WILCZYNSKA, Aleksandra, JURCZUK, Aleksandra, ROMANIUK, Sergiusz, KACZMAREK, Wojciech, BAGIŃSKI, Konrad, DEPTA, Piotr, BAŁDYGA, Paulina and MARCINIAK, Kinga. The Impact of Plant-Based Diets on Inflammation and Immune Function: A Review. Quality in Sport. 2025;47:66733. eISSN 2450-3118.
https://doi.org/10.12775/QS.2025.47.66733
https://apcz.umk.pl/QS/article/view/66733

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 l.p. 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 2025.

The authors declare that there is no conflict of interest regarding the publication of this paper.
Received: 19.11.2025. Revised: 26.11.2025. Accepted: 26.11.2025. Published: 30.11.2025.

The Impact of Plant-Based Diets on Inflammation and Immune Function: A Review

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Abstract

Background:
Chronic low-grade inflammation and immune dysregulation play central roles in cardiometabolic, autoimmune and infectious diseases. Growing evidence indicates that dietary patterns, particularly plant-based diets, may modulate inflammatory processes and immune function through metabolic, microbial and nutrient-related pathways.

Aim:
This narrative review aimed to summarise current evidence on the effects of plant-based dietary patterns on systemic inflammation, immune cell activity, gut microbiota–immune interactions and infection- or autoimmune-related clinical outcomes.

Material and methods:
The review was based on an extensive search of PubMed, Scopus and Google Scholar for studies on plant-based diets, inflammation, cytokines, gut microbiota and metabolic health. Eligible evidence included randomised trials, prospective cohorts, cross-sectional studies, systematic reviews, meta-analyses and mechanistic or microbiome-focused research. Findings were synthesised qualitatively.

Results:
Observational and interventional studies consistently show that healthful plant-based diets are associated with lower CRP, IL-6, TNF-α and other markers of low-grade inflammation. Mechanistic data highlight roles of plant-derived nutrients, short-chain fatty acid production and reductions in ectopic fat in improving immune regulation. Clinical studies suggest potential benefits in reducing the risk or severity of respiratory infections, asthma exacerbations, COVID-19 and selected autoimmune conditions. Effects depend strongly on overall diet quality; highly processed plant-based diets show weaker associations.

Conclusions:
Healthful plant-based dietary patterns may modulate inflammatory pathways, support innate and adaptive immunity and reduce infection-related and autoimmune risks. Despite promising findings, current evidence is limited by heterogeneous diet definitions, short intervention periods and residual confounding. Long-term mechanistic studies are needed, but well-designed plant-based diets appear to be a feasible non-pharmacological approach to improving immune health and reducing chronic inflammation.

Key words: autoimmune disease; cytokines; gut microbiota; immune function; inflammation; metabolic health; plant-based diet; vegan diet; vegetarian diet.

1. Introduction

Chronic inflammation and immune imbalance are increasingly recognised as key drivers of numerous conditions, including metabolic and cardiovascular disorders, autoimmune diseases and impaired resistance to infection (Furman et al., 2019). Although pharmacotherapy remains central to disease management, growing attention has shifted toward lifestyle interventions that modulate inflammatory pathways at early, potentially reversible stages. Among these, plant-based dietary patterns have emerged as promising candidates, supported by a growing body of epidemiological, interventional and mechanistic evidence (Satija et al., 2017; Khalid et al., 2022). Their potential therapeutic value reflects the understanding that long-term immune homeostasis is shaped not only by genetics and environmental exposures, but also by the habitual composition of the diet.

Plant-based diets (PBDs), including vegetarian and vegan patterns, emphasise whole grains, legumes, vegetables, fruits, nuts and seeds, while reducing or eliminating animal products. In this review, the term "plant-based dietary patterns" refers to diets in which the majority of energy is derived from plant foods, with varying degrees of animal product exclusion unless otherwise specified in individual studies. These dietary patterns are naturally rich in fibre, antioxidants, phytochemicals and unsaturated fatty acids-nutrients associated with reduced oxidative stress and improved immune regulation (Khalid et al., 2022). A systematic review and meta-analysis by (Craddock et al., 2019) demonstrated that individuals following vegetarian-based diets exhibit significantly lower concentrations of inflammatory markers such as CRP and fibrinogen compared with omnivores. Similar findings have been reported in large prospective cohorts, where adherence to health-oriented plant-based dietary indices correlates with lower circulating IL-6 and TNF-α levels, independent of confounders including BMI and physical activity (Kharaty et al., 2023). These observations suggest that plant-rich eating patterns may exert anti-inflammatory effects beyond those attributable to general lifestyle behaviours.

Intervention studies further strengthen this evidence base. In a 16-week randomised clinical trial, (Kahleova et al., 2020) showed that a low-fat vegan diet, compared with no dietary change, resulted in significant reductions in body weight, improved insulin sensitivity and marked decreases in hepatocellular and intramyocellular lipid stores-metabolic adaptations linked to lower systemic inflammation. Mechanistic research indicates that several components typical of plant-rich diets-including vitamins A and D, polyphenols derived from fruits and vegetables and n-3 fatty acids-modulate natural killer (NK) cell activity and regulatory T-cell function, with potential implications for immune surveillance (Y. S. Kim et al., 2015). Emerging multi-omics analyses in humans further demonstrate that short-term vegan diet interventions elicit distinct peripheral immune transcriptomic signatures, including upregulation of innate immunity and antiviral response pathways, when compared with ketogenic or baseline diets (Link et al., 2024).

The mechanisms underlying these effects are multifactorial. Diets abundant in whole plant foods provide substantial amounts of polyphenols, antioxidant vitamins and unsaturated fatty acids that modulate oxidative stress, influence NF-κB-dependent signalling and support cellular immune function (Calder, 2021). High fibre intake promotes a gut microbial milieu favouring fermentation and production of immunoregulatory metabolites such as short-chain fatty acids. Conversely, lower consumption of saturated fats, heme iron and advanced glycation

end-products-common in animal-based dietary patterns-reduces exposure to compounds known to activate inflammatory pathways. Together, these characteristics create a dietary environment that may promote greater immune stability and resilience.

Given the rising prevalence of chronic inflammation-related diseases and the expanding evidence linking diet with immune regulation, it is essential to synthesise current knowledge on the impact of plant-based diets on inflammatory and immunological outcomes. This review aims to provide an up-to-date analysis of the relationship between plant-based nutrition, inflammatory biomarkers and immune responses, integrating findings from observational studies, randomised trials and mechanistic research. By outlining both the strengths and limitations of the existing literature, the review seeks to clarify the potential role of plant-based diets in maintaining immune health and reducing disease risk.

2. Methods

This narrative review was conducted on the basis of an extensive literature search aimed at summarising current scientific knowledge on the relationship between plant-based dietary patterns, inflammation and immune function. Relevant studies were identified through searches of major academic databases, including PubMed, Scopus and Google Scholar, with no formal restrictions on publication year. To ensure comprehensive coverage, combinations of keywords such as “plant-based diet,” “vegan,” “vegetarian,” “inflammation,” “immune function,” “cytokines,” “gut microbiota” and “metabolic health” were applied.

Eligibility criteria focused on research exploring the effects of plant-based or predominantly plant-forward dietary patterns on inflammatory biomarkers, immune cell activity, infection-related outcomes or autoimmune disease activity in humans. Priority was given to high-quality evidence, including randomised controlled trials, prospective cohort studies, systematic reviews and meta-analyses. Mechanistic and microbiome-focused studies were also included when they contributed meaningful context regarding potential biological pathways.

Studies were screened for methodological soundness, relevance to the research question and clarity of reported outcomes. Publications lacking empirical data, providing insufficient methodological detail or addressing dietary patterns unrelated to plant-based nutrition were excluded. Extracted findings were synthesised qualitatively, allowing for structured comparison across study types, identification of consistent trends and discussion of areas where evidence remains limited or inconsistent. As this was a narrative review, no formal risk-of-bias assessment or meta-analysis was conducted.

3. Plant-Based Diets and Systemic Inflammatory Markers

Systemic low-grade inflammation, reflected by circulating markers such as C-reactive protein (CRP), interleukin-6 (IL-6) and tumour necrosis factor-α (TNF-α), is a key feature of many chronic cardiometabolic and immune-mediated conditions. A growing body of observational and interventional evidence indicates that plant-based dietary patterns are associated with more favourable inflammatory profiles compared with omnivorous diets.

3.1 Observational evidence

Large cohort and cross-sectional studies consistently show inverse associations between adherence to plant-based dietary indices and inflammatory biomarkers. In the Mitchelstown Cohort Study, including nearly 2000 middle-to older-aged adults, higher scores on overall and healthful plant-based diet indices were associated with significantly lower concentrations of CRP, IL-6 and white blood cell counts, even after adjustment for age, sex, adiposity, smoking, physical activity and medication use (Kharaty et al., 2023). Similar trends have been reported in other plant-based diet indices, where pro-inflammatory dietary scores correlate positively with CRP and cytokines, while more healthful plant-based patterns relate to lower inflammatory burden (Millar et al., 2021; Carey et al., 2024).

In a cross-sectional analysis from the Adventist Health Study-2, (Jaceldo-Siegl et al., 2018) demonstrated that individuals following vegetarian diets had lower CRP and IL-6 levels than non-vegetarians. Mediation analyses indicated that part of this association was explained by lower BMI among vegetarians, but a residual direct effect of vegetarian diet on CRP persisted after accounting for adiposity (Jaceldo-Siegl et al., 2018). Recent data from a Polish cohort of vegans, vegetarians and omnivores further emphasise the importance of diet quality: higher consumption of healthful plant-based foods was associated with lower hsCRP, IL-6 and leukocyte counts, whereas less healthful, processed plant foods were linked with less favourable inflammatory profiles (Mrozik et al., 2025).

At the synthesis level, a systematic review and meta-analysis by (Craddock et al., 2019) including 30 studies reported that vegetarian-based dietary patterns were associated with lower CRP and fibrinogen concentrations, and lower total leukocyte counts, compared with omnivorous diets. An umbrella review of meta-analyses on dietary patterns and CRP found that vegetarian/vegan diets produced modest but statistically significant reductions in circulating CRP, comparable in direction (though smaller in magnitude) to those observed for Mediterranean and energy-restricted diets (Tran et al., 2024).

Collectively, these observational data support the notion that plant-based dietary patterns-particularly those rich in minimally processed plant foods-are associated with lower levels of systemic inflammatory markers across diverse populations.

3.2 Interventional evidence

Controlled intervention studies provide further support for a causal link between plant-based diets and systemic inflammation. Short- to medium-term trials in overweight or high-risk individuals have reported reductions in CRP and selected cytokines following adoption of vegetarian or vegan diets, often alongside improvements in body weight and insulin sensitivity. For example, in a 16-week randomised clinical trial in overweight adults, a low-fat vegan diet led to significant reductions in body weight, improved insulin sensitivity and decreased hepatocellular and intramyocellular lipid content compared with no dietary change (Kahleova et al., 2018). Although inflammatory markers were not the primary endpoint, these metabolic adaptations are strongly associated with lower systemic inflammatory load and may mediate part of the diet-inflammation relationship.

Other trials directly assessing inflammatory biomarkers have reported similar patterns. In patients with rheumatoid arthritis, a low-fat vegan diet led to improvements in clinical symptoms and reductions in markers related to inflammatory activity (McDougall et al., 2002;

Alwarith et al., 2019). More recent randomised studies comparing low-fat vegan diets with other cardioprotective patterns, such as Mediterranean diets, show that vegan interventions can reduce dietary advanced glycation end-products and improve cardiometabolic risk factors, which are closely linked to chronic inflammation (Kahleova et al., 2024).

Overall, interventional evidence suggests that plant-based diets can reduce systemic inflammatory markers, particularly when they lead to weight loss, improved insulin sensitivity and reductions in ectopic fat. However, a number of studies report attenuation of these effects after adjustment for changes in adiposity, indicating that part of the anti-inflammatory impact is mediated by improvements in body composition and metabolic status (Jaceldo-Siegl et al., 2018; Craddock et al., 2019).

3.3 Role of Diet Quality within Plant-Based Patterns

Emerging data indicate that not all plant-based diets confer equal anti-inflammatory benefits. Distinction between healthful plant-based diets, rich in whole grains, fruits, vegetables, legumes, nuts and unsaturated fats, and unhealthful patterns characterised by refined grains, added sugars and ultra-processed plant foods appears critical. Both cohort analyses and cross-sectional studies using healthful and unhealthful plant-based diet indices consistently show that only the healthful variants are associated with lower CRP, IL-6 and TNF-α, whereas unhealthful plant-based patterns may be neutral or even associated with higher inflammatory markers (Satija et al., 2017; Kharaty et al., 2023; Mrozik et al., 2025).

These findings underscore that the anti-inflammatory potential of plant-based diets depends not merely on the exclusion or reduction of animal products, but on the overall quality and degree of processing of plant-derived foods. This nuance is essential when interpreting epidemiological data and designing interventional studies aimed at modulating inflammation through dietary change.

4. Plant-Based Diets and Cellular Immune Function

Plant-based diets (PBDs) may influence cellular immunity through several mechanisms involving natural killer (NK) cells, regulatory T cells (Tregs), and innate antiviral pathways. Evidence in this domain comes from mechanistic research on plant-derived nutrients, human dietary interventions using plant foods, and controlled feeding studies comparing whole dietary patterns.

4.1 Mechanistic Evidence: NK and Treg Modulation

A comprehensive mechanistic review by (Y. S. Kim et al., 2015) summarised evidence that nutrient classes abundant in plant-forward diet-including vitamins A, D, and E, polyphenols from fruits and vegetables, and other bioactive phytochemicals-can modulate NK cell activation, influence cytokine production, and support Treg differentiation and function. These components regulate immune homeostasis through effects on effector cell signalling, transcriptional activity and oxidative stress responses.

Although this review does not specifically evaluate vegan or vegetarian diets, the mechanisms it describes directly relate to nutrient profiles characteristic of PBDs.

4.2 Human Evidence: NK Cells and Plant-Derived Dietary Components

While few clinical trials test whole plant-based diets with NK cell endpoints, several rigorously conducted human studies demonstrate that increasing intake of plant-derived polyphenols and antioxidants can enhance NK cell activity.

In a randomised controlled trial in endurance athletes, McAnulty et al. (2014) found that consuming 250 g of blueberries daily for six weeks increased circulating NK cell counts and attenuated exercise-induced oxidative stress compared with controls. Participants consuming blueberries also exhibited increased IL-10 concentrations, suggesting enhanced anti-inflammatory signalling.

Further supportive evidence comes from immune-focused nutrition trials. In a 77-day randomised placebo-controlled study, Nantz et al. (2006) reported that consumption of a concentrated fruit-and vegetable-based juice powder significantly increased circulating γδ-T cells-innate-like lymphocytes that contribute to early immune surveillance-and improved antioxidant capacity in healthy adults.

Additionally, a large meta-analysis by Hosseini et al. (2018) found that higher fruit and/or vegetable intake was associated with favourable immune profiles, including lower inflammatory cytokines and increased γδ-T cell levels. Although not limited to vegetarians or vegans, these findings support the concept that nutrient-dense plant foods can enhance innate immune cell activity.

Taken together, these studies suggest that characteristic components of plant-based diets-especially polyphenol-rich fruits and vegetables-can improve NK and γδ-T-cell function, although direct trials of full PBD patterns remain scarce.

4.3 Fibre, SCFAs, and Treg Regulation

A key mechanism linking PBDs to immune regulation involves dietary fibre and the associated production of short-chain fatty acids (SCFAs) through microbial fermentation. Two seminal studies provide a clear mechanistic model.

Furusawa et al. (2013) demonstrated that butyrate, a SCFA derived from gut microbial fermentation of plant fibre, induces differentiation of naive T cells into $FoxP3^{+}$ Tregs through epigenetic modification of histone acetylation. Similarly, Smith et al. (2013) showed that SCFAs increase colonic and systemic Treg numbers via GPR43-dependent signalling, resulting in enhanced regulation of inflammatory responses.

Because PBDs are typically high in fermentable fibre, these mechanisms strongly support a biologically plausible link between plant-based eating and improved Treg-mediated immune control.

4.4 Whole-Diet Evidence: Vegan Diet Immune Signatures

Direct evidence on whole plant-based dietary patterns comes from a recent multi-omics crossover feeding study by Link et al. (2024). In this controlled trial, participants followed a

vegan diet and a ketogenic diet in randomised sequence. The vegan diet elicited marked upregulation of innate antiviral response pathways, including interferon-stimulated genes, and altered populations of NK and T-cell subsets, including regulatory T cells. These transcriptomic immune signatures occurred independently of weight change, suggesting a direct effect of diet composition.

5. The Role of the Gut Microbiota as a Mediator of Diet-Immune Interactions

The gut microbiota is increasingly recognised as a central mediator linking dietary patterns with systemic immune function. Plant-based diets (PBDs), characterised by high intakes of dietary fibre, polyphenols and complex carbohydrates, exert profound effects on microbial composition, diversity and metabolic activity. Multiple human cohort studies demonstrate that individuals following vegetarian or vegan diets exhibit greater microbial diversity, higher abundances of saccharolytic taxa such as *Bifidobacterium*, *Faecalibacterium prausnitzii* and *Roseburia*, and reduced levels of pro-inflammatory, bile-tolerant species including *Bilophila wadsworthia* (Tomova et al., 2019; Hills et al., 2019).

Controlled feeding studies further support the microbiota-mediated effects of PBDs. In a crossover intervention, Wu et al. (2011) demonstrated that switching from an animal-based to a plant-based diet elicited rapid increases in SCFA-producing taxa and reductions in inflammatory microbial metabolites such as secondary bile acids and trimethylamine N-oxide (TMAO). These microbial changes correlated with lower expression of inflammatory genes in peripheral blood mononuclear cells. Similar findings were observed in vegans undergoing controlled diet challenges, where plant-rich diets reduced intestinal permeability markers and improved mucosal immune signatures (Roager & Dragsted, 2019).

Together, these findings highlight that the gut microbiota represents a key mechanism by which PBDs influence immune homeostasis. Enhanced SCFA production, increased abundance of beneficial commensals and reductions in microbial-derived inflammatory metabolites form an integrated pathway connecting dietary patterns with systemic inflammation and cellular immune function.

6. Metabolic Pathways as Mediators: Insulin Resistance, Lipotoxicity and Ectopic Fat

Metabolic status is a crucial determinant of immune activity, and many immunomodulatory effects of plant-based diets may arise indirectly through improvements in metabolic homeostasis. Diets rich in whole plant foods consistently reduce body weight, improve insulin sensitivity and lower hepatic and intramyocellular lipid stores-changes that attenuate adipose-derived inflammation and reduce production of pro-inflammatory cytokines such as IL-6 and TNF-α (Kahleova et al., 2020b).

Ectopic fat deposition, particularly in the liver and skeletal muscle, is metabolically and immunologically relevant, as excess lipid accumulation activates inflammatory pathways including JNK and NF-κB signalling. In a 16-week randomised clinical trial in overweight adults, a low-fat vegan diet significantly reduced hepatocellular and intramyocellular lipid

content, alongside improvements in insulin sensitivity and body weight, compared with no dietary change (Kahleova et al., 2020c). These findings are consistent with broader evidence that plant-forward dietary patterns are associated with lower risk of non-alcoholic fatty liver disease and more favourable liver tests in prospective and cross-sectional cohorts (Lv et al., 2023).

These findings collectively indicate that part of the anti-inflammatory effect of PBDs is mediated through favourable alterations in metabolic function, supporting the concept of immunometabolism as a critical interface between diet and immune regulation.

7. Clinical Infectious Disease Outcomes

Beyond surrogate inflammatory and immunological markers, several recent studies suggest that plant-based dietary patterns may translate into clinically relevant reductions in infection-related outcomes. In the Atherosclerosis Risk in Communities (ARIC) cohort, a higher healthy plant-based diet index was associated with a lower risk of hospitalisation for respiratory infections (hazard ratio [HR] 0.86, 95% CI 0.75-0.99) and any infection-related hospitalisation (HR 0.87, 95% CI 0.78-0.97) when comparing extreme quintiles (Kendrick et al., 2023). Randomised data in children with asthma similarly indicate that increasing fruit and vegetable intake-a key component of healthful plant-based diets-reduces the proportion of participants experiencing ≥2 asthma exacerbations and enhances interferon responses to viral stimuli in vitro (Hosseini et al., 2022). Observational evidence from the COVID-19 pandemic further supports a protective role of plant-forward patterns: in a large multinational case-control study, individuals reporting plant-based or pescatarian diets had substantially lower odds of moderate-to-severe COVID-19 compared with those following other dietary patterns (H. Kim et al., 2021), while prospective cohort data show that higher scores for healthy plant-based diets are associated with reduced risk and severity of COVID-19 (Merino et al., 2021; Sharma et al., 2023). More recent cohort analyses and a systematic review and meta-analysis corroborate these findings, reporting lower incidence and/or severity of COVID-19 among adults adhering to plant-based or mainly vegetarian dietary patterns (Acosta-Navarro et al., 2024; Papadaki et al., 2024).

Although residual confounding and self-reported diet limit causal inference, the convergence of data across respiratory infections, asthma-related events and COVID-19 outcomes is consistent with the hypothesis that healthful plant-based diets may enhance host defence and mitigate infection-related morbidity, in part through effects on adiposity, systemic inflammation, and gut microbiota-immune interactions described above.

8. Plant-Based Diets and Autoimmune Disease Activity

Growing evidence suggests that plant-based dietary patterns may modulate immune dysregulation characteristic of autoimmune diseases. Early clinical trials in rheumatoid arthritis (RA) demonstrated that vegan or vegetarian diets can reduce disease activity, joint swelling and pain scores. In a seminal randomised study, a gluten-free vegan diet led to significant reductions in C-reactive protein and DAS28 scores compared with a well-balanced omnivorous diet, indicating improved inflammatory control in RA (Müller et al., 2001). In inflammatory bowel disease (IBD), diet-microbiota interactions are particularly relevant. Observational studies consistently associate high intake of fruits, vegetables and whole grains with lower Crohn’s

disease risk, whereas Western dietary patterns increase relapse frequency. In a prospective interventional study, a semi-vegetarian diet markedly prolonged remission in Crohn's disease, with relapse rates significantly lower than in the omnivorous control group (Chiba et al., 2010).

9. Discussion

The findings summarised in this review indicate that healthful plant-based dietary patterns are consistently associated with lower levels of systemic inflammation and more favourable immune function. Evidence from observational studies, randomised trials and mechanistic research supports the notion that diets rich in minimally processed plant foods contribute to reduced concentrations of CRP, IL-6 and TNF-α, while also influencing innate and adaptive immune pathways. Importantly, the anti-inflammatory effects of plant-based diets appear to depend strongly on overall diet quality; unhealthful plant-based patterns high in refined carbohydrates and ultra-processed foods do not confer similar benefits.

Intervention studies suggest that part of the immunological advantage of plant-based diets is mediated indirectly through improvements in body weight, insulin sensitivity and reductions in ectopic fat, all of which contribute to lower metabolic inflammation. However, mechanistic evidence also points to direct immunomodulatory roles of plant-derived nutrients-such as polyphenols, antioxidant vitamins and unsaturated fatty acids-which can influence NK cell activity, regulatory T-cell differentiation and antiviral transcriptional pathways.

A key mediator of these effects appears to be the gut microbiota, with plant-based diets promoting a microbial profile rich in SCFA-producing taxa and reduced in pro-inflammatory species. SCFAs, particularly butyrate, are known to regulate T-cell homeostasis and enhance mucosal immune function, providing a plausible biological link between dietary fibre intake and systemic immune regulation.

Emerging clinical data suggest that these immunometabolic mechanisms may translate into reduced risk or severity of infectious and autoimmune conditions, including respiratory infections, asthma exacerbations, COVID-19 and inflammatory bowel disease. Although causality cannot be fully established due to heterogeneity in study designs and reliance on self-reported dietary data, the convergence of findings across diverse populations supports a protective role of healthful plant-based diets in immune health.

Overall, the current evidence suggests that well-constructed plant-based diets may represent an effective, non-pharmacological strategy to modulate inflammation and support immune function. Further long-term, rigorously controlled studies are needed to clarify causal pathways and determine which components of plant-based diets are most influential.

10. Limitations

Several limitations within the current body of evidence should be considered when interpreting the findings of this review. First, most observational studies rely on self-reported dietary intake, which is subject to recall bias and misclassification, particularly when distinguishing between healthful and unhealthful plant-based patterns. Heterogeneity in dietary definitions further complicates comparisons across studies, as "plant-based diets" may range from whole-food vegan patterns to highly processed plant-rich diets with substantially different metabolic and immunological effects.

Second, although evidence from randomised controlled trials is growing, relatively few trials have directly assessed inflammatory or immune biomarkers as primary endpoints. Many reported immunological improvements appear to be mediated by weight loss or metabolic changes, making it difficult to isolate direct dietary effects independent of adiposity. Additionally, most interventions are of short duration, limiting understanding of long-term immune adaptation to plant-based diets.

Third, mechanistic insights-particularly those involving the gut microbiota, SCFA signalling and immune transcriptomic pathways-are based on small, tightly controlled studies that may not fully generalize to free-living populations. Considerable interindividual variability in microbiota composition and metabolic phenotype also suggests that responses to plant-based diets may differ across subgroups.

Finally, residual confounding remains a challenge in studies linking plant-based diets to clinical outcomes such as respiratory infections or autoimmune disease activity. Individuals adhering to healthful plant-based diets typically engage in additional health-promoting behaviours, which may partially account for observed associations despite statistical adjustment.

Together, these limitations highlight the need for long-term, well-controlled dietary intervention studies with standardized definitions of plant-based diet quality and comprehensive immune phenotyping to better clarify causality and underlying mechanisms.

11. Conclusions

Healthful plant-based dietary patterns are consistently associated with lower levels of systemic inflammation, favourable modulation of innate and adaptive immune responses and reduced risk of several infection-related and autoimmune outcomes. Evidence from observational cohorts, randomised dietary interventions and mechanistic studies collectively supports the role of nutrient-dense plant foods, gut microbiota-derived metabolites and improved metabolic health as key mediators of these effects. However, the benefits are strongly dependent on overall diet quality, underscoring the distinction between minimally processed, fibre-rich plant foods and unhealthful plant-based patterns high in refined carbohydrates and ultra-processed products.

Despite promising and biologically plausible findings, important gaps remain, including heterogeneity in dietary definitions, limited long-term trials with immune-specific endpoints and challenges related to residual confounding. Further rigorously controlled, mechanistic and multi-omics-integrated research is needed to clarify causal pathways and identify populations most likely to benefit from plant-based dietary interventions.

Taken together, current evidence suggests that well-constructed plant-based diets represent a feasible, non-pharmacological strategy to support immune homeostasis and reduce chronic inflammation, with potential relevance for public health and clinical practice.

Disclosure

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Receiving funding – not applicable

All authors have read and agreed with the published version of the manuscript.

Funding statement

No funding was received for the Authors.

Institutional Review and Board Statement

Not applicable.

Data Availability Statement

Not applicable.

Conflict of Interest Statement

Authors declare no conflicts of interests.

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