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The science, safety, and policy of dietary supplements: A comprehensive review and future roadmap

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ABSTRACT

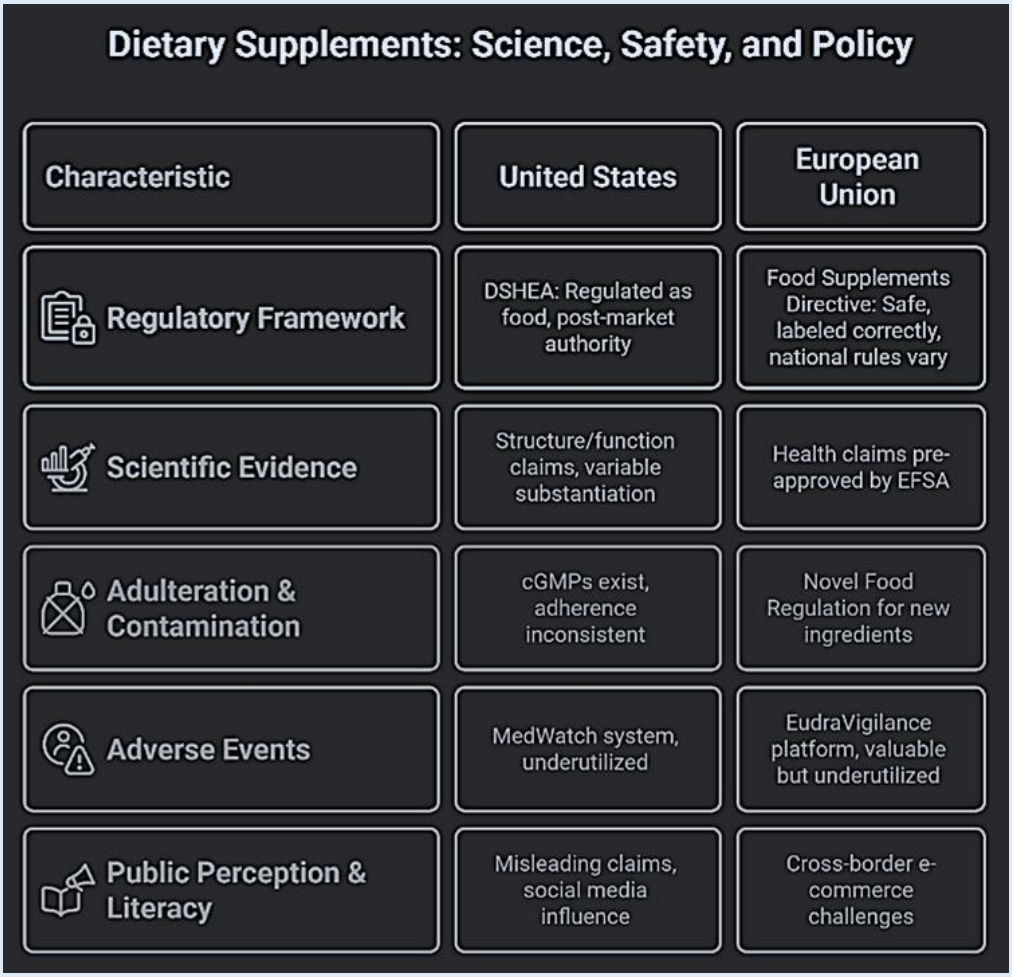
This review offers a new perspective by connecting conversations around dietary supplements with developments in functional food science, highlighting key opportunities to improve clinical validation, regulatory oversight, and public health approaches. By bringing together evidence from both fields, the article proposes an integrated framework aimed at strengthening the credibility, safety, and effectiveness of over-the-counter health products.

Over-the-counter (OTC) dietary supplements are among the fastest-growing areas in the global health and wellness market. Yet, despite their popularity, questions remain about how well these products are regulated, the quality of the supporting scientific evidence, and the consistency of quality assurance practices. These concerns vary widely across countries and regions. This mini review takes a critical look at the major challenges in the OTC supplement space. It focuses on the reliability of the underlying science, ongoing regulatory gaps, safety risks tied to contamination and adulteration, and the widespread use of misleading marketing claims. It also pays close attention to how effective the most common supplements are in clinical settings, patterns of reported side effects, and how well-informed consumers are when choosing these products.

Additionally, the article explores how dietary supplements intersect with functional food science and suggests a combined framework to guide future research and policy development. By drawing on evidence-based analysis, the review stresses the need for more globally consistent regulations, increased transparency from manufacturers, and improved public education to support safe and informed supplement use.

Novelty: This review introduces an interdisciplinary lens that connects the fields of dietary supplements and functional food science. It identifies gaps in translating research into practice, areas where regulations might align, and offers a framework to bring the scientific rigor of functional foods into how dietary supplements are developed, assessed, and regulated.

Keywords: Dietary Supplements; Regulatory Frameworks; Clinical Efficacy; Adverse Events; Functional Food Science; Consumer Health Literacy; Adulteration and Contamination; Evidence-Based Nutrition



Graphical Abstract: The Science, Safety, and Policy of Dietary Supplements:

INTRODUCTION

The global market for over-the-counter (OTC) dietary supplements has experienced exponential growth over the past two decades, reflecting shifting consumer preferences toward preventative healthcare, natural remedies, and personalized wellness. In the United States alone, it is estimated that over 75% of adults report using some form of dietary supplement, with similar trends observed across Europe, Asia, and emerging economies. These products include a wide array of vitamins, minerals, herbs, amino acids, enzymes, and other bioactive compounds marketed to enhance health,

support immune function, improve cognition, boost energy, and even prevent or treat diseases [1-2].

Even though dietary supplements are widely used, the industry still faces major scientific, regulatory, and ethical issues. Unlike prescription drugs, most supplements don't go through strict approval processes before hitting the market. They're often sold with little solid proof that they work and without thorough safety testing. On top of that, the rules around supplements differ a lot depending on where you are, making it hard to have consistent standards or proper oversight. This has raised concerns among clinicians, scientists, and public health officials about the quality, consistency, and reliability of these products [3–6].

A central issue is the uneven scientific foundation underpinning the health claims associated with supplements. While some ingredients are supported by randomized controlled trials (RCTs) and meta-analyses, many others rely on anecdotal evidence, preliminary in vitro studies, or poorly designed clinical trials. Inconsistent dosages, bioavailability issues, and population heterogeneity further complicate the interpretation of efficacy data. The U.S. Preventive Services Task Force (USPSTF), for example, has found insufficient evidence to recommend routine multivitamin consumption for the prevention of cardiovascular disease or cancer in healthy adults [7].

The safety profile of dietary supplements also presents a critical concern. Numerous reports have documented adverse events (AEs) associated with supplement use, including hepatotoxicity, cardiovascular complications, and interactions with prescription medications. Some products are found to be adulterated with pharmaceuticals, heavy metals, or microbial contaminants, often unbeknownst to the consumer. Surveillance systems for monitoring such events are fragmented and often underutilized, making it difficult to quantify the true public health burden [5,8-9].

Adding to this complexity is the issue of consumer misinformation and labeling inaccuracies. Many products feature exaggerated or misleading claims that can foster unrealistic expectations or promote inappropriate use. Given that supplements are often self-prescribed, particularly among vulnerable populations such as the elderly or chronically ill, the potential for harm is amplified [10-11].

In parallel, the burgeoning field of functional food science offers insights and potential models for improving supplement design and oversight. Functional foods, which are consumed as part of a normal diet and provide physiological benefits beyond basic nutrition, often undergo more structured clinical testing, regulatory scrutiny, and biomarker validation. The integration of these approaches into the supplement industry could serve to enhance credibility, efficacy, and consumer trust.

This review aims to synthesize the current scientific and regulatory landscape surrounding OTC dietary supplements. It explores the robustness of clinical evidence, highlights safety and quality control issues, examines consumer behavior and health literacy, and proposes actionable recommendations grounded in both public health and functional food science. By adopting a critical and evidence-based lens, the goal is to inform stakeholders—including clinicians, researchers, policymakers, and consumers—about the opportunities and limitations inherent in the current supplement paradigm.

Methodology: This review employed a structured literature search strategy to identify relevant articles, regulatory documents, and expert commentaries related to over-the-counter dietary supplements. The primary databases used were PubMed, Scopus, Web of Science, and Google Scholar, with a focus on literature published between 2010 and 2025. Emphasis was placed on systematic reviews, randomized controlled trials, meta-

analyses, and official guidelines from international health agencies (e.g., FDA, EFSA, WHO). To integrate functional food perspectives, open-access articles from the Food Science Publishers journals (www.FFHDJ.com) were selectively reviewed, with a focus on concepts related to bioactive compounds, microbiome modulation, and personalized nutrition. Keywords used in the search included: "dietary supplements," "adulteration," "regulatory frameworks," "consumer safety," "clinical efficacy," "functional foods," and "nutritional interventions." Reference snowballing and citation tracking were used to enrich the dataset and validate critical insights. Only peer-reviewed sources in English were considered.

Regulatory Frameworks and Oversight

A. United States: The United States regulates dietary supplements under the Dietary Supplement Health and Education Act (DSHEA) of 1994. Under DSHEA, supplements are classified as food products rather than pharmaceutical drugs, which means manufacturers do not need FDA approval before bringing most products to market. Manufacturers bear the responsibility for ensuring product safety and accurate labeling before sale [1]. This pre-market autonomy contrasts sharply with the regulatory demands placed on pharmaceutical agents.

The FDA retains post-marketing authority to act against adulterated or misbranded supplements. This includes issuing warning letters, mandating recalls, or enforcing compliance through legal channels. Nevertheless, with constrained resources and the enormous volume of products—exceeding 80,000 currently available in the U.S. market—regulatory enforcement tends to be reactive rather than preventive [2]. Moreover, manufacturers aren't obligated to provide evidence backing their structure/function claims unless specifically challenged, which results in significant variation in how well health claims are scientifically supported [12].

Various efforts to strengthen oversight have included establishing current Good Manufacturing Practices (cGMPs), which mandate that facilities maintain quality, purity, and consistency standards. Still, compliance varies considerably, particularly among smaller companies or overseas manufacturers. The introduction of a voluntary Supplement Ingredient Directory and recent proposals, such as the Dietary Supplement Listing Act of 2023, aim to improve transparency and regulatory tracking [13].

Dietary supplement regulation in America operates through a complex system that's primarily shaped by the Generally Recognized as Safe (GRAS) designation, working alongside the Dietary Supplement Health and Education Act of 1994 (DSHEA). GRAS functions as a regulatory classification within the U.S. Food and Drug Administration (FDA) that permits specific substances to be incorporated into food products without premarket approval, assuming they have been deemed safe by qualified experts. This designation proves essential for dietary supplements because it establishes both safety parameters and regulatory compliance requirements for ingredients found in these products. Companies can achieve GRAS status either through scientific procedures or by demonstrating historical common use in food prior to 1958. DSHEA, on the other hand, provides a framework for dietary supplements, balancing consumer access with safety regulations.

While the GRAS designation and DSHEA provide a framework for regulating dietary supplements, the system faces notable challenges. The self-affirmation process for GRAS status and the broad claims allowed under DSHEA have led to debates about the adequacy of current regulations in protecting consumer health. As the dietary supplement market continues to grow, ongoing evaluation and potential reform of these regulatory mechanisms are essential to address safety concerns and maintain public trust.

B. European Union: Dietary supplements in the European Union (EU) fall under the Food Supplements Directive 2002/46/EC, which basically says that supplements have to be safe and labeled properly. But here's the catch—each member state can add its own national rules on top of this, which creates a patchwork of regulations across Europe. If you want to use novel ingredients, you'll need approval under the Novel Food Regulation (EU) 2015/2283, and this process is pretty strict when it comes to pre-market testing [14-15].

The European Food Safety Authority (EFSA) is basically the gatekeeper when it comes to checking whether health claims are scientifically valid under Regulation (EC) No. 1924/2006. This is where Europe really differs from the U.S.—over there, health claims have to get approval beforehand and need solid scientific backing, including actual human studies. Just to give you an idea of how tough EFSA is, they've rejected more than 80% of the health claims submitted between 2008 and 2020—that's a pretty high bar [14].

Traditional herbal medicinal products can also fall under Directive 2004/24/EC, which is known as the Traditional Herbal Medicinal Products Directive (THMPD), when they're intended for therapeutic use. This provides a simplified registration process based on traditional use, as long as safety and quality standards are met [15].

These regulatory tools haven't solved all the problems, though. Online sales across borders and uneven enforcement between member states still allow products with unproven claims or questionable ingredients to reach consumers. Key future goals include strengthening mutual recognition and creating unified national lists of approved substances [16-17].

C. Asia: Dietary supplement regulation across Asia is complicated and differs significantly between countries. These systems aim to protect public health by ensuring supplements are safe, effective, and high-quality, important considerations given their growing popularity due to perceived health benefits. Major Asian countries like India, China, Japan, and several Southeast Asian nations have developed different regulatory approaches for these products. Here's a breakdown of how different regions handle supplement regulation.

India: In India, the Food Safety and Standards Authority of India (FSSAI) manages dietary supplements under the Food Safety and Standards Act (FSS Act) of 2006. This law covers licensing, labeling, product standards, and health claims, and it requires scientific proof for any claims companies make [18-19].

FSSAI's rules are strong and focus on consumers, often stricter than those in nearby countries like Cambodia [18].

China and Japan: Both China and Japan have well-organized systems for dietary supplements. What makes Japan particularly interesting is its FOSHU (Foods for Specified Health Use) and FFC (Foods with Function Claims) programs, which set clear rules about what health claims companies can make [20].

These programs don't mess around—they require thorough scientific testing to back up any health benefits claimed, putting both effectiveness and consumer safety at the top of their priority list [20].

Southeast Asia: Southeast Asian countries like Indonesia, Malaysia, the Philippines, Singapore, and Thailand have all created their own rules for controlling health claims on dietary supplements and functional foods [21].

The problem is that these regulations aren't consistent, and countries use different standards for what counts as acceptable evidence. This creates headaches for companies trying to coordinate efforts and trade across the region [21].

The bottom line is that while these regulatory systems try to protect consumers and make sure products

work, the patchwork of different rules across Asia makes life difficult for supplement manufacturers trying to sell their products in multiple markets. If countries could get their regulations more aligned, it would probably lead to better public health outcomes and help the supplement industry grow more effectively across the region.

Scientific Evidence and Clinical Efficacy: Even though dietary supplements are popular, the research backing them varies dramatically in strength and quality. Some nutrients and compounds like omega-3 fatty acids, vitamin D, and folic acid have been thoroughly studied using randomized controlled trials (RCTs) and meta-analyses. Others lack sufficient data or rely solely on early-stage or observational studies. For instance, solid evidence shows that folic acid helps prevent neural tube defects, but claims about cognitive improvement or anti-aging effects from certain herbal products largely lack scientific support [22–23].

When researchers analyze large studies together, they find mixed results across different populations and product formulations. In 2022, the U.S. Preventive Services Task Force (USPSTF) concluded that multivitamins, individual vitamins like E and beta-carotene, and most mineral supplements provide little to no benefit for preventing heart disease or cancer in healthy adults [7]. Even when supplements do work, issues with how well the body absorbs them, proper dosing, and how nutrients interact with each other make the results complicated [23,24].

Figuring out whether supplements actually work gets even harder because of publication bias and selective reporting. Studies that show no effects or negative results are less likely to get published, which leads to overestimating how well supplements work in both public perception and scientific literature. Additionally, studies funded by supplement companies often lack strict methodology or have conflicts of interest that might affect how objective the findings are [25].

Research reviews show that some supplements, like omega-3 fatty acids for reducing heart disease risk or probiotics for preventing diarrhea caused by antibiotics, do provide meaningful clinical benefits when used correctly [26-27]. However, how well they work often depends on the specific situation, including the population being studied, existing health conditions, dosage amounts, and product quality. These important details need to be clearly explained to consumers to prevent misunderstandings and help people make evidence-based decisions.

Adulteration and Contamination: Safety and credibility threats to dietary supplements arise critically from adulteration and contamination. Pharmaceutical agents such as sibutramine (an anorectic), sildenafil (for erectile dysfunction), or corticosteroids often get added illicitly through intentional adulteration. Efficacy enhancement motivates these additions, but serious health risks can result [28,9].

Manufacturing practices, quality control systems, and environmental exposure can all cause contamination when they prove inadequate or poor. Detectable levels of heavy metals (e.g., lead, arsenic, cadmium) appear in various herbal and nutritional products, along with microbial pathogens and pesticide residues. Analytical techniques like ICP-MS (Inductively Coupled Plasma Mass Spectrometry) and LC-MS/MS (Liquid Chromatography–Mass Spectrometry) reveal widespread contamination through studies. Regions with less stringent oversight source products that show particularly concerning contamination levels [29–31].

Mandatory third-party testing remains absent, which compounds this issue substantially. Standardized global quality benchmarks also don't exist. Consumer misconceptions contribute as well - the assumption that "natural" equals "safe" leads many to underestimate risks

from contaminants and adulterants mistakenly. Numerous recalls get issued by regulatory agencies, yet their reactive enforcement approach still exposes consumers to harm.

Manufacturing surveillance enhancement becomes necessary because of these safety breaches. Batch-level testing and international quality standards harmonization are also required. Transparency tools such as blockchain-based traceability systems are proposed to improve global supply chain accountability [32].

Consumer Safety and Adverse Events: Dietary supplement-linked adverse events (AEs) now constitute a growing public health concern. Annual emergency department visits in the U.S. exceeded 23,000 due to supplement-related adverse effects, as estimated by a 2015 study. Most frequently implicated were weight-loss, energy, and sexual enhancement products in these cases [5,9].

Most common AEs encompass hepatotoxicity, cardiovascular effects (e.g., arrhythmias, hypertension), and allergic reactions. Frequent underreporting of these risks happens because mandatory adverse event reporting requirements are absent in many jurisdictions. Consumers perceive supplements as inherently safe, which contributes to this problem. Interactions between supplements and prescription drugs become particularly concerning when cytochrome P450 enzymes (CYPs) get involved - pharmacokinetic alterations can occur, leading to increased toxicity or reduced medication efficacy [10]. The elderly, polypharmacy patients, pregnant women, and individuals with chronic illnesses comprise populations at higher risk. Documented serious outcomes through several case reports and series include acute liver failure and hospitalization. Valuable monitoring systems exist through the FDA's MedWatch and European EudraVigilance platform, yet they continue to be underutilized.

Reduction of preventable harm becomes possible through education campaigns, provider-patient communication, and improved labeling with evidence-based warnings. When supplement use integration occurs into electronic health records and clinical decision support tools, another promising strategy emerges for enhancing safety oversight.

Public Perception and Health Literacy: Dietary supplements widespread appeal gets fueled by a combination of consumer health beliefs, dissatisfaction with conventional medicine, and aggressive marketing tactics. Natural, safer alternatives to pharmaceuticals are how many individuals perceive supplements - this perception frequently leads to overlooking their pharmacological activity complexity, as survey data indicates [6,33].

Companies use marketing strategies that exploit regulatory loopholes to make structure/function claims that imply benefits without direct evidence. Social media, celebrity endorsements, and online influencers play an increasingly important role in shaping public attitudes, sometimes spreading misinformation or unverified testimonials. The rise of e-commerce further complicates oversight by allowing consumers to access unregulated or counterfeit products from global markets [16,30].

Health literacy serves as a key determinant of safe and effective supplement use. Studies consistently show that consumers frequently misinterpret labels, fail to recognize contraindications, and remain unaware of reporting mechanisms for adverse events. Vulnerable populations, including the elderly and individuals with low educational attainment, are especially susceptible to these problems.

Improving consumer understanding requires a multifaceted strategy: more explicit labeling with standardized information, inclusion of risk data, culturally tailored educational initiatives, and greater engagement of healthcare professionals. Digital platforms and mobile

apps can also serve as valuable tools for improving decision-making and product transparency.

Future Directions and Recommendations: Product efficacy enhancement, consumer safety improvement, and regulatory integrity strengthening require a comprehensive strategy, given the evolving landscape of dietary supplement use. International markets across regulatory harmonization should receive priority first for ensuring consistent safety standards, labeling requirements, and health claims evidence thresholds. Centralized global database establishment for adverse event reporting and product tracking would strengthen post-marketing surveillance and transparency significantly.

Randomized controlled trials generating high-quality clinical evidence should become the future research focus. Population-specific responses, bioavailability, and long-term safety profiles need particular emphasis in these studies. Funding mechanisms supporting independent, non-industry-sponsored research are crucial for bias minimization and trust enhancement. Mechanistic insights can get provided through systems biology, nutrigenomics, and microbiome science integration, facilitating personalized supplementation strategies development.

Reinforcement of consumer education and healthcare professional training should occur finally. Public health curricula need to supplement literacy embedding, plus digital decision-support tools access expansion that guides evidence-based usage. Through these coordinated, multi-pronged efforts, dietary supplements can transform into scientifically validated and ethically managed modern healthcare components.

Major thematic challenges and policy recommendations surrounding dietary supplements are summarized in Table 1. Regulatory gaps, scientific evidence, and public health strategies discussed throughout this review receive a concise overview through this presentation.

Table 1: Summary of key themes and policy implications in dietary supplement science

Section	Key Points	Policy Implications
Regulatory Frameworks	US (DSHEA), EU (EFSA); varied global oversight; enforcement inconsistencies	There is a need for harmonized global regulations and mandatory pre-market checks.
Scientific Evidence	Mixed evidence base; some RCT-supported (omega-3, folic acid); others lack substantiation	Promote independent, high-quality trials and more transparent communication of efficacy.
Adulteration & Contamination	Adulteration with drugs; contamination with heavy metals/microbes; lack of testing standards	Mandatory third-party testing; international quality benchmarks
Adverse Events	23,000+ ER visits/year in US; underreported; drug interactions common	Improve adverse event reporting systems; train healthcare providers
Public Perception & Literacy	Low health literacy, misleading marketing, and social media influence	Label reform, consumer education, and digital transparency tools
Future Recommendations	Need for harmonized trials, better evidence, and digital safety tools	Collaborative global studies; support from non-commercial funding sources
Functional Food Science Integration	Functional foods offer clinical models; insights from AI, microbiome, and bioavailability science.	Apply biomarker validations; align supplement standards with functional food science.

Connection to Functional Food Science: Evidence-based, integrated nutritional approaches for health promotion strategies can advance through the promising intersection between dietary supplements and functional food science. Foods that provide benefits beyond their fundamental nutritional value get defined as functional foods—these share significant conceptual and application overlap with dietary supplements. Functional

foods often undergo stricter evaluation regarding bioavailability, clinical outcomes, and regulatory scrutiny, however, offering a structured model for supplement industry emulation.

The Functional Foods in Health and Disease Journal (FFHDJ) recent publications have emphasized nutrients and bioactive compounds' role in physiological system modulation, including immune system, microbiome, and metabolic pathways [34–37]. Micronutrient dose–response relationship research has revealed efficacy thresholds that could guide rational supplement formulation, for instance [34]. Artificial intelligence and computational modeling advances now enable predictive assessment of bioactive shelf life and health outcomes—tools that could translate into the supplement field for improved product reliability and consumer safety [35].

The microbiome's centrality in health and disease underscores food matrix interaction relevance, a domain better studied in functional food science than supplements. Microbiota-targeted delivery systems integration, synergistic compound formulations, and systems biology perspectives could enhance supplement efficacy and mechanistic validity [36].

Bridging dietary supplements with functional food science enhances the scientific integrity of health claims and aligns both industries toward a shared vision of preventive, personalized nutrition. Regulatory bodies and researchers should consider standard harmonization, biomarker tool sharing, and interdisciplinary collaboration promotion to ensure supplements meet efficacy and safety benchmarks set by functional food counterparts.

Role of Dietary Supplements in Specific Populations and Clinical Contexts: General population broad assessments of dietary supplements often yield mixed or insufficient evidence, yet their role becomes more defined when evaluated within specific populations and clinical contexts. Risk-benefit analysis shifts significantly for groups with unique physiological needs or health challenges—elderly individuals, pregnant women, and athletes. Targeted supplementation can move from discretionary choice to medically recommended intervention in these cases, addressing specific vulnerabilities, supporting physiological demands, or mitigating deficiencies.

Increased nutritional needs and chronic disease risk characterize older adults. Community and primary care settings show that oral nutritional supplements for malnourished or at-risk older adults improve outcomes like body weight and reduce hospitalizations [34]. Nutritional interventions, including supplementation, represent a key ongoing research area for people with dementia to manage weight loss and improve quality of life [35]. Bone health research shows that vitamin D combined with calcium supplementation can effectively increase bone mineral density in the femoral neck and lumbar spine among older adults, according to a 2024 meta-analysis [36]. Older adults' cognitive health represents another major research area, with systematic reviews suggesting that vitamin D, probiotics, and polyunsaturated fatty acids (PUFAs) supplementation may help reduce cognitive decline [37]. High polypharmacy risk also faces older adults, however, which elevates the potential for adverse supplement-drug interactions, making informed medical guidance essential.

Maternal nutrition during pregnancy proves crucial as it directly impacts fetal development, making targeted supplementation a standard part of prenatal care. Evidence-based guidelines from 2024 strongly recommend periconceptional folic acid supplementation to significantly reduce the risk of neural tube defects [38]. Beyond folic acid, prenatal supplements evaluation in 2024 highlighted their importance in helping women meet increased needs for iron, iodine, and vitamin D during pregnancy [39]. Rodent model research suggests that certain functional food components, like EGCG from

green tea, may be safe and effective for managing conditions like chronic hypertension during pregnancy, though more human research needs completion [40].

Supplement use among athletes is widespread for performance enhancement, recovery improvement, and health maintenance under intense physical stress. Functional foods and bioactive compounds' role in sports nutrition represents an evolving field focused on tailoring nutritional strategies to individual needs [41]. Specific ergogenic aids use gets supported by a large body of evidence. Network meta-analyses from 2025 have shown that caffeine, creatine, beta-alanine, and sodium bicarbonate supplements can improve various athletic performance aspects in sports ranging from soccer to combat sports, for instance [42-43]. Carbohydrate supplementation also receives strong support for enhancing endurance performance in young athletes [44]. This supplement category is associated with significant risk, however, as sports and weight-loss products frequently get implicated in adverse events and can undergo adulteration with banned stimulants.

CONCLUSION

Over-the-counter dietary supplements represent a dynamic and rapidly expanding health and wellness market sector. This review reveals that despite their widespread use, scientific, regulatory, and quality control frameworks supporting these products often prove inconsistent and insufficient. Standardized pre-market evaluation lacks, limited post-marketing surveillance exists, and frequent misalignment between product claims and clinical evidence contributes to a risk-laden consumer environment.

Scientific investigations have shown that certain supplements offer measurable benefits, particularly in populations with deficiencies or specific medical contexts, while many products fail to demonstrate consistent efficacy. Adulteration, contamination, and misleading labeling prevalence underscore the need for a robust overhaul of the current oversight mechanisms.

This review's key insight involves potential synergy between dietary supplements and functional food science field. Supplement design and regulation can become more evidence-based and consumer-protective by adopting frameworks from the latter—including biomarker validation, dose-response modeling, and matrix-based delivery.

Multi-sectoral collaboration proves essential looking forward. Regulators must enforce science-based standards, researchers must pursue rigorous and transparent efficacy trials, and consumers should receive empowerment through improved education and labeling. Only through coordinated reform and evidence-aligned innovation can dietary supplements fulfill their promise as safe, effective, and trustworthy health interventions.

Abbreviations: AEs – Adverse Events; CYP – Cytochrome P450; DSHEA – Dietary Supplement; Health and Education Act; EFSA – European Food Safety Authority; EMA – European Medicines Agency; DA – Food and Drug Administration; FOSHU – Foods for Specified Health Uses; FFHDJ – Functional Foods in Health and Disease Journal; FFS – Functional Food Science; IBS – Irritable Bowel Syndrome; ICP-MS – Inductively Coupled Plasma Mass Spectrometry; LC-MS/MS – Liquid Chromatography–Mass Spectrometry; RCT – Randomized Controlled Trial; THMPD – Traditional; Herbal Medicinal Products Directive; USPSTF – U.S. Preventive Services Task Force

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