The performance paradox: nutritional strategies in competitive bodybuilding vs. recreational fitness

[1]Alisia D. Perşa, [2]Claudiu L. Cenan

[1] Faculty of Nursing and Health Sciences, University of Medicine and Pharmacy "Iuliu Haţieganu" Cluj-Napoca, Cluj-Napoca, Romania; [2] WABBA International Bodybuilding and Fitness LTD, E11 1HT London, United Kingdom. Corresponding author: A. D. Perșa, persaalisiadania@gmail.com

Abstract. This paper aims to conduct a comparative analysis of the metabolic, hormonal, and psychological impacts generated by extreme nutritional strategies in professional bodybuilding compared to the balanced dietary patterns characteristic of recreational sports. The central objective is to evaluate the long-term biological cost associated with extreme aesthetics and to identify the geroprotective benefits of maintenance fitness. A review of recent literature was conducted, synthesizing data on physiological adaptation mechanisms to hyperproteinemia, specific nutritional cycling, low energy availability, and their impact on endocrine axes. Furthermore, nutritional interventions aimed at mitigating oxidative stress and joint degradation were evaluated. The analysis indicates that nutrition in elite bodybuilding, while effective for hypertrophy, frequently induces severe endocrine imbalances, transient insulin resistance, and intestinal dysbiosis. An increased incidence of psycho-nutritional disorders, such as orthorexia and bigorexia, was observed. In contrast, recreational sports promote metabolic flexibility, hormonal stability, and osteoarticular integrity, acting as a preventive factor against sarcopenia and metabolic diseases. Reverse dieting strategies and targeted supplementation have proven essential in risk management. There is a fundamental divergence between aesthetic performance and metabolic health. While elite bodybuilding often sacrifices longevity in favor of muscle volume, recreational nutrition represents a sustainable investment in vitality and autonomy. The nutrition specialist must act as a risk mediator, prioritizing long-term homeostasis and psycho-nutritional balance.

Key Words: professional bodybuilding, recreational sports, nutritional strategies, biological cost, metabolic flexibility.

Introduction. Over the past decade, the global health landscape has experienced a paradigm shift, with resistance training evolving from a niche activity into a central pillar of the modern lifestyle (Bull et al 2020). According to the IHRSA Global Report, the fitness industry has reached historic milestones, with the number of active health club members exceeding 180 million worldwide. This exponential growth is not merely quantitative but also qualitative, leading to a clear polarization of practitioners objectives. On the one hand, we are witnessing a democratization of recreational fitness, where metabolic health and well-being are prioritized. On the other hand, the influence of social media and the professionalization of the sport have accelerated the popularity of competitive bodybuilding, a discipline that pushes the physiological limits of hypertrophy and body composition (Cimino et al 2025). This "fitness revolution" has brought about a surge in the dietary supplements market and specialized diets, transforming nutrition from mere supportive care into a critical tool for manipulating physique (Garthe & Maughan 2018). However, the gap between the extreme aesthetics of the elite bodybuilder and the sustainability of the recreational practitioner raises essential questions regarding the long-term biological cost of these dietary strategies (Chappell et al 2018). It is important to note that the present analysis focuses primarily on competitive elite bodybuilding, investigating the physiological impact of the extreme practices required to achieve competition shape, and does not address the recreational practice of strength training aimed at improving overall health.

Definition of Concepts. To understand the long-term impact on the organism, a clear

distinction between the objectives and methodologies of these two forms of activity is necessary. Professional bodybuilding is defined as an aesthetic discipline centered on maximizing muscle hypertrophy and minimizing subcutaneous adipose tissue. It operates on a periodization model, divided into two critical phases: Bulking Phase (Muscle Mass Increase): Characterized by a controlled caloric surplus and high training volume, aimed at achieving maximum protein synthesis. Cutting Phase: A period of severe caloric restriction intended to reduce body fat percentage to minimum physiological levels (often below 5-7% for men and 10-12% for women), while simultaneously maintaining the accumulated muscle mass (Helms et al 2014; Iraki et al 2019).

Despite the physiological stress induced by competitive rigors, professional bodybuilding offers physiological adaptations with remarkable prophylactic potential. Massive muscle hypertrophy is not merely an aesthetic success but constitutes a genuine metabolic buffer, increasing the basal metabolic rate and optimizing insulin sensitivity through the increased density of GLUT4 transporters. Furthermore, the intense mechanical loading specific to high-intensity resistance training stimulates bone remodeling, providing a critical structural reserve against osteoporosis. From a gerontological perspective, the high level of fat-free mass (FFM) acquired acts as a major protective factor against sarcopenia, delaying the threshold of biological frailty associated with aging. Additionally, the nutritional rigor required for this sport cultivates dietary discipline and a profound understanding of macronutrients which, if correctly channeled post-career, can support longevity (see details in Cenan & Perșa 2026; Petrescu-Mag & Arévalo-Sierra 2026; Nicula & Arévalo-Sierra 2026).

Recreational sport (maintenance fitness) aims to achieve and maintain homeostasis. The primary objective is not to exceed physiological limits, but to optimize health parameters (blood pressure, lipid profile, insulin sensitivity). The activity is consistent, avoiding aggressive weight fluctuations, and focuses on longevity and functionality, aligning with the recommendations of international health organizations (Momma et al 2022). While the recreational athlete seeks balance, the professional bodybuilder seeks extreme adaptation to constant stress.

Nutrition as a Determinant Factor. Nutrition in the context of resistance training goes beyond its simple role as an energy provider, acting as a complex epigenetic and metabolic modulator. Its role can be analyzed across two fundamental axes, which often conflict in performance sports (Mallett 2025).

The Anabolic Axis (Supporting Hypertrophy): The primary objective in bodybuilding is to optimize the Net Protein Balance (NPB). This is achieved by manipulating amino acid availability, particularly leucine (Morton et al 2018). While the recreational athlete seeks a balance that allows for regeneration, the elite bodybuilder forces this balance toward chronic anabolism, often through massive caloric surpluses that can generate additional metabolic stress.

The Protective Axis (Cellular Protection and Homeostasis): Beyond building new tissue, nutrition must manage the oxidative stress induced by intense exertion. Micronutrients (vitamins C, E, zinc, selenium) and phytochemical compounds play a critical role in neutralizing Reactive Oxygen Species (ROS) (Koutakis et al 2018).

However, a paradox arises here: in bodybuilding, the emphasis on macronutrients (protein/carbohydrates) often overshadows micronutrient intake, leading to a state of low-grade systemic inflammation (Grill 2021). In contrast, recreational nutrition emphasizes micronutrient density, favoring cellular protection and longevity over extreme muscle mass. While the recreational athlete achieves homeostatic balance through micronutrient density, the performance bodybuilder often operates in a zone of compensated metabolic stress, where hypertrophy is prioritized over long-term cellular integrity.

Objective of the Review. The present work aims to conduct a comparative analysis of the metabolic, hormonal, and psychological impact generated by extreme nutritional strategies in professional bodybuilding, in relation to the balanced dietary models specific to recreational sports. The focal point of the analysis is the evaluation of the biological cost associated with recurrent bulking and cutting cycles. We will investigate the extent to which

these aggressive fluctuations in body composition and energy availability can precipitate endocrine and metabolic imbalances with long-term residual effects, impacting the quality of life. Furthermore, the review will highlight the geroprotective (anti-aging) potential of recreational nutrition, based on the maintenance of homeostasis and metabolic flexibility. The ultimate goal is to provide nutrition and dietetics specialists with a critical perspective on the risks associated with extreme aesthetic performance, while offering mitigation solutions through evidence-based nutritional interventions.

Nutritional Strategies

Nutrition in elite male bodybuilding. In performance bodybuilding, nutrition is exclusively subordinated to the goals of maximum hypertrophy and aesthetic conditioning. This approach involves strategies that push the limits of metabolic homeostasis through two primary mechanisms: hyperproteinemia and extreme caloric cycling.

Hyperproteinemia and Systemic Health: Although the optimal threshold for muscle protein synthesis (MPS) is reported in the literature to be approximately 1.6 - 2.2 g/kg body weight, elite athletes frequently adopt regimens exceeding 3.0 - 3.5 g/kg, which can be associated with several risks. While recent meta-analyses confirm that healthy kidneys adapt efficiently to increased protein intake through "hyperfiltration" (a normal physiological response, not a disease), the very long-term effects remain questionable. Maintaining the kidneys in this state of maximum demand for decades, a common occurrence among athletes, may accelerate the natural decline of renal function with aging (Devries et al 2018). Although a high-protein diet is safe for healthy subjects, avoiding chronic excess is essential to protect the long-term renal reserve. Furthermore, high-protein diets, which are often deficient in plant fibers, favor proteolytic fermentation in the colon. This process produces toxic metabolites (ammonia, hydrogen sulfide, p-cresol) that can alter the intestinal barrier and promote a state of chronic systemic inflammation (Cresci & Bawden 2015).

Extreme Cycling: Bulking vs. Cutting: Bulking Phase (Caloric Surplus): Often implemented in the form of "dirty bulking," this involves high consumption of saturated fats and simple sugars. Consequences include the alteration of the lipid profile (increased LDL and triglycerides) and the induction of transient insulin resistance due to mitochondrial oxidative stress (Ribeiro et al 2019). Cutting Phase (Severe Deficit): The extreme caloric restriction required to achieve minimum body fat percentages triggers a cascade of negative metabolic adaptations. These include a decrease in the basal metabolic rate, a sharp decline in free testosterone levels, and an increase in serum cortisol (Longstrom et al 2020).

Micronutrient Imbalances and Bone Density: During periods of prolonged "cutting," the exclusion of many food groups is associated with deficiencies in essential micronutrients (Vitamin D, Calcium, Magnesium). Correlated with low androgen levels, this phenomenon may contribute to a premature decrease in bone mineral density, increasing the risk of osteoporosis in later life, a paradox for an athlete with impressive muscle mass (Iraki et al 2019; Rossow et al 2013).

Nutrition in recreational sports for men. Unlike elite bodybuilding, the nutrition of the recreational athlete does not aim to exceed physiological limits but to optimize them. The central objective is to maintain a healthy body composition while simultaneously supporting longevity processes.

Sustainability and Psychosomatic Stress Management: A defining feature of this model is dietary flexibility. The absence of the need to maintain obsessive control over every kilocalorie prevents the onset of chronic diet-induced stress. From an endocrine perspective, this translates into lower serum cortisol levels compared to elite athletes under restriction. A sustainable diet favors a healthy relationship with food, reducing the risk of orthorexia and maintaining the gut-brain axis in functional balance (Paixão et al 2020; Tomiyama et al 2010; Madison & Kiecolt-Glaser 2019).

Metabolic Flexibility: The Engine of Cellular Health: A major advantage for the recreational athlete is the development of metabolic flexibility, the body's ability to

efficiently switch between carbohydrate and lipid oxidation depending on availability and exercise intensity. While the pro bodybuilder may suffer from "metabolic inflexibility" due to massive caloric surpluses or extreme deficits, the recreational athlete maintains high insulin sensitivity and robust mitochondrial function, preventing long-term metabolic diseases (San-Millán & Brooks 2018).

Preventive Role, Energy Availability, and Recovery: Maintaining a normocaloric or slightly hypercaloric diet ensures optimal Energy Availability (EA). This moderate energy surplus is critical for: Osteoarticular Health: It allows for adequate collagen synthesis and cartilage regeneration, processes that are often inhibited in states of severe deficit (Areta et al 2020). Muscle Recovery: It supports protein synthesis without overstraining renal function through unnecessary excesses, maintaining the positive nitrogen balance required for functionality rather than just aesthetic volume (Witard et al 2025).

Nutrition in elite female bodybuilding. In competitive female bodybuilding, the pressure to achieve minimum adiposity (often below the physiological threshold of 10-12%) forces the organism into a state of energy crisis. While aesthetic goals are met, the integrity of the endocrine axes is severely compromised.

Low Energy Availability (LEA) and RED-S: The modern concept of RED-S (Relative Energy Deficiency in Sport) has expanded the former "Female Athlete Triad" perspective, demonstrating that energy deficiency affects not only bones and menstruation but also basal metabolism, immunity, and protein synthesis. The critical threshold for maintaining physiological functions is approximately 30 kcal/kg FFM/day (FFM - Fat-Free Mass). Below this level, the body enters a "conservation mode," sacrificing non-essential functions for survival, such as reproduction (Mountjoy et al 2023).

Impact on the Hypothalamic-Pituitary Axes (HPT and HPG): The Reproductive Axis (HPG): Severe caloric restriction suppresses the pulsatile secretion of Gonadotropin-Releasing Hormone (GnRH), leading to low levels of estrogen and progesterone. The result is functional hypothalamic amenorrhea. In the long term, hypoestrogenism does not only affect fertility but also increases premature cardiovascular risk through endothelial dysfunction. The Thyroid Axis (HPT): To conserve energy, the body reduces the conversion of the T4 hormone into its active form, T3 (triiodothyronine). This "adaptive hypothyroidism" lowers the basal metabolic rate, making fat loss increasingly difficult and favoring post-contest weight rebound (Hulmi et al 2017).

Bone Health: Estrogen plays a vital role in inhibiting osteoclasts (the cells that break down bone). Its absence, combined with calcium and vitamin D deficiencies from restrictive diets, can contribute to an accelerated loss of bone mineral density. Unlike muscle mass, which can be recovered, the bone capital lost during periods of prolonged amenorrhea is often irretrievable, exponentially increasing the risk of stress fractures and early-onset osteoporosis in later life (Gibson et al 2024).

Nutrition in recreational sports for women. In contrast to the rigors of elite bodybuilding, the female recreational model (3 training sessions/week) prioritizes longevity by maintaining High Energy Availability (HEA > 45 kcal/kg FFM/day). This approach provides the necessary support for the optimal functioning of the endocrine system, avoiding the metabolic "survival mode."

The Importance of Lipids in Hormonal Homeostasis: One of the most significant differences compared to the male population is the female reproductive system's critical dependence on dietary fat intake. Healthy fats (Omega-3, monounsaturated fats) serve as precursors for cholesterol synthesis, which is the "raw material" for estrogen and progesterone. By maintaining a fat intake of over 0.8–1.0 g/kg body weight, the recreational athlete prevents the onset of menstrual dysfunction, ensuring the cardiovascular and neuronal protection provided by estrogen (Cristodoro et al 2024).

Micronutrient Management: Iron: Women of childbearing age have a significantly higher risk of iron-deficiency anemia. Resistance training, even at a moderate intensity, increases iron requirements due to losses through sweat and the phenomenon of hemolysis. Recreational nutrition allows for a diversified diet that meets these needs, maintaining oxygen transport capacity and energy levels (Sim et al 2019). Furthermore,

low ferritin is considered a limiting factor for motivation in women. Calcium and Bone Health: In the absence of stress induced by caloric deficits, moderate resistance training becomes the most potent osteogenic stimulus. The availability of calcium and Vitamin D within a stable hormonal environment (estrogen present) transforms recreational sports into the most effective tool for osteoporosis prevention. Additionally, estrogen has a protective effect on muscles (Massini et al 2022), helping to reduce muscle breakdown during exercise. The recreational athlete fully benefits from this "natural anabolic," which the pro bodybuilder loses with the onset of amenorrhea.

Flexibility Relative to the Menstrual Cycle: A major advantage of recreational nutrition is the ability to adjust caloric and macronutrient intake according to the phases of the menstrual cycle. For example, slightly increasing caloric and protein intake during the luteal phase (when the metabolic rate naturally increases) prevents binge eating episodes and chronic fatigue, a luxury an elite bodybuilder in the midst of a "cutting" phase cannot afford (Paludo et al 2022).

Short-term Metabolic and Psychological Impact. The impact of diets specific to elite bodybuilding is not limited to changes in body composition but induces a systemic reconfiguration. While recreational sport tends to maintain a state of balance, extreme performance forces the organism to operate at the limit of biological survival and mental stability (Figure 1).

Energy availability (EA). Energy Availability is defined as the energy remaining for the organism's vital functions after subtracting the cost of training. The State of LEA (Low Energy Availability): A threshold below 30 kcal/kg FFM/day is considered critical. In the short term, LEA triggers a decrease in leptin (the satiety hormone) and an increase in ghrelin, generating a state of chronic hunger (Fagerberg 2018). Furthermore, the body reduces the resting metabolic rate (RMR) to conserve energy, affecting protein synthesis and immune function (Trexler et al 2014). This explains why elite athletes are often vulnerable to respiratory infections during "cutting" periods (Simpson et al 2015).

Psychonutrition: the relationship with food. Performance bodybuilding imposes a rigid dietary dichotomy ("clean" vs. "dirty" foods). Orthorexia Nervosa, the obsession with food purity and the microscopic control of macronutrients, can lead to social isolation and severe anxiety (Longobardi et al 2017). In bodybuilding, the line between discipline and pathology is extremely thin (Fatima & Sarfraz 2022). Furthermore, bigorexia (Muscle Dysmorphia) is a psychological disorder in which an individual becomes obsessed with the idea that their body is too small, too weak, or insufficiently muscular. Although it is not an eating disorder per se, it dictates nutritional behavior, pushing the athlete toward protein and supplement consumption that far exceeds biological needs, ultimately impacting self-esteem and the quality of daily life (Ganson et al 2025).

The microbiome and high-protein / restrictive diets. From the perspective of modern nutrition, the microbiome is a key metabolic organ. Dysbiosis in Bodybuilding: "Monotonous" diets (e.g., chicken, rice, and broccoli consumed over several months) reduce microbial diversity. A protein intake exceeding 2.5 g/kg body weight, combined with a low intake of fermentable fibers (prebiotics), favors proteolytic bacteria (Omer et al 2025). Dietary diversity is the best predictor of microbiome health, a factor that is often lacking in the elite bodybuilder but present in the recreational athlete. Toxic Metabolites: The fermentation of undigested proteins in the colon produces compounds such as ammonia, p-cresol, and indoles, which can induce inflammation of the intestinal mucosa (Windey et al 2011; Russell et al 2011). In contrast, the recreational athlete benefits from dietary variety that supports short-chain fatty acid (SCFA) producing bacteria, such as butyrate, which exerts systemic anti-inflammatory effects (Xu & He 2025).

The Role of Nutrition in Mitigating Adverse Effects. Although physiological wear and tear is inherent to high-performance sports, targeted nutritional interventions can act as damage control mechanisms. The objective is not merely to suppress symptoms but to support endogenous repair processes and maintain systemic resilience.

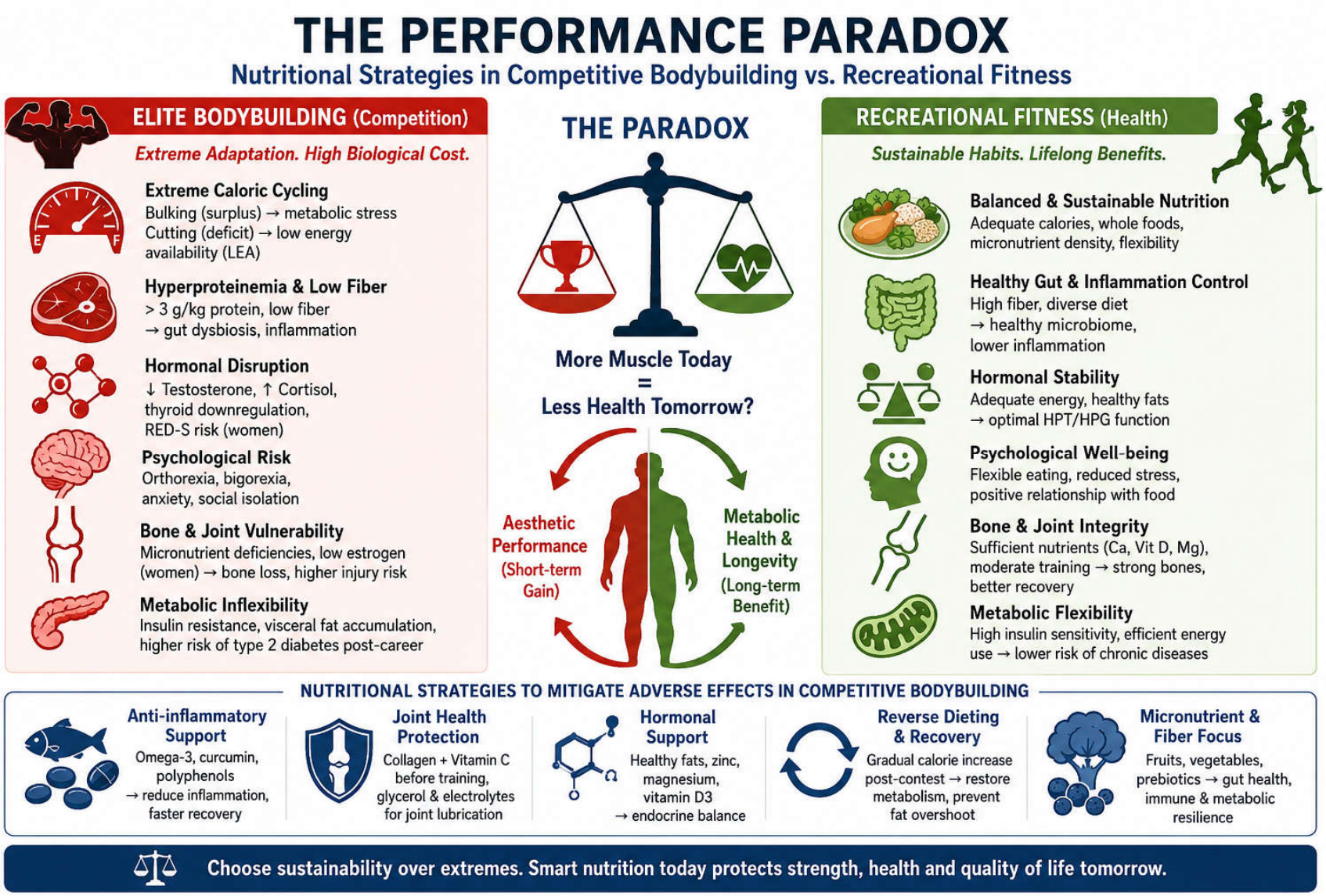

Figure 1. Nutritional strategies in competitive bodybuilding versus recreational fitness.

Anti-inflammatory agents and the resolution of inflammation. High-weight and high-volume training can generate muscular micro-trauma and a state of low-grade systemic inflammation. Omega-3 fatty acids (EPA and DHA) act by replacing arachidonic acid in cell membranes, reducing the production of pro-inflammatory eicosanoids. An Omega-3 Index > 8% is associated with faster recovery and enhanced cardiovascular protection (Anzalone et al 2019; Thielecke & Blannin 2020). Compounds such as curcumin and anthocyanins modulate the NF-κB signaling pathway, reducing oxidative stress and markers of exercise-induced muscle damage (EIMD), thereby facilitating recovery without compromising the anabolic signaling necessary for hypertrophic adaptations (Fernandez-Lazaro et al 2020). A critical aspect in the resolution of inflammation induced by high-intensity physical exertion is maintaining vascular health. Polyphenols, with a particular emphasis on anthocyanins, play a dual role: they act as anti-inflammatory agents by inhibiting the NF-κB pathway and, simultaneously, support endothelial function. These compounds and their gut microbiota-derived metabolites improve nitric oxide bioavailability, thereby counteracting the increase in arterial stiffness that may be associated with extreme strength training (Laudani et al 2023). This action not only facilitates faster recovery but also protects the integrity of the cardiovascular system in the long term. However, the goal is not to completely inhibit the inflammatory response, as it is necessary for muscle growth, but to manage it to prevent it from becoming chronic.

Joint health through nutrition. Joints and connective tissues often represent the "weak link" in performance bodybuilding, where mechanical stress exceeds the recovery rate of the extracellular matrix. Modern nutrition can support their integrity through the Collagen-Vitamin C synergy. The ingestion of 15g of hydrolyzed collagen along with 50mg of Vitamin C, 60 minutes before training, optimizes the availability of precursors at the moment of peak mechanical loading. This protocol stimulates new collagen synthesis in fibroblasts by activating the enzymes prolyl hydroxylase and lysyl hydroxylase, which are essential for the structural stability of tendons and cartilage (Shaw et al 2016). Maintaining fluid homeostasis is critical for performance athletes. Glycerol and adequate electrolyte intake (Sodium, Potassium, Magnesium) maintain osmotic pressure and the viscosity of synovial fluid, which is essential for joint lubrication under high mechanical loads. By creating an osmotic gradient, this combination facilitates hyperhydration and optimizes the plasma ultrafiltration rate into the joint cavity. The result is an enriched synovial fluid that protects the cartilage against shear forces and premature wear (Khatri et al 2021; Van Rosendal et al 2009). However, it is important to note that for joint health (collagen), the timing of ingestion is more important than the total amount, as blood flow to the tendons is limited and increases only during exercise.

Hormonal support and endocrine recovery. Endocrine recovery following phases of severe caloric restriction (cutting) represents a priority for the restoration of the hypothalamic-pituitary axis. Restrictive diets can induce a marked decrease in testosterone levels alongside an increase in cortisol, signaling profound physiological stress. In this context, the replenishment of dietary lipids (saturated and monounsaturated fats) becomes critical. These provide the necessary cholesterol as a precursor for the synthesis of steroid hormones, facilitating the return of testosterone and estrogen levels to optimal parameters and restoring the metabolic balance required for anabolism (Whittaker & Harris 2022). The restoration of endocrine homeostasis is conditioned by the availability of micronutrients acting as essential cofactors in enzymatic and hormonal pathways: Zinc: Plays a decisive role in steroidogenesis and the maintenance of male reproductive health, being directly correlated with sperm quality and optimal testosterone levels (Fallah et al 2018). Magnesium: Contributes to the regulation of the hypothalamic-pituitary-adrenal (HPA) axis, reducing anxiety and subjective stress, critical factors in controlling cortisol secretion and improving sleep quality (Boyle et al 2017). Vitamin D3: Acts as a pro-hormone with systemic impact; optimizing its levels is associated with increased physical efficiency and superior metabolic adaptation in performance athletes (Wiciński et al 2019). Post-competition caloric intake management is just as critical as the deficit itself. The implementation of a "reverse dieting" strategy (a progressive and controlled increase in

calories) is essential to counteract the metabolic and endocrine adaptations induced by prolonged restriction. Severe caloric deficit induces a decrease in the basal metabolic rate and leptin levels, signaling a state of energy crisis to the hypothalamus. A gradual transition toward maintenance allows for the restoration of energy availability and thyroid function, thereby preventing the excessive adipose rebound (fat overshooting) that frequently occurs when a large caloric surplus is introduced into a metabolism still adapted to a low energy level (Trexler et al 2014).

Long-Term Impact on Quality of Life. The quality of life in former performance athletes is often marked by a paradox: an apparently robust cardiovascular system, yet coupled with metabolic and psychological fragility. The biological cost of extreme aesthetic performance can manifest through structural and functional alterations that persist long after the competitive career has ended.

Evaluation of the psychonutritional impact. The transition from elite sport to daily life is the most critical period for a bodybuilder's mental health. Research on the post-career transition of athletes indicates a persistence of rigorous dietary control mechanisms, a phenomenon described as the evolution of sporting discipline toward Orthorexia Nervosa. This "quantitative monitoring mentality," characterized by an obsession with weights and the biochemical purity of food, does not fade upon retirement from competitive activity. On the contrary, it tends to consolidate into behavioral rigidity that compromises dietary diversity and significantly degrades the former athlete's social quality of life (Segura-Garcia et al 2014). After years of severe restriction, many athletes develop episodes of hyperphagia (binge eating). This represents a frequent consequence of the severe and prolonged caloric restrictions during their sporting career. According to the phenomenon of "starvation-induced hyperphagia," chronic deprivation programs the organism for an accelerated recovery of energy reserves. Post-retirement, this metabolic adaptation translates into compulsive eating episodes that favor the weight overshoot phenomenon, a rapid weight gain dominated by the accumulation of visceral adipose tissue. This type of central adiposity is associated with high metabolic risk, transforming what was once dietary discipline into a pathological vulnerability after the end of their performance career (Dulloo et al 1997; Saarni et al 2006). Muscle Dysmorphia (Bigorexia) represents a major psychological barrier in the post-career transition, as the distorted body image persists in the form of chronic dissatisfaction. Research regarding psycho-educational interventions in athletes has observed that dysmorphic symptomatology is deeply rooted in athletic identity, which means that retiring from competition does not automatically eliminate high-risk behaviors (Sandgren et al 2022). On the contrary, in the absence of a clear sporting objective, the former athlete may resort to the continuous use of unsafe supplements or extreme restrictive diets in an attempt to maintain an unrealistic aesthetic standard.

The impact of metabolic inflexibility on systemic health. The specialized literature suggests the existence of a metabolic memory mediated through epigenetic modifications, which persists after periods of severe caloric restriction. This epigenetic memory causes the organism to favor fat storage at the first opportunity, a survival mechanism that becomes pathological in a modern context. Functional exhaustion of the pancreas and the desensitization of insulin receptors represent central mechanisms in metabolic pathology induced by an extreme athletic lifestyle. This degradation is mediated by endoplasmic reticulum stress and the phenomenon of glucolipotoxicity, which induce premature apoptosis of pancreatic beta cells (Hotamisligil 2010).

The Impact of Uncontrolled Caloric Overconsumption: Prolonged periods of aggressive caloric surplus, characterized by a high intake of saturated fats and refined sugars, promote the accumulation of intramyocellular lipids (IMCL). These compounds negatively interfere with the insulin signaling cascade, inhibiting the translocation of the GLUT4 transporter to the sarcolemma, which underpins the onset of peripheral insulin resistance (Samuel & Shulman 2012).

Insulin Dynamics and Diabetes Risk: The alternation between compensatory hyperinsulinemia, characteristic of hypertrophy phases, and periods of severe energy

deficit exerts considerable homeostatic pressure on the pancreatic axis. In the long term, this metabolic stress depletes the functional reserve of the pancreas. This process can culminate in the onset of type 2 diabetes, particularly in subjects presenting the TOFI phenotype (Thin-Outside, Fat-Inside), individuals with apparently healthy muscle mass but critical deposits of visceral and ectopic fat (Thomas et al 2012).

Evolution Toward Metabolic Inflexibility: The deterioration of energy substrate mechanisms can lead to a loss of the body's ability to efficiently switch between fatty acid and glucose oxidation. In patients over 50 years of age, this metabolic inflexibility manifests clinically through chronic fatigue syndrome, difficulties in managing body weight, and a state of low-grade inflammation, factors that undermine longevity and quality of life (Goodpaster & Sparks 2017).

Conclusions. The present review highlights a fundamental divergence between performance nutrition in bodybuilding and recreational nutrition, demonstrating that short-term aesthetic goals can enter into severe conflict with long-term metabolic health. Nutrition in elite bodybuilding acts as a tool for aggressive physiological manipulation. Recurrent bulking and cutting cycles, chronic hyperproteinemia, and periods of Low Energy Availability (LEA) are associated with a biological cost that includes hormonal dysfunctions (RED-S), microbiome alterations, and increased vulnerability of the osteoarticular system. The onset of insulin resistance and metabolic inflexibility post-career suggests that the organism sacrifices longevity mechanisms in favor of extreme muscle hypertrophy. In opposition, recreational sport, supported by a balanced and flexible diet, emerges as a genuine geroprotective agent. By maintaining homeostasis and insulin sensitivity, this nutritional model not only prevents metabolic diseases but also ensures a superior quality of life in later years, transforming physical activity into a health investment rather than a high-interest loan from the future. For the nutrition and dietetics specialist, the critical role is to act as a "risk mediator." A profound understanding of anti-inflammatory agents, hormonal support, and joint health through nutrition can mitigate the damages of performance. However, the message remains clear: metabolic sustainability and psychonutritional balance constitute the only path toward an old age marked by autonomy and vitality.

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Authors:
Alisia Dania Perșa, Faculty of Nursing and Health Sciences, University of Medicine and Pharmacy "Iuliu Hațieganu", 8 Victor Babeș Street, 400012 Cluj-Napoca, Cluj County, Romania, e-mail: persaalisiadania@gmail.com
Claudiu Laurențiu Cenan, WABBA International Bodybuilding and Fitness LTD, 8 Gainsborough Road, London E11 1HT, United Kingdom, e-mail: claudiu.cenan@gmail.com

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