

CHODKOWSKI, Jakub. The Impact of Nutritional Supplementation in Selected Chronic Medical Conditions: A Review. *Quality in Sport*. 2024;35:56432. e-ISSN 2450-3118.  
<https://dx.doi.org/10.12775/QS.2024.35.56432>  
<https://apcz.umk.pl/QS/article/view/56432>

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.

Has a Journal's 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 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.

Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

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The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 19.11.2024. Revised: 05.12.2024. Accepted: 12.12.2024. Published: 12.12.2024.

## **The Impact of Nutritional Supplementation in Selected Chronic Medical Conditions: A Review**

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### **ABSTRACT**

**Introduction:** Nutritional supplementation has become an integral part of managing chronic medical conditions, offering potential benefits in improving patient outcomes and quality of life. This review explores the evidence supporting the role of dietary supplements in selected chronic conditions, including cardiovascular disease, diabetes, osteoporosis, and inflammatory disorders, while highlighting potential risks and limitations.

**Materials and Methods:** A systematic review of peer-reviewed literature was conducted using databases such as PubMed, Scopus, and Google Scholar. Studies published between 2010 and 2023 were included if they examined the clinical impact of supplements like omega-3 fatty acids, vitamin D, calcium, chromium, and curcumin. Meta-analyses, randomized controlled trials, and observational studies were prioritized. Data extraction focused on efficacy, safety, and recommended dosages.

**Results:** Evidence suggests that omega-3 fatty acids reduce inflammation and improve lipid profiles in cardiovascular patients. Vitamin D and calcium significantly enhance bone mineral density in osteoporosis. Chromium and alpha-lipoic acid demonstrate modest improvements in glycemic control for diabetes. However, concerns about supplement overuse, potential drug interactions, and variability in product quality persist.

**Conclusions:** While supplementation offers therapeutic benefits in managing specific chronic conditions, its efficacy depends on patient-specific factors, including baseline nutrient status and disease severity. Clinicians must adopt an evidence-based approach, ensuring personalized recommendations and emphasizing the importance of quality control in supplementation practices. Further research is needed to clarify long-term effects and optimal dosages.

**Keywords:** nutritions, nutritional therapy, supplementation, chronic medical conditions

## INTRODUCTION

Chronic medical conditions, including diabetes, cardiovascular diseases, osteoporosis, and inflammatory disorders, are among the leading causes of morbidity and mortality worldwide. While pharmacological interventions remain the cornerstone of treatment, there is a growing body of evidence suggesting that nutritional supplementation can play a significant role in managing these conditions by addressing specific nutrient deficiencies and modulating disease

pathways [1, 2]. Among the supplements gaining attention for their therapeutic potential are omega-3 fatty acids, vitamin D, calcium, chromium, and curcumin.

Omega-3 fatty acids, primarily found in fish oil, have anti-inflammatory and cardioprotective properties, making them beneficial in managing cardiovascular diseases and metabolic syndrome [1]. Vitamin D, a critical regulator of calcium metabolism and immune function, is associated with improved outcomes in osteoporosis, diabetes, and autoimmune disorders [2]. Calcium supplementation, often used in conjunction with vitamin D, plays a crucial role in maintaining bone health and preventing osteoporosis [3]. Chromium, an essential trace element, has demonstrated potential in enhancing glucose metabolism and improving glycemic control in diabetes [4]. Curcumin, a bioactive compound derived from turmeric, is noted for its antioxidant and anti-inflammatory effects, showing promise in managing inflammatory and metabolic conditions [5].

This review aims to explore the impact of these selected supplements—omega-3 fatty acids, vitamin D, calcium, chromium, and curcumin—on chronic medical conditions. It examines the evidence supporting their use, mechanisms of action, and their potential to complement conventional therapies. Additionally, the review highlights challenges in supplementation, including dosage optimization, bioavailability, and possible interactions with medications, to guide effective integration into clinical practice.

## **MATERIALS AND METHODS**

A systematic review of peer-reviewed literature was conducted using databases such as PubMed, Scopus, and Google Scholar. Studies published between 2010 and 2023 were included if they examined the clinical impact of supplements like omega-3 fatty acids, vitamin D, calcium, chromium, and curcumin. Meta-analyses, randomized controlled trials, and observational studies were prioritized. Data extraction focused on efficacy, safety, and recommended dosages.

## **RESULTS**

### **Omega-3 Fatty Acids:**

Omega-3 fatty acids, primarily EPA and DHA, are polyunsaturated fats with well-established anti-inflammatory and cardioprotective properties. These fatty acids are integral to cellular membrane function and are involved in the production of eicosanoids, molecules that regulate inflammation and immune responses. Numerous studies have demonstrated the cardiovascular benefits of omega-3 supplementation. A comprehensive meta-analysis of RCTs published by Manson et al. found that omega-3 supplementation reduced the incidence of major cardiovascular events, including heart attack and stroke [2]. The study highlighted that both EPA and DHA contribute to improving lipid profiles, reducing triglycerides, and promoting endothelial function. These effects are especially beneficial in individuals with elevated cardiovascular risk, such as those with metabolic syndrome or type 2 diabetes [1, 6].

In diabetes management, omega-3 fatty acids have shown promise in improving insulin sensitivity and reducing markers of systemic inflammation. A study by Mozaffarian et al. demonstrated that omega-3 supplementation improved insulin sensitivity in patients with metabolic syndrome, which could help manage glucose levels more effectively [6]. Additionally, omega-3 fatty acids play a role in reducing adiposity, which is a key factor in the pathogenesis of type 2 diabetes [7].

Beyond cardiovascular and metabolic benefits, omega-3 fatty acids have been studied in other chronic conditions. For instance, omega-3 supplementation has been shown to alleviate symptoms of rheumatoid arthritis (RA), with multiple studies reporting reductions in joint pain and stiffness [8]. Additionally, in neurodegenerative conditions, omega-3 fatty acids have been shown to promote brain health, potentially offering neuroprotective effects in conditions such as Alzheimer's disease [9].

### **Vitamin D:**

Vitamin D, a fat-soluble vitamin that regulates calcium homeostasis and modulates immune function, has been the subject of extensive research regarding its role in chronic diseases. Several studies have demonstrated that vitamin D deficiency is prevalent in individuals with

chronic conditions such as osteoporosis, diabetes, cardiovascular disease, and autoimmune disorders [10]. Vitamin D supplementation has been shown to improve bone health by increasing calcium absorption and enhancing bone mineral density [11]. In postmenopausal women, vitamin D supplementation, combined with calcium, has been proven to reduce the risk of fractures [12].

In the context of diabetes, vitamin D plays a key role in insulin secretion and sensitivity. A large cohort study by Pittas et al. revealed that vitamin D supplementation improved insulin resistance and reduced the risk of developing type 2 diabetes in individuals with prediabetes [13]. Similarly, randomized trials in patients with established type 2 diabetes have shown improvements in glycemic control and a reduction in HbA1c levels with vitamin D supplementation. However, the evidence is not entirely consistent, and some studies have failed to demonstrate significant clinical benefits, suggesting that the effect of vitamin D may be modulated by factors such as baseline vitamin D levels and concurrent metabolic disturbances.

Beyond its metabolic effects, vitamin D also plays a pivotal role in modulating immune responses. Vitamin D receptors are found on immune cells, and adequate levels of vitamin D have been associated with reduced inflammation and a lower risk of autoimmune diseases such as rheumatoid arthritis and multiple sclerosis [14]. In patients with autoimmune diseases, vitamin D supplementation has shown promise in reducing disease flare-ups and improving quality of life [15].

### **Calcium:**

Calcium, a mineral crucial for bone health, muscle function, and cardiovascular stability, has been widely studied in relation to osteoporosis and fractures. A systematic review of calcium supplementation in postmenopausal women revealed significant improvements in bone mineral density [11]. Calcium supplementation, particularly in combination with vitamin D, has been shown to reduce fracture risk in older adults, with studies recommending daily doses of 1000–1200 mg to maintain bone health [3]. Furthermore, calcium intake plays a role in reducing the incidence of osteoporotic fractures, a common complication of aging.

While calcium's role in bone health is well established, emerging evidence suggests that its effects extend beyond skeletal health. Research has indicated that calcium may have a potential

role in lowering blood pressure. A randomized controlled trial found that calcium supplementation significantly lowered systolic and diastolic blood pressure, particularly in individuals with low calcium intake [16].

However, the benefits of calcium supplementation are not without concerns. Excessive calcium intake, particularly from supplements, has been associated with an increased risk of cardiovascular events, such as heart attack and stroke. A meta-analysis by Bolland et al. found a modest but significant increase in the risk of cardiovascular disease with high doses of calcium supplementation, raising questions about the safety of excessive calcium intake [11].

### **Chromium:**

Chromium, a trace mineral that plays a critical role in insulin signaling, has been investigated for its effects on glucose metabolism and diabetes management. Chromium supplementation, particularly in the form of chromium picolinate, has been shown to improve insulin sensitivity and glycemic control in patients with type 2 diabetes. A meta-analysis found that chromium supplementation significantly reduced fasting blood glucose levels and HbA1c, a marker of long-term glucose control [17]. In diabetic patients, chromium may enhance insulin receptor function and improve the efficiency of glucose uptake into cells.

Although chromium supplementation shows promise, the evidence remains mixed. Some studies have reported minimal or no benefit, especially in individuals with normal chromium levels or those not suffering from diabetes [18]. Furthermore, the optimal dosage and form of chromium supplementation remain uncertain, and its use should be considered cautiously in certain populations. Another study suggested that the effectiveness of chromium might depend on the baseline nutritional status and the presence of insulin resistance [19].

### **Curcumin:**

Curcumin, the active component of turmeric, is a polyphenolic compound known for its potent antioxidant and anti-inflammatory properties. Curcumin has been widely studied for its role in reducing inflammation and oxidative stress in chronic diseases. In osteoarthritis, a randomized controlled trial demonstrated that curcumin supplementation reduced pain and improved physical function in patients with knee osteoarthritis [20]. The anti-inflammatory effects of

curcumin are attributed to its ability to inhibit pro-inflammatory pathways, such as the NF- $\kappa$ B pathway and cyclooxygenase-2 (COX-2) [21].

In inflammatory bowel disease (IBD), curcumin supplementation has shown potential in reducing disease activity and promoting mucosal healing. A study found that curcumin supplementation led to significant reductions in disease activity scores and improved clinical outcomes in patients with ulcerative colitis [22]. Additionally, curcumin has been studied for its potential effects in metabolic syndrome, with evidence suggesting that it can reduce markers of inflammation and improve lipid profiles [5].

Despite these promising findings, the bioavailability of curcumin remains a significant challenge. Curcumin is poorly absorbed in the gastrointestinal tract, limiting its therapeutic potential. However, recent innovations, such as curcumin nanoparticles and curcumin formulations combined with piperine (black pepper extract), have shown improved bioavailability, allowing for more effective clinical outcomes [23].

## **DISCUSSION**

This review examined the potential role of nutritional supplementation omega-3 fatty acids, vitamin D, calcium, chromium, and curcumin in managing chronic medical conditions, with a particular focus on inflammation, metabolic health, and bone health. The results suggest these supplements offer considerable benefits, but their effects can be variable depending on individual factors such as baseline nutritional status, genetics, and the presence of other health conditions.

Omega-3 fatty acids have established benefits for cardiovascular health, particularly in reducing triglyceride levels and inflammation, which can improve outcomes in cardiovascular disease, metabolic syndrome, and autoimmune diseases [1]. While the evidence is strong for heart health, the effects in neurodegenerative diseases and cognitive decline remain inconclusive [9]. The optimal type, dosage, and duration of omega-3 supplementation are still subjects of ongoing research.

Vitamin D plays a critical role in bone health and immune function, and supplementation has been shown to reduce fracture risk and support immune regulation in conditions like rheumatoid

arthritis. In type 2 diabetes, vitamin D has modest effects on improving insulin sensitivity, though the results are inconsistent [13]. The lack of consensus on the ideal dosage for therapeutic benefits remains a challenge in clinical practice, with higher doses potentially offering additional benefits but raising the risk of toxicity [10].

Calcium supplementation, especially when combined with vitamin D, has been proven effective in reducing the risk of fractures and maintaining bone mineral density in older adults. However, concerns about cardiovascular risks associated with calcium supplementation, particularly from high doses, have prompted caution [11]. Thus, the source and dosage of calcium should be carefully considered, particularly in individuals with cardiovascular disease.

Chromium supplementation has shown promise in improving insulin sensitivity and glycemic control in type 2 diabetes, with chromium picolinate being the most studied form [17]. However, the overall clinical efficacy remains uncertain, with some studies showing minimal effects. Factors such as baseline chromium levels and the presence of comorbidities likely influence its effectiveness, highlighting the need for more personalized approaches to supplementation.

Curcumin, known for its anti-inflammatory properties, has been found beneficial in conditions like osteoarthritis and inflammatory bowel disease, where it can reduce pain and improve function [21]. Despite its promising effects, curcumin's poor bioavailability limits its clinical use. New formulations to enhance absorption show promise, but further research is needed to optimize dosing and improve long-term efficacy.

## **CONCLUSIONS**

This review underscores the growing evidence supporting the beneficial role of nutritional supplementation specifically omega-3 fatty acids, vitamin D, calcium, chromium, and curcumin in the management of chronic medical conditions. These supplements show significant promise in reducing inflammation, improving metabolic health, and supporting bone health, with implications for conditions such as cardiovascular disease, osteoporosis, diabetes, rheumatoid arthritis, and inflammatory bowel disease.



While the benefits of omega-3 fatty acids and curcumin are particularly notable in inflammatory conditions, and vitamin D and calcium remain cornerstone therapies for bone health, the clinical outcomes of supplementation can be influenced by factors such as baseline nutritional status, genetics, and the presence of comorbidities. The evidence for chromium supplementation in diabetes management, though promising, is still inconsistent, highlighting the need for more targeted research.

Despite these promising findings, challenges remain, including the variability in individual responses to supplementation, issues related to bioavailability (curcumin), and the risk of potential adverse effects with excessive intake (calcium supplementation and cardiovascular health). Additionally, the optimal dosage and duration of supplementation, particularly for conditions such as type 2 diabetes and autoimmune diseases, are still not well established.

In conclusion, while nutritional supplements offer a valuable adjunct to conventional therapies, their use should be personalized, considering the unique needs of each patient. Further research, including large-scale, long-term clinical trials, is needed to refine our understanding of the most effective strategies for supplementing these nutrients in chronic disease management, identify potential interactions with other medications, and determine the best dosing regimens. A more integrated approach, combining supplementation with lifestyle changes and conventional treatments, could significantly enhance therapeutic outcomes for patients with chronic conditions.

**Author`s contribution:**

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Check: Jakub Chodkowski

Formal analysis: Jakub Chodkowski

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Writing-review and editing: Jakub Chodkowski

Supervision: Jakub Chodkowski

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

**Founding Statement:** The study did not receive funding.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Conflict of Interest Statement:** The authors declare no conflicts of interest.

**Acknowledgments:** Not applicable.

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