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Short Commentary

Nutrition, Supplementation and Sustainability: toward an Integrative and Preventive Approach

Flavia Del Grosso[1]*, Dario Turco[2] and Ramiro Francesco Ramirez[3]

[1]*European Association for Sports Dentistry (EA4SD), Siena, Italy*

[2]*Hygiene and Preventive Medicine, Formia, Italy*

[3]*Content Ed Net srl, Rome, Italy*

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Introduction

Nutritional supplementation is widely diffused in both the general population and athletes, often without strict medical indication. While supplements may be useful in selected cases, their overuse raises concerns regarding efficacy, safety, and environmental sustainability. Modern food systems, environmental pollution, and lifestyle restrictions contribute to nutritional challenges, but indiscriminate supplement use risks undermining both health and ecological balance. In this commentary to a recent critical review [1], we highlight the importance of provenance control, sustainable production, and holistic integration of supplementation into preventive medicine. A conscious, integrative approach is needed, one that respects patients, promotes planetary health, and aligns performance with sustainability.

In the contemporary digital environment, where self-diagnosis and health information sourced from non-professional online content often overshadows medical advice and facilitate the rapid spread of misinformation, nutritional supplementation remains a topic of considerable confusion and controversy. The classical principle "let food be thy medicine" reminds us that balanced nutrition must remain the foundation of health, with supplementation reserved for clinically proven needs. Yet, environmental degradation, food processing, and lifestyle restrictions make it increasingly difficult to meet all nutritional demands through diet alone [1].

Supplementation: between Necessity and Overuse

Sports nutrition is defined as the branch of nutritional science concerned with optimizing athletic performance, facilitating recovery, and preserving the athlete's health through the appropriate provision of food, energy, and nutrients. Moreover, an adequate dietary regimen is fundamental for sustaining glycogen reserves, meeting energy requirements, promoting muscle recovery, and preventing micronutrient deficiencies [2].

The global prevalence of nutritional supplement use is high, particularly among athletes. However, data are often unreliable, as many individuals self-prescribe without professional guidance. In the context of sports, the prevalence of nutritional supplement use is considerable, with estimates ranging from 40% to nearly 100% of athletes, depending on the sporting discipline, level of competition, and the operational definition of supplementation. Nevertheless, in the absence of a diagnosed nutrient deficiency, supplementation is unlikely to enhance performance and may, in fact, exert adverse effects on both athletic performance and overall health. Key concerns related to supplement use include athletes' limited awareness of product composition, the potential for excessive consumption, and the frequent reliance on advice provided by non-qualified individuals [3].

Physicians, often influenced by patient expectations, may at times prescribe nutritional supplements indiscriminately. Such practices are problematic, as unwarranted supplementation neither prevents disease nor supports health, but rather contributes to the medicalization of lifestyle and imposes additional ecological burdens [4]. Scientific literature confirms that supplementation is useful only under medical supervision and in well-defined contexts. In sports, for example, targeted supplementation may be required to sustain glycogen reserves, energy metabolism, and recovery [5].

The Environmental Burden of Supplementation

Beyond individual health, supplementation entails broader consequences. The production, packaging, and distribution of supplements generate a measurable environmental impact. Several studies highlight this dimension: plant-based protein supplements, for example, generally present a lower carbon footprint compared to animal-based proteins [6]. Given the high consumption volumes in athletic populations, nutritional choices in sport may significantly affect environmental outcomes.

***Corresponding author:** Flavia Del Grosso, European Association for Sports Dentistry (EA4SD), Siena, Italy, Tel: +39 3288141935; E-mail: flavia.delgrosso@gmail.com

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Conscious evaluation should therefore extend beyond clinical efficacy to include: [1]

- **Origin and regulation:** provenance strongly influences safety and sustainability. Purchased online supplements often bypass national regulations. Harmonization efforts, such as Directive 2002/46/EC in Europe, have improved consumer protection, but globalized trade still poses risks [7].
- **Production and processing:** the cultivation, extraction, and transformation of raw materials impact both quality and ecological footprint. Sustainable sourcing and transparent supply chains should be prioritized.
- **Packaging:** reducing plastic, preferring recyclable or biodegradable alternatives (e.g., glass, aluminum, paper), and promoting bulk or semi-processed products (e.g., dried herbs) can lower environmental impact.

In this context, plant-based dietary supplements may confer benefits for athletic performance and could serve as an alternative, and potentially a substitute, for animal-derived supplements. Evidence suggests that athletes adhering to a vegetarian diet exhibit significantly higher values of relative oxygen consumption and maximal power output compared to their omnivorous counterparts. However, no significant differences have been observed in parameters related to muscular strength [8].

The field of alternative proteins requires greater scientific engagement to advance research and develop viable substitutes for conventional meat, egg, and dairy products. Current alternatives encompass plant-, insect-, fungal-, algal-, and fermentation-based proteins, as well as cultivated meat. Fermentation, in particular, contributes to environmental sustainability by utilizing locally available resources with minimal additional agricultural inputs and reduced energy requirements compared with conventional food processing methods, an aspect of particular relevance in low-income regions. From a nutritional perspective, fermented products are increasingly of interest to athletes, as they provide a valuable source of macronutrients and micronutrients, including proteins, essential fatty acids, soluble fibre, minerals, vitamins, and essential amino acids. Moreover, their prebiotic content and the presence of specific lactic acid bacterial strains support gut health, enhance protein synthesis and mineral bioavailability, and ultimately contribute to improved sports nutrition outcomes [9].

Although plant-derived proteins are generally considered to have lower biological quality compared to animal-based proteins, several novel protein sources (both of plant and animal origin) emerge as potentially valuable for sports performance, in addition to offering environmental advantages when adopted as dietary supplements. Within this framework, plant proteins are of particular interest, as they contain bioactive compounds capable of mitigating the elevated oxidative stress associated with intense exercise [10].

Finally, global trends and growing consumer concerns are driving significant shifts in nutrition, which in turn are influencing the sports nutrition sector. In line with rising health consciousness, consumers increasingly prefer products that are natural, plant-based, free from animal-derived ingredients, minimally processed, and sourced locally and seasonally. These preferences are progressively shaping the development and positioning of sports nutrition products [11]. Therefore, this need should be considered by prescribers when discussing nutritional supplements in athletes, and in general for patients.

Toward Integrative and Preventive Medicine

The potential dual benefits for both human health and the environment underscore the opportunity for a paradigm shift in sports supplementation. Supplement use should not be regarded as a quick fix or consumer commodity, but rather as part of a holistic model of care that integrates conventional medicine, nutritional science, and sustainability principles, thereby addressing health and ecological challenges in parallel. Physicians and nutritionists could apply a balanced approach between sustainability and health benefits when prescribing to athletes, with particular attention to abuse and health risks.

Within this framework, integrative medicine emphasizes prevention as the primary strategy, promoting healthy lifestyles, balanced diets, and evidence-based supplement use. Respect for the athlete or patient must be accompanied by respect for the environment, acknowledging the profound interconnection between human and planetary health. The growing emphasis on sustainability within sports nutrition highlights the need for more targeted research that explicitly links the health benefits of plant-based, animal-free supplements with their positive environmental impact. Randomized studies of equivalence between plant-based and animal-based nutritional supplement could help the scientific community to better elucidate the equivalence, while these results could be translated in a post hoc analysis on environmental outcomes, such as carbon footprint.

In conclusion, while nutritional supplementation can play an important role in athletic performance and in specific clinical contexts, its application must be carefully justified. Both clinicians and athletes should adopt an integrative, prevention-oriented approach that is medically supervised and environmentally conscious. In this way, supplementation can contribute not only to individual performance and recovery but also to planetary sustainability, representing a unique opportunity to align preventive medicine, human well-being, and ecological responsibility.

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