

Nutritional Modulation of Prostatic Inflammation: Micronutrients and Diet Patterns in BPH Prevention and Management

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ABSTRACT

Benign prostatic hyperplasia (BPH) is a progressive, non-malignant enlargement of the prostate gland that is common in aging men and is often associated with lower urinary tract symptoms (LUTS). While hormonal and genetic factors are traditionally implicated in its pathogenesis, chronic low-grade inflammation has emerged as a critical driver of disease initiation and progression. Nutritional factors, including both individual micronutrients and broader dietary patterns, significantly influence the prostatic inflammatory microenvironment. This review examines the role of specific vitamins, minerals, fatty acids, and phytonutrients in modulating inflammation and oxidative stress in the prostate. Furthermore, it explores the impact of dietary patterns such as the Mediterranean diet, plant-based diets, and Western-style diets on the risk and severity of BPH. Clinical and preclinical evidence indicates that anti-inflammatory and antioxidant-rich diets may reduce the incidence, progression, and symptom severity of BPH. Emphasis is placed on the therapeutic potential of zinc, selenium, vitamin D, omega-3 fatty acids, polyphenols, and dietary fiber. This review advocates for integrative dietary strategies to complement pharmacological management and reduce the burden of BPH, especially in aging populations.

Keywords: Benign prostatic hyperplasia, Chronic inflammation, Micronutrients, Dietary patterns, Prostate health

INTRODUCTION

Benign prostatic hyperplasia (BPH) is a highly prevalent age-associated urological condition that poses a significant clinical burden worldwide [1]. It is defined by the non-malignant proliferation of epithelial and stromal cells in the transitional zone of the prostate gland, leading to an increase in prostate volume and a progressive narrowing of the urethral lumen [2]. This anatomical alteration causes lower urinary tract symptoms (LUTS), including urinary hesitancy, weak stream, nocturia, urgency, and incomplete bladder emptying [1]. Collectively, these symptoms impair quality of life, increase the risk of urinary retention and infection, and contribute to significant morbidity in aging male populations. Epidemiological studies estimate that nearly 50 percent of men in their fifties and up to 90 percent of men aged 80 and older have histologic evidence of BPH [3]. While hormonal dysregulation—particularly involving the androgen dihydrotestosterone (DHT)—has traditionally been considered a primary driver of prostatic growth, recent research has emphasized the critical role of chronic inflammation in the pathophysiology of BPH [4]. Histological analyses of prostate tissue from men with BPH reveal a high prevalence of inflammatory cell infiltrates, elevated expression of inflammatory cytokines, and fibrosis [5]. These findings support the hypothesis that BPH is not merely a hormonally driven process, but a chronic inflammatory disease involving immune dysregulation, oxidative stress, and microvascular injury.

Importantly, inflammation in BPH is not limited to the glandular microenvironment. Systemic inflammation and metabolic dysfunction—often seen in conditions such as obesity, insulin resistance, and cardiovascular disease—also appear to influence the course and severity of BPH [6]. This observation has prompted growing interest in identifying modifiable lifestyle factors, including dietary intake, that may prevent or mitigate the onset and

progression of prostatic enlargement. Diet influences inflammation both systemically and locally, through modulation of immune responses, oxidative stress, hormonal signaling, and microbial metabolism [7].

Several nutrients and dietary patterns have demonstrated the capacity to modulate inflammation, improve antioxidant defense systems, and reduce the risk of BPH. For example, diets rich in plant-based foods, omega-3 fatty acids, and phytonutrients have been associated with reduced prostate volume and lower LUTS scores [8]. Conversely, high intake of red meat, processed foods, saturated fats, and refined carbohydrates—hallmarks of the Western diet—have been linked to increased prostate size, inflammation, and symptom burden [9]. Given the modifiable nature of dietary habits and their far-reaching physiological effects, nutrition offers a promising, non-pharmacological strategy for the prevention and management of BPH. In particular, targeting prostatic inflammation through nutritional interventions may provide benefits beyond symptom control, including slowing disease progression and enhancing the effectiveness of conventional therapies. This review explores the role of key micronutrients and overall dietary patterns in modulating prostatic inflammation, aiming to inform integrative clinical approaches that prioritize prostate health through nutritional strategies.

Prostatic Inflammation and Its Nutritional Modulators

Chronic inflammation is now regarded as a key contributor to the initiation and progression of benign prostatic hyperplasia [6]. Unlike acute inflammation, which is typically short-lived and protective, chronic inflammation involves persistent immune cell infiltration, cytokine release, oxidative stress, and tissue remodeling [10]. In BPH, this inflammatory response drives epithelial and stromal proliferation, fibrosis, angiogenesis, and resistance to apoptosis—factors that collectively contribute to prostate enlargement and lower urinary tract dysfunction [11]. Histologically, prostatic inflammation is characterized by perivascular and periglandular infiltration of lymphocytes, macrophages, and mast cells, along with elevated levels of pro-inflammatory mediators such as tumor necrosis factor-alpha (TNF- α), interleukin-6 (IL-6), interleukin-8 (IL-8), cyclooxygenase-2 (COX-2), and inducible nitric oxide synthase (iNOS) [12]. These cytokines and enzymes sustain a feed-forward cycle of tissue injury and repair, creating a microenvironment that favors hyperplasia.

Nutritional factors can profoundly influence this pro-inflammatory state. Certain dietary components act as immune modulators, either attenuating or exacerbating chronic inflammation. Micronutrients such as zinc, selenium, vitamin D, and omega-3 fatty acids have demonstrated anti-inflammatory and antioxidant properties that may counteract the inflammatory milieu of the prostate [13]. These micronutrients not only influence immune cell activation and cytokine production but also enhance the activity of endogenous antioxidant enzymes such as superoxide dismutase (SOD), glutathione peroxidase (GPx), and catalase, thereby reducing oxidative damage to prostatic tissue [14].

Zinc

Zinc plays a critical role in immune function, wound healing, hormone regulation, and antioxidant defense. The prostate contains one of the highest concentrations of zinc in the body, and its depletion is associated with increased oxidative stress, epithelial proliferation, and prostate enlargement [15]. Zinc inhibits the activation of NF- κ B, a master regulator of inflammatory gene expression, and suppresses the production of IL-6 and TNF- α [16]. Supplementation studies in animal models of BPH have shown that zinc reduces prostate weight, mitigates histopathological changes, and improves antioxidant enzyme activity [17].

Selenium

Selenium is an essential trace element involved in the synthesis of selenoproteins, particularly glutathione peroxidase, which detoxifies hydrogen peroxide and lipid peroxides [18]. Selenium exerts anti-inflammatory effects by reducing oxidative stress and modulating immune responses [19]. Epidemiological data suggest that higher selenium levels are inversely associated with prostate volume and PSA levels. In rodent models, selenium supplementation has been shown to suppress COX-2 expression, decrease leukocyte infiltration, and reduce prostate mass in testosterone-induced BPH [20].

Vitamin D

Vitamin D modulates both innate and adaptive immunity and has been shown to downregulate pro-inflammatory cytokines while promoting regulatory T cell activity [21]. The prostate expresses vitamin D receptors (VDR), and vitamin D analogs have been shown to inhibit cell proliferation and induce differentiation in prostate cells [22]. Low serum vitamin D levels have been correlated with increased LUTS severity, higher PSA concentrations, and greater risk of BPH-related complications [23]. Vitamin D may also enhance the expression of antioxidant enzymes and protect against oxidative DNA damage in the prostate [24].

Omega-3 Fatty Acids

Omega-3 polyunsaturated fatty acids (PUFAs), particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are derived from marine sources and have strong anti-inflammatory effects [25]. These fatty acids suppress the synthesis of pro-inflammatory eicosanoids, inhibit NF- κ B signaling, and promote the resolution of inflammation

via specialized pro-resolving mediators [26]. In preclinical models of BPH, omega-3 supplementation has been shown to reduce prostate weight, suppress inflammatory cytokines, and improve histological architecture [27]. These findings underscore the capacity of specific micronutrients to modulate prostatic inflammation and potentially alter the trajectory of BPH. Nutritional interventions that incorporate these elements may offer a valuable complement to pharmacologic and surgical therapies, particularly in patients with early-stage disease or those seeking non-invasive management options.

Dietary Patterns and Risk of BPH

While individual micronutrients offer targeted anti-inflammatory and antioxidant benefits, overall dietary patterns exert a more comprehensive influence on prostate health through cumulative and synergistic effects. Emerging epidemiological and clinical research suggests that long-term adherence to specific dietary patterns can either mitigate or exacerbate the risk and progression of benign prostatic hyperplasia (BPH) [28]. Diets characterized by high intake of plant-based foods, unsaturated fats, and fiber appear to have a protective effect, whereas those dominated by processed meats, saturated fats, and refined sugars are associated with increased prostatic inflammation, greater prostate volume, and worsened lower urinary tract symptoms (LUTS) [29].

The Mediterranean diet, rich in fruits, vegetables, whole grains, legumes, olive oil, nuts, and fish, is among the most studied for its anti-inflammatory and antioxidant properties. This diet provides abundant phytonutrients, omega-3 fatty acids, and monounsaturated fats that collectively suppress pro-inflammatory cytokines and enhance cellular antioxidant defenses [30]. Several studies have demonstrated that men adhering to the Mediterranean diet have lower PSA levels, reduced LUTS severity, and smaller prostate volume compared to those consuming Western-style diets [31].

Plant-based diets, including vegetarian and vegan patterns, are similarly associated with reduced systemic inflammation and lower BPH prevalence. These diets are naturally low in saturated fats and high in fiber, flavonoids, and other phytochemicals that may inhibit hormonal pathways and inflammatory mediators involved in prostate enlargement [32].

In contrast, the Western dietary pattern—characterized by high consumption of red and processed meats, dairy, refined grains, and sugary beverages—has been linked to metabolic syndrome, systemic inflammation, and increased BPH risk [33]. This pattern promotes oxidative stress and elevates levels of IL-6, CRP, and TNF- α , all of which are implicated in prostatic hyperplasia. Overall, dietary patterns profoundly shape the inflammatory landscape of the prostate, making them critical targets for preventive and therapeutic interventions in BPH management.

CONCLUSION

Nutritional modulation represents a safe, cost-effective, and clinically relevant strategy for managing and potentially preventing benign prostatic hyperplasia. Both specific micronutrients and overall dietary patterns can significantly influence the prostatic inflammatory environment, oxidative stress burden, and hormonal balance as key determinants of prostate health. A diet rich in anti-inflammatory and antioxidant nutrients such as zinc, selenium, vitamin D, omega-3 fatty acids, and polyphenols, combined with adherence to healthy dietary patterns like the Mediterranean or plant-based diets, holds promise in mitigating BPH risk and alleviating symptom severity. Future research should focus on longitudinal dietary intervention studies, the development of personalized nutritional guidelines, and the integration of dietary counseling into routine urological practice.

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