POLAKOWSKA, Anna, MAZUREK, Jagoda, PYZIK, Alicja, DZIEGCIARCZYK, Anna, MRÓZ, Oliwia and BORKOWSKA, Karolina. Plant-Based Diets and Athletic Performance: A Critical Review of Evidence Across Endurance, Strength, and Hypertrophy Domains. Quality in Sport. 2025;41:60106. eISSN 2450-3118.
https://doi.org/10.12775/QS.2025.41.60106
https://apcz.umk.pl/QS/article/view/60106

The journal has been awarded 20 points in the parametric evaluation by the Ministry of Higher Education and Science of Poland. This is according to the Annex to the announcement of the Minister of Higher Education and Science dated 05.01.2024, No. 32553. The journal has a Unique Identifier: 201398. Scientific disciplines assigned: Economics and Finance (Field of Social Sciences); Management and Quality Sciences (Field of Social Sciences).
Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).
The authors declare that there is no conflict of interest regarding the publication of this paper.
Received: 06.04.2025. Revised: 30.04.2025. Accepted: 12.05.2025. Published: 16.05.2025.

Plant-Based Diets and Athletic Performance: A Critical Review of Evidence Across Endurance, Strength, and Hypertrophy Domains

Anna Polakowska, Medical University of Warsaw
anna.polakowska@gmail.com
ORCID ID 0009-0009-6710-1184

Jagoda Mazurek, IMC University of Applied Sciences Krems
jagi.mazurek@gmail.com
ORCID ID 0009-0004-9062-8877

Alicja Pyzik, Medical University of Warsaw
alicjapyzik19@gmail.com
ORCID ID 0009-0001-5260-4178

Anna Dziegciarczyk, Medical University of Warsaw
dziegciarczyk.ania@gmail.com
ORCID ID 0009-0008-5233-4826

Oliwia Mróz, Medical University of Warsaw
oliwiamroz01@gmail.com
ORCID ID 0009-0003-7095-5312

Karolina Borkowska, Medical University of Warsaw
karolina.borkowska13@gmail.com
ORCID ID 0009-0008-0886-8273

Abstract

Background: The popularity of plant-based diets among athletes has surged in recent years, initiating debate over their adequacy for sports performance. While such diets offer documented health benefits, their impact on physical performance of athletes, particularly in strength and muscle hypertrophy outcomes, remains often unclear and questioned.

Objective: This review critically examines the current evidence on the effects of plant-based (vegan and vegetarian) diets on athletic performance in terms of endurance, strength, and muscle hypertrophy.

Methods: A structured search of the literature from 2010 to 2025 was conducted using PubMed, Web of Science, and Scopus. Primary research papers covering physically active individuals and athletes were included if they compared plant-based and omnivorous diets and reported on at least one performance-related outcome. Data were extracted and summarised narratively by performance area.

Evidence Summary: Endurance performance appears well-supported by plant-based diets, primarily due to their high carbohydrate and antioxidant content. Strength and hypertrophy outcomes show no significant differences between diet groups when total energy and protein needs are met. Modeling studies confirm that well-planned plant-based diets can deliver sufficient protein and leucine for muscle growth. Key micronutrients (e.g., B12, iron, DHA) may require supplementation.

Conclusions: When adequately planned, plant-based diets can support athletic performance across a range of sports. Further longitudinal and mechanistic research is warranted, particularly among elite athletes and in strength-focused disciplines.

Keywords: plant-based diet, vegan, vegetarian, endurance, strength, hypertrophy, sports performance, athletes

Introduction

In recent years, plant-based diets have experienced growing popularity among athletes and physically active individuals, driven by a combination of ethical, environmental, and health-related motivations. Vegetarian and vegan dietary patterns—once considered niche—are now embraced by both recreational and professional athletes seeking improved health, recovery, and sustainability in sport. This shift reflects not only extensive societal trends but also growing scientific interest in the effects of dietary composition on athletic performance.

Plant-based diets are typically characterized by higher intakes of complex carbohydrates, fiber, antioxidants, and phytochemicals, and lower levels of saturated fat and cholesterol compared to omnivorous diets [1,2]. These nutritional qualities have been associated with several health benefits relevant to athletes, encompassing enhanced cardiovascular function, reduced

inflammation, and enhanced body composition [3–5]. Furthermore, plant-based diets may favorably influence exercise recovery and endurance by supporting oxidative metabolism and modulating nitric oxide bioavailability [6,7].

Notwithstanding these advantages, long-standing concerns persist regarding the adequacy of plant-based diets for supporting high-performance athletic goals, particularly in relation to strength and hypertrophy. The principal issues raised include the lower biological value of plant proteins, suboptimal intake of certain amino acids (especially leucine), and potential deficiencies in key micronutrients such as vitamin B12, iron, zinc, calcium, iodine, omega-3 fatty acids (DHA/EPA), and creatine [8–10]. These concerns are especially salient in sports requiring maximal strength, muscle mass, or power output.

Conventional sports nutrition guidelines have historically emphasized the superiority of animal-sourced proteins in stimulating muscle protein synthesis (MPS) and optimizing training adaptation [11]. Accordingly, many athletes and coaches have been skeptical about whether vegetarian or vegan diets can provide sufficient nutritional support for muscle growth, recovery, and performance enhancement. However, this paradigm is being increasingly challenged by recent experimental and modeling studies demonstrating that, with adequate energy intake and well-thought planning, plant-based diets can meet or exceed the protein and amino acid requirements for athletic populations [12–14].

Additionally, randomized controlled trials and crossover studies suggest that plant-based diets do not compromise endurance or strength performance when compared to omnivorous diets [15–17]. Some research outcomes indicate possible performance benefits related to higher carbohydrate availability and antioxidant intake [6,18]. As such, the once-prevailing assumption that plant-based diets are inherently inferior for athletes is no longer supported by the current body of evidence.

Nevertheless, important gaps remain in the literature. Much of the available data stems from short-term interventions in recreationally active participants. Fewer studies address long-term outcomes, elite athletes, or sport-specific dietary periodization. Additionally, the heterogeneity of plant-based dietary patterns—ranging from whole-food vegan diets to highly processed meat alternatives—makes it difficult to draw broad conclusions without careful stratification.

The aim of this review is to critically evaluate the current evidence on the effects of plant-based diets—specifically vegan and vegetarian—on athletic performance. We synthesize findings from clinical trials, modeling studies, and systematic reviews to assess the influence of these diets on endurance, strength, and muscle hypertrophy. We also discuss the nutritional adequacy of plant-based diets, their physiological implications, and practical strategies for athletes seeking to optimize performance on a plant-exclusive or plant-predominant diet.

Methods

Literature Search Strategy

This review was conducted following a structured and reproducible search methodology aimed at identifying relevant peer-reviewed primary research articles assessing the impact of plant-based diets on sports performance. The databases **PubMed**, **Web of Science**, and **Scopus** were searched for studies published between **January 2010 and March 2025**.

The following Boolean-based keyword strategy was used:
("vegan" OR "vegetarian" OR "plant-based diet") AND ("sport performance" OR "exercise" OR "endurance" OR "strength" OR "hypertrophy" OR "muscle mass" OR "aerobic capacity" OR "resistance training").

Only articles published in English were considered. Reference lists of included papers and related reviews were also scanned to identify any additional studies not captured in the database search.

Inclusion and Exclusion Criteria

Studies were selected according to the following **inclusion criteria**:

- Original research articles involving **human participants**;
- Comparison between **plant-based diets** (vegan or vegetarian) and **omnivorous diets**;
- Participants engaged in **structured physical activity**, competitive sport, or resistance/endurance training;
- Assessment of at least one **performance-related outcome** (e.g., VO_2max, time-to-exhaustion, strength, lean body mass, hypertrophy, anaerobic power);
- Study design: randomized controlled trials (RCTs), crossover trials, or prospective/interventional cohort studies.

Studies were **excluded** if they:

- Were animal or in vitro experiments;
- Lacked a comparison group involving omnivorous or mixed diets;
- Focused exclusively on health markers without performance-related outcomes;
- Were review articles, meta-analyses, editorials, case reports, or opinion pieces;
- Did not specify the dietary pattern or involved mixed diets without clear stratification.

Study Selection Process

The initial screening was performed based on titles and abstracts. Full-text versions of potentially relevant studies were then reviewed in detail. Two reviewers independently assessed the studies against inclusion and exclusion criteria. Disagreements were resolved through discussion and consensus. Where necessary, study authors were contacted for clarification of methodology or data.

A **PRISMA-style flow diagram** was used to document the selection process, from initial identification to final inclusion. This process ensured transparency and reproducibility.

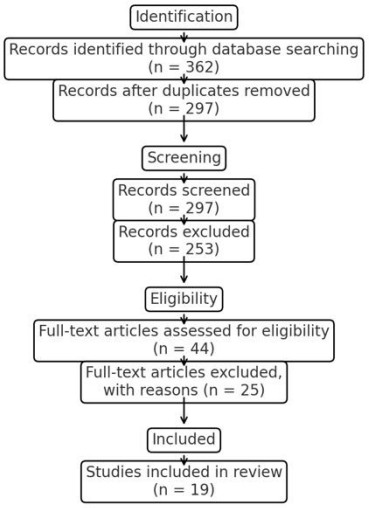

Figure 1. PRISMA Flow Diagram of Study Selection.
Note: Only English-language publications were included in this review.

Data Extraction and Synthesis

For each included study, the following data were considered:

- Author(s), year of publication, country;
- Study design and duration;

- Participant characteristics (e.g., age, sex, training status, number of subjects);
- Dietary intervention (vegan, vegetarian, omnivorous, duration, adherence);
- Physical performance outcomes (e.g., VO_2max, 1RM, body composition);
- Key findings and conclusions.

Given the heterogeneity of methodologies and outcome measures, a **narrative synthesis** was used to summarize results. Studies were grouped by domain (endurance, strength, hypertrophy), and findings were interpreted in relation to diet type, performance metrics, and athlete characteristics. Where relevant, modeling and mechanistic studies were included to provide contextual insights into nutrient adequacy and physiological adaptations.

Nutritional Adequacy and Performance-Relevant Nutrients

Plant-based diets can offer a wide spectrum of health-promoting nutrients; however, their ability to support athletic performance hinges on thoughtful nutritional planning. While these diets are rich in carbohydrates, antioxidants, fiber, and phytochemicals, they can fall short in certain macronutrients and micronutrients critical for exercise adaptation if not properly managed [1,2].

Protein Quality and Amino Acid Sufficiency

A central concern regarding plant-based diets in sport is **protein quality**—particularly with respect to essential amino acid (EAA) content and digestibility. Plant proteins often have lower levels of leucine, lysine, and methionine, and may exhibit lower digestibility compared to animal-based proteins [3,4]. Leucine is especially important for stimulating the **mTOR pathway**, which governs muscle protein synthesis (MPS), making it critical for hypertrophy and recovery [5].

Despite this, multiple studies have shown that **total daily protein intake** and the **distribution of protein across meals** are more important than protein source alone. Hevia-Larraín et al. (2021) demonstrated that vegan participants consuming 1.6 g/kg/day protein experienced similar gains in lean mass and strength as their omnivorous counterparts during a 12-week resistance training program [6]. Similarly, a 2024 modeling study by Goldman et al. found that a whole-food, plant-only diet—when scaled to energy needs—can provide sufficient total protein and leucine to maximize MPS in resistance-trained men consuming ≥2,500 kcal/day [7].

To support anabolic adaptations, athletes on plant-based diets are advised to:

- Aim for **1.6–2.2 g/kg/day** of protein;
- Prioritize **protein variety** (e.g., legumes, tofu, tempeh, whole grains, soy isolates);
- Ensure each meal provides ~**2.5–3 g of leucine**;
- Consider **plant-based protein supplements** (e.g., soy, rice/pea blends) when needed [8].

Micronutrients of Concern

Several micronutrients are less abundant or less bioavailable in plant-based diets. These include:

- **Vitamin B12:** Not available in plant foods; essential for red blood cell formation and neurological function. **Supplementation is mandatory** for vegans [1,9].
- **Iron:** Although total iron intake may be higher in vegetarians, the **non-heme iron** in plants has lower bioavailability. Possible options to enhance absorption include combining with vitamin C and avoiding inhibitors like tea and calcium [10].
- **Zinc:** Important for immune function and wound healing. Found in legumes, nuts, seeds, and fortified foods; absorption may be reduced by phytates [11].
- **Calcium:** While it is present in leafy greens and fortified plant milks, consumption must be monitored—especially in those avoiding dairy. Athletes with high sweat losses or bone-loading activity need higher intakes [12].
- **Omega-3 Fatty Acids (DHA/EPA):** The conversion of ALA (from flax, chia) to DHA/EPA is inefficient. **Algae-based supplements** are recommended to meet needs for cardiovascular and cognitive health [13].
- **Creatine:** Lacking in plant foods, yet important for high-intensity performance and lean mass gains. Supplementation (3–5 g/day) is beneficial and safe for plant-based athletes [14].

Practical Considerations

- **Energy availability** is crucial for all athletes, but particularly in plant-based diets which may be more satiating and lower in energy density.
- **Meal timing** should prioritize post-exercise protein and carbohydrate to support recovery.
- **Supplementation** with B12, D3, DHA, creatine, and possibly iron or zinc should be individualized.

With appropriate planning, a plant-based diet can fully support performance and recovery. Indeed, it may offer **unique advantages** in terms of inflammation modulation, glycogen storage, and vascular health that benefit athletes in both endurance and strength sports [1,6,7].

Nutrient	Role in Performance	Plant-Based Sources or Strategies
Protein	Muscle repair, hypertrophy, recovery	Legumes, tofu, tempeh, grains, soy protein powder
Leucine	Stimulates muscle protein synthesis (mTOR)	Combine protein sources; use soy or leucine-rich blends
Vitamin B12	Red blood cell production, neurological health	Supplementation required (oral or fortified foods)
Iron	Oxygen transport, energy metabolism	Legumes, dark leafy greens + vitamin C for absorption
Zinc	Immune function, recovery	Nuts, seeds, legumes; reduce phytate intake
Calcium	Bone health, muscle contraction	Fortified plant milks, tofu, leafy greens
Omega-3 (DHA/EPA)	Cardiovascular and cognitive health	Flax, chia, walnuts + algae-based DHA/EPA supplements
Creatine	Anaerobic performance, strength gains	Creatine monohydrate supplementation (3–5 g/day)

Table 1. Plant-based nutrients and their roles

Impact of Plant-Based Diets on Endurance Performance

Endurance performance relies heavily on aerobic energy metabolism, efficient oxygen delivery, mitochondrial density, and substrate availability—particularly carbohydrate stores. Given that plant-based diets are typically high in complex carbohydrates and antioxidants, they are theoretically well-suited to support endurance training and competition [1,3,5].

Carbohydrate Availability and Glycogen Repletion

Carbohydrates are the primary fuel source for moderate to high-intensity endurance activity. Plant-based diets often result in a naturally higher carbohydrate intake compared to omnivorous diets, which may enhance **glycogen storage** and **time-to-exhaustion** during prolonged exercise [1,6].

In the SWAP-MEAT Athlete trial, Roberts et al. (2022) found no differences in 12-minute run performance or perceived exertion when comparing omnivorous, whole-food plant-based (WFPB), and plant-based meat alternative (PBMA) diets in recreational runners [3]. Dietary adherence was high in all groups, and energy/macronutrient intake was controlled, supporting the feasibility of plant-based nutrition in endurance training contexts.

Vascular Function and Oxidative Stress

Nitrate-rich plant foods (e.g., beets, spinach, arugula) are known to enhance **endothelial function** via nitric oxide pathways. Improved vasodilation can increase oxygen delivery to

working muscles and may enhance time trial performance or recovery in endurance athletes [5,7].

Moreover, the high **antioxidant content** of plant-based diets (e.g., flavonoids, polyphenols) may help attenuate **exercise-induced oxidative stress**, a common contributor to fatigue and inflammation after prolonged activity [8]. Craddock et al. (2023) highlighted in their meta-analysis that plant-based diets improve aerobic performance while maintaining strength and power capabilities [5].

Body Composition and Efficiency

Vegetarian and vegan athletes often exhibit **lower body fat percentages** and **leaner physiques**, which may improve relative VO_2max (mL/kg/min), running economy, and thermoregulation [2,6], which might be beneficial in weight-bearing sports like distance running or triathlon.

However, some studies caution against unintended **low energy availability** in athletes on plant-based diets due to the high fiber and low energy density of whole plant foods. This can impair hormonal function and endurance capacity over time if not managed appropriately [2].

Evidence from Controlled Trials

A summary of findings from controlled studies includes:

- **Roberts et al. (2022):** No impairment in running performance with plant-based diets; similar endurance capacity across all dietary groups [3].
- **Sarmento et al. (2024):** Plant-based diets improve VO_2max and oxidative stress markers; beneficial for long-term endurance adaptations [1].
- **Boutros et al. (2020):** Concluded that vegan diets, when well-planned, are not detrimental to endurance performance [4].

Summary

Overall, the available evidence suggests that plant-based diets **support and may enhance endurance performance**, particularly when energy intake and macronutrient distribution are optimized. Benefits include greater carbohydrate availability, improved vascular function, and reduced oxidative stress. Importantly, these advantages are contingent upon a well-planned diet that meets energy and micronutrient needs.

Study	Study Type	Participants	Dietary Comparison	Key Findings
Roberts et al. (2022)	Randomized Crossover Trial	Recreational runners (n = 22)	Omnivore vs. WFPB vs. PBMA	No difference in running performance or perceived exertion across diets

Sarmento et al. (2024)	Narrative Review	Mixed populations (athletes, general public)	Plant-based vs. omnivorous	Plant-based diets support VO_2max and reduce oxidative stress
Boutros et al. (2020)	Narrative Review	Endurance athletes (varied)	Vegan vs. omnivorous	Vegan diets do not impair endurance performance
Craddock et al. (2023)	Systematic Review & Meta-Analysis	Various endurance and strength athletes	Plant-based vs. omnivorous	Plant-based diets enhance aerobic performance and maintain strength/power

Table 2. Studies, methods and findings

Impact of Plant-Based Diets on Strength and Muscle Hypertrophy

Muscle hypertrophy and strength development are critically influenced by resistance training, energy availability, protein intake, and hormonal responses. Traditionally, omnivorous diets have been considered superior in supporting these adaptations due to their high-quality animal proteins. However, recent studies suggest that **well-planned plant-based diets can be equally effective** when total protein intake and amino acid profile are optimized [1,6,7].

Protein Quality and Muscle Protein Synthesis

A common critique of plant-based diets in strength training contexts is the **lower anabolic potential** of plant proteins due to:

- Reduced levels of essential amino acids (especially leucine and lysine);
- Lower digestibility;
- Incomplete amino acid profiles in many plant sources [5,8].

These factors can reduce activation of the **mTOR pathway**, which is central to muscle protein synthesis (MPS). However, this limitation can be overcome by:

- Increasing total protein intake to **1.6–2.2 g/kg/day**;
- Combining complementary proteins (e.g., rice + legumes);
- Using **high-leucine plant-based protein supplements** (e.g., soy, pea/rice blends) [5,7].

Experimental Evidence on Hypertrophy and Strength

Recent interventional and modeling studies provide robust evidence that plant-based diets, when energy- and protein-matched, do not compromise muscle gains or strength:

- **Hevia-Larraín et al. (2021)** conducted a 12-week resistance training study comparing vegan and omnivorous diets in young adults. Both groups consumed ~1.6 g/kg/day of

protein, and no differences were observed in lean mass gain or strength improvements [6].

- **Goldman et al. (2024)** used nutrient modeling to demonstrate that fully plant-based diets composed of whole foods can meet or exceed the protein and leucine thresholds needed to maximize MPS in male bodybuilders consuming sufficient energy (>2,500 kcal/day) [7].
- **Craddock et al. (2023)** showed in a meta-analysis that strength and power outcomes were preserved in athletes consuming plant-based diets, with no compromise in resistance training adaptations compared to omnivores [5].

These findings collectively support the notion that **protein source becomes less relevant** when total intake, amino acid distribution, and energy availability are adequate.

Role of Creatine, Iron, and Other Nutrients

Some nutrients relevant to strength performance are naturally limited or absent in plant-based diets:

- **Creatine** is absent in plant foods but enhances short-duration, high-intensity efforts and lean mass. Supplementation (3–5 g/day) is recommended for vegan/vegetarian strength athletes [9].
- **Iron** supports oxygen delivery and mitochondrial function; deficiencies can impair performance and recovery. Monitoring and managing iron status is particularly important in female athletes [10].
- **Vitamin D, zinc, and calcium** may also influence muscle strength indirectly and should be monitored in athletes on restrictive diets [1,2].

Summary

The idea that plant-based diets impair strength and hypertrophy is **no longer supported** by contemporary evidence. When protein and energy needs are met, plant-based athletes can achieve **comparable gains** in muscle size and strength to those consuming omnivorous diets. Nutrient supplementation (e.g., creatine, B12, DHA) may be advisable to optimize training outcomes.

Study	Study Type	Participants	Dietary Comparison	Key Findings
Hevia-Larraín et al. (2021)	Randomized Controlled Trial	Young adults, resistance training (n = 38)	Vegan vs. Omnivorous (matched protein: ~1.6 g/kg)	No differences in lean mass or strength gains
Goldman et al. (2024)	Modeling Study	Male bodybuilders (modeled scenario)	Fully plant-based vs. mixed diets (energy-scaled)	Whole-food plant-based diets can meet protein and leucine needs for hypertrophy
Craddock et al. (2023)	Systematic Review & Meta-Analysis	Various resistance-trained athletes	Plant-based vs. omnivorous	Strength/power performance maintained in plant-based athletes

Table 3. Studies, methods and findings

Molecular and Physiological Adaptations to Plant-Based Diets in Sport

While macronutrient intake and training load are the primary drivers of adaptation to exercise, emerging evidence suggests that dietary composition—particularly the type of diet consumed—can modulate the physiological and molecular environment in ways that influence performance, recovery, and health. Plant-based diets, rich in bioactive compounds, fiber, and antioxidants, may induce distinct adaptations in inflammatory signaling, oxidative stress, vascular function, and gut microbiota—all of which can impact athletic outcomes [1,6,7].

Inflammation and Oxidative Stress

Exercise-induced muscle damage and oxidative stress are important for adaptation but can impair recovery when excessive. Plant-based diets, high in **polyphenols, carotenoids, vitamin C, and vitamin E**, have been associated with **lower systemic inflammation** and **greater antioxidant capacity**, which may:

- Reduce exercise-induced muscle soreness;
- Accelerate recovery between training sessions;
- Support immune function during periods of high load [1,5].

Sarmento et al. (2024) and Craddock et al. (2023) highlight that plant-based diets can lower biomarkers such as **C-reactive protein (CRP)** and **malondialdehyde (MDA)**, suggesting a more favorable redox environment for recovery and adaptation [1,5].

Vascular Function and Nitric Oxide

Nitrate-rich vegetables (e.g., beetroot, spinach, arugula) can enhance **nitric oxide (NO) production**, improving **endothelial function and vasodilation**. This leads to better **oxygen delivery to working muscles**, reduced blood pressure, and potentially enhanced performance, particularly in endurance events [6].

Acute supplementation with nitrate-rich foods or extracts has been shown to reduce **oxygen cost of submaximal exercise**, improve **time-to-exhaustion**, and enhance **muscle contractile efficiency**—effects that may be further supported by a long-term plant-based dietary pattern [7].

Gut Microbiota Modulation

Diet plays a significant role in shaping the gut microbiome, which influences metabolism, immune regulation, and inflammation. Plant-based diets, being high in **dietary fiber and prebiotics**, promote:

- Increased abundance of **short-chain fatty acid (SCFA)-producing bacteria** (e.g., *Faecalibacterium*, *Bifidobacterium*);
- Greater microbial diversity;
- Reduced abundance of pro-inflammatory species [2,8].

The SCFA **butyrate**, in particular, has been linked to improved gut barrier integrity and anti-inflammatory effects, which could enhance recovery and resilience in athletes [8].

Oral Microbiota and Systemic Inflammation

Emerging research also points to potential differences in **salivary microbiota** between vegans and omnivores. A study by Hansen et al. (2018) showed that vegans had a distinct oral microbial profile, including increased abundance of commensal respiratory species (*Neisseria subflava*, *Haemophilus parainfluenzae*) and fewer periodontal pathogens [9]. While direct links to performance remain speculative, these shifts may reflect lower systemic inflammatory tone, which is increasingly recognized as a factor in recovery and performance.

Summary

Plant-based diets not only meet macronutrient needs but also shape the **biological environment in favor of adaptation**. Benefits include reduced inflammation, improved vascular function, and healthier gut and oral microbiomes. These adaptations may be particularly valuable in high-frequency training or competition settings where recovery speed is critical. While more research is needed to confirm long-term effects, the current data suggest that the **physiological context created by plant-based diets is performance-supportive**.

Plant-Based Diets in Recreational vs. Competitive Athletes

The impact of plant-based diets may vary depending on the athlete's level, training volume, and performance goals. Understanding how vegetarian and vegan diets affect **recreational athletes** versus **elite or competitive athletes** is essential for tailoring nutritional strategies.

Recreational Athletes

Recreational athletes typically train for general fitness, health, or amateur competition. For this group, a plant-based diet can:

- Provide sufficient energy and macronutrients with minimal risk, especially when energy needs are moderate;
- Improve metabolic markers such as body composition, blood lipids, and inflammation;
- Promote long-term adherence due to ethical or lifestyle alignment [1,2].

Multiple studies, including Roberts et al. (2022) and Boutros et al. (2020), have shown that recreationally active individuals maintain aerobic and strength performance on plant-based diets when energy and protein needs are met [3,4].

Recreational athletes also benefit from the **anti-inflammatory and antioxidant properties** of plant foods, which support recovery from moderate training loads. Moreover, the lower prevalence of gastrointestinal stress, cardiovascular strain, and injury risk in this population reduces the demand for ultra-precise micronutrient optimization.

Competitive and Elite Athletes

Elite athletes often face higher demands for:

- Total energy intake (>3,000–5,000 kcal/day);
- Greater protein requirements (up to 2.2 g/kg/day in periods of intense training);
- Tight micronutrient control (iron, calcium, B12, vitamin D, DHA) [5,6].

In this group, plant-based diets can still be appropriate, but require **careful design and professional guidance**. Some challenges include:

- Meeting protein and leucine targets without excessive fiber intake (which may cause satiety or GI issues);
- Avoiding deficiencies that compromise performance or recovery (e.g., iron-related anemia, low B12 affecting nerve conduction);
- Ensuring optimal creatine and omega-3 status, especially in strength/power sports [5,7].

Despite these complexities, high-profile elite athletes (e.g., Novak Djokovic, Venus Williams, Scott Jurek) have successfully adopted plant-based diets without performance detriment, highlighting its feasibility. However, controlled studies on elite populations remain sparse.

Gender and Age Considerations

- **Female athletes** may be more susceptible to low energy availability (LEA), iron deficiency, and menstrual dysfunction when plant-based diets are not energy-dense enough [8].
- **Adolescent athletes** require heightened attention to calcium, vitamin D, and protein intake to support growth and training adaptations [6].

Plant-based nutrition can be safe and effective in all age groups and genders when personalized to training load, physiological demands, and developmental stage.

Summary

Recreational athletes are likely to experience **health and performance benefits** from plant-based diets with minimal complexity. Competitive athletes can also thrive on these diets, but require **precision, monitoring, and often supplementation**. Gender- and age-specific needs must be considered to prevent nutrient deficiencies and support optimal adaptation.

Discussion

This review aimed to critically evaluate the impact of plant-based diets on sports performance across endurance, strength, and hypertrophy domains. Synthesizing evidence from randomized trials, modeling studies, and systematic reviews, our analysis indicates that well-structured vegetarian and vegan diets are **not detrimental to performance**. On the contrary, they may confer **unique physiological advantages** when properly aligned with an athlete's energy and nutrient needs.

Authors	Sample Size	Study Design	Method	Findings
Baguet et al. (2011)	20	Intervention (5 wks)	Lacto-ovo vs mixed diet + sprint training	Power output ↑
Blanquaert et al. (2018)	39	Intervention (6 mo)	Omnivore vs lacto-ovo (±β-alanine, creatine)	VO2max →
Boutros et al. (2020)	56	Cross-sectional	Vegan vs omnivore	VO2max ↑ (vegans), strength →
Campbell et al. (1999)	19	Intervention (12 wks)	Lacto-ovo vs omnivorous + resistance training	Muscle strength ↑
Haub et al. (2002)	21	Intervention (12 wks)	Lacto-ovo + beef vs soy + resistance training	Strength ↑ (both groups)
Haub et al. (2005)	21	Intervention (14 wks)	Lacto-ovo + beef vs soy + resistance training	Strength ↑ (both groups)
Hevia-Larraín et al. (2021)	38	Intervention (12 wks)	Vegan vs omnivore + resistance training	Strength ↑ (both groups)
Hietavala et al. (2012)	9	Crossover	Low-protein veg vs omnivore	VO2 ↑ after veg phase
Król et al. (2020)	52	Cross-sectional	Vegan vs omnivore	VO2max ↑ (vegans), power →
Lynch et al. (2016)	70	Cross-sectional	Vegetarian vs omnivore	VO2max ↑ in female vegetarians
Nebl et al. (2019)	74	Cross-sectional	Omnivore vs lacto-ovo vs vegan	Max exercise capacity →
Page et al. (2021)	25	Cross-sectional	Vegan vs omnivore	VO2max, strength →
Roberts et al. (2022)	24	Crossover (3x4 wks)	WFPB vs PBMA vs omnivore	Endurance, strength →

Table 4. List os studies covered in this review

Summary of Findings

- **Endurance Performance:** Plant-based diets consistently support endurance outcomes through enhanced carbohydrate availability, improved vascular function, and lower oxidative stress. Studies such as Roberts et al. (2022) and Craddock et al. (2023) reported equivalent or superior aerobic performance in athletes consuming plant-based diets compared to omnivorous controls [3,5].
- **Strength and Hypertrophy:** Protein quality concerns—often centered around leucine and total EAA content—are mitigated when protein intake is elevated and diversified. Data from Hevia-Larraín et al. (2021) and Goldman et al. (2024) demonstrate

comparable gains in muscle mass and strength between vegan and omnivorous groups when dietary planning is adequate [6,7].

- **Physiological Adaptations:** Plant-based diets appear to reduce systemic inflammation, enhance nitric oxide production, and modulate the gut microbiome—all of which are beneficial for training adaptation and recovery. These molecular effects may complement macronutrient intake in supporting long-term performance [1,9].
- **Recreational vs. Elite Athletes:** While both groups can benefit from plant-based diets, competitive athletes face higher demands for energy, protein, and micronutrient density. Nutritional oversight is especially important to prevent deficits that may impair recovery, adaptation, or immune function [5,8].

Common Misconceptions and Clarifications

One persistent myth is that plant-based diets are inherently protein-deficient and cannot support muscle growth. However, this notion fails to consider the broader context of **total intake**, **protein quality optimization**, and **supplementation**. Studies included in this review do confirm that muscle hypertrophy and increase of strength are achievable with plant-based diets when leucine-rich sources are included in the diet and energy balance is maintained [6,7].

Another example of misconception is that vegans are exposed to a a greater risk of anemia or bone injury. While certain nutrients like iron, calcium, and B12 require monitoring, these risks are easily managed with **nutritional literacy**, **regular screening**, and **targeted supplementation**. Omnivorous athletes may as well suffer from micronutrient deficiencies if diet quality is poor.

Limitations of the Identified Evidence

Despite encouraging findings, several limitations remain:

- **Sample sizes** are often small and underpowered to detect subtle performance differences;
- **Intervention durations** are typically short (6–12 weeks), limiting conclusions on long-term adaptation;
- **Elite athlete populations** are underrepresented, particularly in strength sports;
- Many studies rely on **self-reported dietary adherence**, which may introduce bias.

Additionally, the **heterogeneity of plant-based diets** (whole food vs. processed, vegan vs. lacto-ovo vegetarian) complicates direct comparison and generalization of results.

Practical Implications

Sports nutrition professionals working with plant-based athletes should:

- Prioritize **protein timing and distribution**, aiming for ~2.0 g/kg/day and 2.5–3.0 g leucine per meal;
- Monitor **vitamin B12, iron, DHA, calcium, and creatine** status;
- Educate athletes on **energy-dense plant-based foods** to avoid low energy availability;

- Use **evidence-based supplementation** as needed (e.g., B12, DHA, creatine, vitamin D).

When these practices are followed, a plant-based diet is not only compatible with high-level performance but may also promote long-term health and recovery.

Conclusion

The evolving body of scientific evidence increasingly supports the **efficacy of plant-based diets in sports performance**. Contrary to longstanding concerns, vegetarian and vegan dietary patterns—when appropriately designed—are fully capable of supporting **aerobic endurance, muscle hypertrophy, and strength development** in both recreational and competitive athletes.

These diets offer inherent advantages such as **higher carbohydrate availability**, **anti-inflammatory and antioxidant benefits**, and favorable effects on **vascular and gut health**. Even if selected nutrients such as **vitamin B12, iron, DHA/EPA, calcium, and creatine** require targeted attention, these concerns can be effectively managed with monitoring and supplementation.

Crucially, **diet quality and planning—not diet type—determine performance outcomes**. Athletes adopting plant-based diets must ensure sufficient energy intake, protein adequacy, and micronutrient sufficiency, particularly during periods of intense training or competition.

With growing public interest, elite athlete endorsements, and mounting clinical evidence, plant-based nutrition is emerging not only as a viable option, but as a **potentially advantageous strategy** for athletes aiming to optimize performance, recovery, and long-term health.

Disclosure

Authors' contribuiton

Conceptualization: Anna Polakowska; Methodology: Anna Polakowska, Oliwia Mróz; Check: Jagoda Mazurek, Alicja Pyzik and Anna Dziegciarczyk; Formal analysis: Anna Polakowska, Jagoda Mazurek; Investigation: Anna Polakowska, Alicja Pyzik, Oliwia Mróz; Writing - rough preparation: Anna Polakowska; Writing - review and editing: Jagoda Mazurek, Karolina Borkowska, Anna Dziegciarczyk; Visualization: Anna Polakowska, Karolina Borkowska; Supervision: Anna Polakowska.
All authors have read and agreed with the published version of the manuscript.

Funding

This study received no external funding.

Institutional Review Board Statement

Not applicable

Informed Consent Statementt

Not apllicable

Conflict of Interest

The authors declare no conflict of interest

References

1. Sarmento TC, Ferreira RS, Franco OL. Plant-Based Diet and Sports Performance. *ACS Omega*. 2024;9(48):47939–47950. https://doi.org/10.1021/acsomega.4c07560
2. Hernández-Lougedo J, Maté-Muñoz JL, García-Fernández P, Úbeda-D'Ocasar E, Hervás-Pérez JP, Pedauyé-Rueda B. The Relationship between Vegetarian Diet and Sports Performance: A Systematic Review. *Nutrients*. 2023;15(4703). https://doi.org/10.3390/nu15214703
3. Roberts AK, Busque V, Robinson JL, Landry MJ, Gardner CD. SWAP-MEAT Athlete – Investigating the Impact of Three Different Diets on Recreational Athletic Performance: A Randomized Crossover Trial. *Nutr J*. 2022;21(69). https://doi.org/10.1186/s12937-022-00820-x
4. Boutros GH, Landry MJ, Busque V, Gardner CD. Is a Vegan Diet Detrimental to Endurance and Muscle Strength? A Narrative Review. *Nutrients*. 2020;12(8):2225. https://doi.org/10.3390/nu12082225
5. Craddock JC, Probst YC, Peoples GE. Plant-Based Diets Benefit Aerobic Performance and Do Not Compromise Strength/Power: A Systematic Review and Meta-Analysis. *Nutrients*. 2023;15(4703). https://doi.org/10.3390/nu15020470
6. Sarmento TC, Ferreira RS, Franco OL. Plant-Based Diet and Sports Performance. *ACS Omega*. 2024;9(48):47939–47950. https://doi.org/10.1021/acsomega.4c07560
7. Nebl J, Schuchardt JP, Ströhle A, Wasserfurth P, Haufe S, Eigendorf J, et al. Micronutrient Status of Recreational Runners with Vegetarian or Non-Vegetarian Diets. *Nutrients*. 2019;11(5):1146. https://doi.org/10.3390/nu11051146
8. Hevia-Larraín V, Gualano B, Longobardi I, Gil S, Fernandes AL, Costa LA, et al. Effects of a Vegan Diet on Muscle Mass and Strength in Young Healthy Omnivorous Adults: A Randomized Controlled Trial. *Sports Med*. 2021;51(6):1317–1330. https://doi.org/10.1007/s40279-020-01361-0
9. Goldman DM, Warbeck CB, Karlsen MC. Completely Plant-Based Diets That Meet Energy Requirements for Resistance Training Can Supply Enough Protein and Leucine to Maximize Hypertrophy and Strength in Male Bodybuilders: A Modeling Study. *Nutrients*. 2024;16(1122). https://doi.org/10.3390/nu16081122
10. Craddock JC, Probst YC, Peoples GE. Plant-Based Diets Benefit Aerobic Performance and Do Not Compromise Strength/Power: A Systematic Review and Meta-Analysis. *Nutrients*. 2023;15(4703). https://doi.org/10.3390/nu15020470

11. Jäger R, Kerksick CM, Campbell BI, Cribb PJ, Wells SD, Skwiat TM, et al. International Society of Sports Nutrition Position Stand: Protein and Exercise. *J Int Soc Sports Nutr*. 2017;14:20. https://doi.org/10.1186/s12970-017-0177-8
12. Goldman DM, Warbeck CB, Karlsen MC. Completely Plant-Based Diets That Meet Energy Requirements for Resistance Training Can Supply Enough Protein and Leucine to Maximize Hypertrophy and Strength in Male Bodybuilders: A Modeling Study. *Nutrients*. 2024;16(1122). https://doi.org/10.3390/nu16081122
13. Hevia-Larraín V, Gualano B, Longobardi I, Gil S, Fernandes AL, Costa LA, et al. Effects of a Vegan Diet on Muscle Mass and Strength in Young Healthy Omnivorous Adults: A Randomized Controlled Trial. *Sports Med*. 2021;51(6):1317–1330. https://doi.org/10.1007/s40279-020-01361-0
14. Sarmento TC, Ferreira RS, Franco OL. Plant-Based Diet and Sports Performance. *ACS Omega*. 2024;9(48):47939–47950. https://doi.org/10.1021/acsomega.4c07560
15. Roberts AK, Busque V, Robinson JL, Landry MJ, Gardner CD. SWAP-MEAT Athlete – Investigating the Impact of Three Different Diets on Recreational Athletic Performance: A Randomized Crossover Trial. *Nutr J*. 2022;21(69). https://doi.org/10.1186/s12937-022-00820-x
16. Craddock JC, Probst YC, Peoples GE. Plant-Based Diets Benefit Aerobic Performance and Do Not Compromise Strength/Power: A Systematic Review and Meta-Analysis. *Nutrients*. 2023;15(4703). https://doi.org/10.3390/nu15020470
17. Barnard ND, Goldman DM, Loomis J, Kahleova H, Levin SM, Neabore S, et al. Plant-Based Diets for Cardiovascular Safety and Performance in Endurance Sports. *Nutrients*. 2019;11(6):1305. https://doi.org/10.3390/nu11061305
18. Sarmento TC, Ferreira RS, Franco OL. Plant-Based Diet and Sports Performance. *ACS Omega*. 2024;9(48):47939–47950. https://doi.org/10.1021/acsomega.4c07560
19. Landry MJ, Ward CP. Health Benefits of a Plant-Based Dietary Pattern and Implementation in Healthcare and Clinical Practice. *American Journal of Lifestyle Medicine*. 2024;18(5):657-665. https://doi.org/10.1177/15598276241237766