same research group, enhancing understanding of the results of the analysed studies. This approach increases the robustness of findings, minimizes speculation and improves data interpretation. Additionally, incorporating recognized control diets in 60% of the analysed studies further enhances the validity and generalizability of the conclusions.

Future research should focus on populations with overweight and obesity, those living with chronic conditions and comorbidities, individuals with elevated BFM, and athletic populations. Interventions should prioritize high-quality, whole-food or minimally processed diets while evaluating BW loss, body composition and health markers. Studies comparing vegan diets should control for BMI and prior PA experience, examining different types of PA's effects on BW loss and body composition. Detailed dietary intake reporting is essential for assessing nutrient adequacy and comparing outcomes with non-vegan diets.

6. Conclusions

In conclusion, this narrative review of 16 studies indicates that vegan diets can lead to greater reductions in BW and more favourable changes in body composition compared to control diets, which include high-carbohydrate lacto-ovo, traditional and vegan-type Mediterranean, animal-based ketogenic, portion-controlled and therapeutic omnivorous and Western-type diets. However, some studies report significant muscle mass loss. To mitigate this loss, strategies such as regular PA, particularly resistance training, ensuring adequate protein intake and applying modest energy restrictions without compromising nutrient adequacy are recommended. Additionally, individual factors also influence outcomes, such as baseline BMI and health status.

Further research is needed to address existing gaps in knowledge and to assist professionals in guiding individuals towards better dietary and lifestyle choices, ultimately aimed at improving public health. Additionally, contextualising real-world dilemmas enhances understanding of the theme.

Author contributions

Conceptualization, B. J. and K. W.; methodology, B. J. and D. R. T.; investigation, B. J.; writing – original draft preparation, B. J.; writing – review and editing, B. J., N. F. M., Z. F., D. R. T. and K. W.; supervision, B. J., N. F. M., Z. F., D. R. T. and K. W. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest

B. J. declares he is the first author of two of the narrative-included studies. The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Abbreviations

ApoB	Apolipoprotein B
ALA	Alpha-linolenic acid
BF	Body fat
BIA	Bioelectrical impedance analysis
BMI	Body mass index
BP	Blood pressure
BW	Body weight
CT	Computed tomography
CVD	Cardiovascular disease
DII	Dietary inflammatory index
DAS28	Disease activity score 28
DHA	Docosahexaenoic acid
DOS	Düsseldorf orthorexia scale
DXA	Dual-energy X-ray absorptiometry
EPA	Eicosapentaenoic acid
EVOO	Extra virgin olive oil
FFM	Fat-free mass
GDP	Gross domestic product
HbA1c	Glycated haemoglobin
HDL	High-density lipoprotein
HOMA-IR	Homeostatic model assessment for insulin resistance
hs-CRP	High-sensitivity C-reactive protein
IGF-1	Insulin-like growth factor 1
ISSN	International Society of Sports Nutrition
LBM	Lean body mass
LDL	Low-density lipoprotein
MET	Metabolic equivalent
MR	Meal replacement
MRI	Magnetic resonance imaging (scan)
MRS	Magnetic resonance spectroscopy (scan)
MSOA	Metabolic syndrome-associated osteoarthritis
NCEP	National Cholesterol Education Program
NCT	National Clinical Trial number
NS	Non-significant
NCD	Noncommunicable chronic disease
OGIS	Oral glucose insulin sensitivity
OMN	Omnivorous diet
OMN-C	Omnivorous diet control group
OMN-TR	Omnivorous diet with resistance training group
PA	Physical activity
PROMIS	Patient-reported measurement information system
PubMed	Public medical literature database
RA	Rheumatoid arthritis
RCT	Randomized controlled trial
SMM	Skeletal muscle mass
SSB	Sugar-sweetened beverages
TMAO	Trimethylamine-*N*-oxide
UPF	Ultra-processed food
US	Ultrasound imaging
UV	Ultraviolet
VAT	Visceral adipose tissue
VEG	Vegan diet
VEG-C	Vegan diet control group

VEG-TR	Vegan diet with resistance training group
WFV	Whole-food vegan
WHO	World Health Organization
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index

Data availability

The data used to support the findings of this study are included within the article.

Appendix A. Search string strategy used across the PubMed/Medline database.

PubMed/ Medline	(("Body Mass Index"[Mesh] OR "Body Mass Index"[tiab] OR "Quetelet's Index*"[tiab] OR "Quetelets Index*" [tiab] OR "Quetelet Index*" [tiab]) OR ("Body Composition"[Mesh] OR "Body Composition*"[tiab]) OR ("BW Loss"[Mesh] OR "BW Loss*"[tiab] OR "BW Reduction*"[tiab] OR "Body Mass Loss*"[tiab] OR "Muscle Preservation*"[tiab] OR "Muscle Mass*"[tiab] OR "Fat-free mass*"[tiab] OR "Muscle Mass Loss*"[tiab] OR "Fat Mass Loss?"[tiab]) OR ("Obesity"[Mesh] OR "Obesity"[tiab] OR "Body Fat"[tiab] OR "Fat Percentage"[tiab])) AND (("Diet, Vegetarian"[Mesh] OR "Vegetarian Diet?"[tiab] OR "Vegetarianism"[tiab]) OR ("Diet, Vegan"[Mesh] OR "Vegan Diet"[tiab] OR "Veganism"[tiab] OR "Plant-based Diet*"[tiab] OR "Plant Based Diet*"[tiab]" OR "Whole-food"[tiab] OR "Whole food"[tiab])) AND (("Electric Impedance"[Mesh] OR "Electric Impedance"[tiab] OR "Bioimpedance*"[tiab] OR "BIA"[tiab] OR "Bioelectrical Impedance Analysis"[tiab]) OR ("X-Ray Absorptiometry"[tiab] OR "DEXA"[tiab] OR "Dual-Energy X-Ray Absorptiometry"[tiab]) OR ("Magnetic Resonance Imaging"[Mesh] OR "Magnetic Resonance Imaging"[tiab]) OR "Tomography"[tiab]) AND (2014:2024[dp])

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