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DECISION-MAKING IN SPORTS NUTRITION: AN EVIDENCE-BASED AND PERSONALIZED APPROACH (A REVIEW)

Zhanna V. Grishina¹✉, Anastasia I. Kadykova¹, Nikita S. Gladyshev^{1,2}, Evgeniy D. Kopylov^{1,2}, Andrey V. Zholinsky¹, Vladimir S. Feshchenko¹, Roman V. Deev^{1,2}

¹ National Center for Sports Medicine of the Federal Medical and Biological Agency, Moscow, Russia

² Petrovsky National Research Centre of Surgery, Moscow, Russia

Introduction. Nutritional support for elite athletes significantly affects performance and health, including recovery and adaptation to training loads, body composition, and immune system status. At the same time, in practice, the prescription of specialized sports nutrition products (SSNPs) is often empirical and fails to account for the athlete's actual diet, energy availability, laboratory parameters, and specific features of the training process. This increases the risk of unjustified prescription of SSNPs and dietary supplements.

Objective. Systematization of current approaches to clinical decision-making in the field of nutritional support for athletes and development of a practice-oriented model for selecting components of a nutritional program.

Discussion. The following key stages in clinical decision-making were identified: defining the goal, assessment of energy availability and baseline nutrition, laboratory verification of suspected deficiencies, risk stratification, selection of a minimally sufficient intervention in the form of SSNPs and dietary supplements. In most cases, the correction of the baseline diet was shown to be a priority, whereas additional nutritional support should be applied in a targeted manner and only when clinical or laboratory indications are present.

Conclusions. Based on current literature data, an algorithm for clinical decision-making in the field of nutritional support for professional athletes has been developed. Rational nutritional support for athletes should rely on the principles of evidence-based practice, personalization, clinical safety, and dynamic monitoring. Clinical decision-making should be based not on the expansion of the regimen of SSNPs and dietary supplements used, but on a sequential algorithm: diet → targeted diagnostics → clinically justified intervention → assessment of dynamics. The correction of baseline nutrition and energy availability is the priority; SSNPs and dietary supplements should be applied in a targeted manner and only when their benefits and safety for the specific type of exercise have been established.

Keywords: sports medicine; nutritional support; clinical decision-making; energy availability; relative energy deficiency syndrome; REDs; iron deficiency; vitamin D; ergogenic aids; biomarkers; personalized approach

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AI tools use. Artificial intelligence (AI) tools were used for the graphical representation of the developed clinical decision-making algorithm for nutritional support (the service <https://mermaid.ai/web> was used).

✉ Zhanna V. Grishina grinzanetk@gmail.com

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ПРИНЯТИЕ ВРАЧЕБНЫХ РЕШЕНИЙ В ОБЛАСТИ НУТРИТИВНОЙ ПОДДЕРЖКИ СПОРТСМЕНОВ: ДОКАЗАТЕЛЬНЫЙ И ПЕРСОНИФИЦИРОВАННЫЙ ПОДХОД (ОБЗОР)

Ж.В. Гришина¹✉, А.И. Кадыкова¹, Н.С. Гладышев^{1,2}, Е.Д. Копылов^{1,2}, А.В. Жолинский¹, В.С. Фещенко¹, Р.В. Деев^{1,2}

¹ Национальный центр спортивной медицины Федерального медико-биологического агентства, Москва, Россия

² Российский научный центр хирургии им. академика Б.В. Петровского, Москва, Россия

Введение. Нутритивная поддержка спортсменов высокого класса существенно влияет на работоспособность и здоровье атлетов, включая процессы восстановления и адаптации к тренировочным нагрузкам, состав тела и состояние иммунной системы. Вместе с тем на практике назначения специализированных продуктов для питания спортсменов (СПП) нередко носят эмпирический характер и не всегда основываются на оценке фактического рациона спортсмена, его энергетической доступности, а также лабораторных показателей и особенностях тренировочного процесса. Это повышает риск необоснованного назначения СПП и биологически активных добавок к пище (БАД).

Цель. Систематизация современных подходов к принятию врачебных решений в области нутритивной поддержки спортсменов и разработка практико-ориентированной модели выбора компонентов нутритивной программы.

Обсуждение. Выделены ключевые этапы принятия врачебного решения: определение цели, оценка энергетической доступности и базового питания, лабораторная верификация предполагаемых нарушений, стратификация риска, выбор минимально достаточного вмешательства в виде СПП и БАД. Показано, что в большинстве случаев первоочередное значение имеет коррекция основного рациона питания, тогда как дополнительная нутритивная поддержка должна применяться «точно» и при наличии клинических или лабораторных показаний.

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Выводы. На основании современных данных литературы разработан алгоритм принятия врачебных решений в области нутритивной поддержки профессиональных спортсменов. Рациональная нутритивная поддержка спортсменов должна строиться на принципах доказательности, персонализации, клинической безопасности и динамического наблюдения. Врачебное решение должно базироваться не на расширении схемы применяемых СПП и БАД, а на последовательном алгоритме: рацион → таргетная диагностика → клинически обоснованное вмешательство → оценка динамики. Приоритет — коррекция базового питания и энергетической доступности; СПП и БАД применяются адресно и при доказанной пользе и безопасности для конкретного вида нагрузки.

Ключевые слова: спортивная медицина; нутритивная поддержка; врачебное решение; энергетическая доступность; синдром относительного дефицита энергии; REDs; дефицит железа; витамин D; эргогенные средства; биомаркеры; персонифицированный подход

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✉ Гришина Жанна Валерьевна grinzanetk@gmail.com

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INTRODUCTION

Nutritional support in high-performance sports is considered an integral part of the medical and biological support system, affecting tolerance to training loads, adaptive processes, recovery, injury prevention, and maintenance of the athlete's health¹ [1, 2]. At the same time, modern sports nutritionology extends far beyond the simple calculation of dietary calorie content and includes the assessment of energy adequacy, macro- and micronutrient supply, eating behavior, and the justification and safety of using specialized sports nutrition products (SSNPs) and dietary supplements² [2].

In clinical practice, a sports medicine physician often faces a contradiction between the high prevalence of dietary supplement and SSNP use among athletes (ranging from 40 to 100% [3]) and the insufficient justification of the corresponding prescriptions³ [3]. A significant proportion of nutritional interventions are initiated under the influence of coaching recommendations, popularized regimens involving dietary supplements and SSNPs, or marketing influences. This increases the risk not only of low efficacy but also of clinical errors, including unjustified use of iron medications, vitamin D, high-protein SSNPs, and ergogenic aids⁴ [4–6], as well as the risk of doping contamination, documented to be present in 12–58% of non-certified products⁵ [3].

This issue is of particular relevance given the high prevalence of conditions associated with low energy availability (LEA) and Relative Energy Deficiency in Sport (REDs)⁶ [6]. These conditions are characterized by decreased sports performance, impaired recovery, frequent injuries, menstrual dysfunction in female athletes, deterioration of bone metabolism, and adverse psychological status. At the same time, isolated laboratory abnormalities do not always permit correct interpretation of the clinical picture. Their interpretation should take into account the training phase, training load, and the characteristics of the baseline diet. In this regard, clinical decision-making in the field of nutritional support should follow a sequential algorithm based on the principles of evidence-based medicine, personalized care, and safety.

The study purpose was to systematize current approaches to clinical decision-making in the field of nutritional support for athletes and to develop a practice-oriented model for selecting nutritional prescriptions in sports medicine.

A narrative review was conducted without a formal systematic search. Normative documents from international professional societies were purposefully selected — the International Olympic Committee (IOC), the American College of Sports Medicine in collaboration with the Academy of Nutrition and Dietetics and Dietitians of Canada (ACSM/AND/DC), the International

¹ Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. 2016. <https://doi.org/10.1016/j.jand.2015.12.006>; IOC consensus statement: dietary supplements and the high-performance athlete. 2018. <https://doi.org/10.1136/bjsports-2018-099027>; IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update. <https://doi.org/10.1136/bjsports-2018-099193>

² International Society of Sports Nutrition position stand: protein and exercise. 2017. <https://doi.org/10.1186/s12970-017-0177-8>

³ IOC consensus statement: dietary supplements and the high-performance athlete. 2018. <https://doi.org/10.1136/bjsports-2018-099027>

⁴ International Society of Sports Nutrition position stand: caffeine and exercise performance. 2021. <https://doi.org/10.1186/s12970-020-00383-4>

⁵ IOC consensus statement: dietary supplements and the high-performance athlete. 2018. <https://doi.org/10.1136/bjsports-2018-099027>

⁶ IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update. <https://doi.org/10.1136/bjsports-2018-099193>; 2023 International Olympic Committee's (IOC) consensus statement on Relative Energy Deficiency in Sport (REDs). <https://doi.org/10.1136/bjsports-2023-106994>

Society of Sports Nutrition (ISSN), as well as key original studies, meta-analyses, and systematic reviews on the topic under study.

The search was conducted in the bibliographic databases PubMed and eLibrary for the period 2005–2025 on the following topics: nutrition and athletes; energy availability; relative energy deficiency in sport; carbohydrate and endurance; protein requirement and resistance exercise; iron deficiency and athletes; vitamin D and athletes; caffeine / creatine / nitrate / beta-alanine / sodium bicarbonate and performance; dietary supplements and doping. Equivalent keywords were included in the search in Russian. Where multiple editions of a single normative/regulatory document existed, the edition in effect at the time of manuscript writing was used.

The present work has a number of limitations that should be taken into account when interpreting the conclusions:

- the numerical reference values (daily macronutrient ranges, ferritin and 25(OH)D thresholds, ergogenic substance doses) are provided as average values. Individual variability may be significant and, in some cases, exceed average differences;
- the review does not detail the specifics of nutritional support in individual groups of athletes — para-athletes, youth and veteran athletes, athletes with confirmed chronic diseases, etc., for each of which separate methodological documents exist.

MAIN BODY

Structure of clinical decision-making

The conducted literature review showed that rational decision-making in the field of nutritional support for athletes cannot be reduced to the simple prescription of SSNPs and/or dietary supplements. Clinical decision-making should include several sequential stages: identification of the clinical problem → confirmation of its nutritional nature → exclusion of non-nutritional causes (gastrointestinal diseases, endocrinopathies, overtraining) → determination of the goal of nutraceutical prescription → selection of a minimally sufficient strategy → monitoring⁷ [7]. The most frequent indications for considering the application of nutritional support are decreased performance, delayed recovery, signs of low energy availability (LEA), recurrent injuries, suspected

iron deficiency, the need for body composition correction, and preparation for competitions with high metabolic demands⁸ [1, 2, 4, 8].

Assessment of basic nutrition and energy sufficiency

The literature review shows that, in a significant proportion of cases, the starting point for clinical decision-making should be an assessment of the athlete's baseline diet⁹ [2]. In many athletes, in addition to long intervals between meals and the absence of an adapted competition nutrition strategy, the following are also commonly found:

- insufficient total caloric intake;
- mismatch between carbohydrate consumption and training load volume;
- uneven distribution of protein intake throughout the day.

Low energy availability (LEA). Recent publications emphasize that LEA underlies a wide range of problems — from decreased athletic performance to hormonal status disturbances and impaired bone synthesis¹⁰ [9, 10]. Energy availability (EA) is calculated as (energy intake — exercise energy expenditure)/ fat-free mass (FFM), kcal/kg FFM/day.

Historically, the threshold of 30 kcal/kg FFM/day was considered the boundary below which a cascade of hormonal and metabolic disturbances develops [11]. In the current IOC consensus (2023)¹¹ and the associated validated IOC REDs CAT2¹² tool, this concept has been reformulated as follows:

- the LEA effects are considered as a continuum from adaptive (short-term, moderate, compensable) to problematic (long-lasting, profound, maladaptive);
- the single numerical EA threshold is replaced by individual assessment taking into account sex, menstrual cycle phase, genetics, psychological status, and baseline load;
- physiological manifestations have been expanded: neurocognitive and mental outcomes have been added to the reduction of reproductive function, bone mineral density, immunity, cardiovascular and hematological status;
- decreased performance is separately described: impairment of endurance, strength, coordination, cognitive performance, and motivation;

⁷ Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. 2016. <https://doi.org/10.1016/j.jand.2015.12.006>; IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update. <https://doi.org/10.1136/bjsports-2018-099193>

⁸ IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update. <https://doi.org/10.1136/bjsports-2018-099193>; International Society of Sports Nutrition position stand: protein and exercise. 2017. <https://doi.org/10.1186/s12970-017-0177-8>

⁹ Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. 2016. <https://doi.org/10.1016/j.jand.2015.12.006>; International Society of Sports Nutrition position stand: protein and exercise. 2017. <https://doi.org/10.1186/s12970-017-0177-8>

¹⁰ IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update. <https://doi.org/10.1136/bjsports-2018-099193>

¹¹ 2023 International Olympic Committee's (IOC) consensus statement on Relative Energy Deficiency in Sport (REDs). 2023. <https://doi.org/10.1136/bjsports-2023-106994>

¹² Review of the scientific rationale, development and validation of the International Olympic Committee Relative Energy Deficiency in Sport Clinical Assessment Tool: V. 2 (IOC REDs CAT2). 2023. <https://doi.org/10.1136/bjsports-2023-106914>

- diagnosis relies on the IOC REDs CAT2 — a multifactorial scoring scale integrating clinical, laboratory, and psychometric data.

Consequently, in athletes having complaints of chronic fatigue, unstable body weight, recurrent stress fractures, menstrual cycle disturbances in female athletes, or decreased libido, erectile dysfunction, or reduced morning testosterone levels in male athletes, the primary intervention should be the restoration of energy intake¹³ [6]. In contrast, correction of isolated symptoms (e.g., prescribing iron supplements for reduced ferritin without restoring EA) is of insufficient efficacy and delays the establishment of the correct diagnosis.

Carbohydrates. Baseline carbohydrate provision is calculated relative to body weight and distributed according to the volume and intensity of the training microcycle. According to the joint position stand of ACSM/AND/DC¹⁴ [12] and the recommendations of Burke et al. [1], the recommendations for carbohydrate intake are as follows:

- light load (up to 1 h/day of low intensity) — 3–5 g/kg/day;
- moderate (~ 1 h/day) — 5–7 g/kg/day;
- high (1–3 h/day of moderate or high intensity) — 6–10 g/kg/day;
- extreme (> 4–5 h/day) — 8–12 g/kg/day.

Regarding carbohydrate intake during exercise, additional intake of fast carbohydrates is not required for exercise lasting < 45 min; for exercise lasting 45–75 min, small amounts or carbohydrate mouth rinsing are acceptable; for exercise lasting 1–2.5 h, it is recommended to consume 30–60 g of carbohydrates per hour. For exercise exceeding 2.5 h, intake of up to 90 g/h is recommended, provided that different types of fast carbohydrates are combined (glucose + fructose, 2:1) and prior gastrointestinal adaptation has been performed¹⁵ [1, 13]. If less than 8 h elapse between exercise sessions, it is recommended to ingest carbohydrates at a rate of 1.0–1.2 g/kg/h during the first 4 hours after exercise¹⁶.

Existing carbohydrate periodization strategies (“low-carbohydrate training / high-carbohydrate loading before competition”) [14] allow selective activation of mitochondrial biogenesis signaling pathways during low-intensity training while maintaining high carbohydrate availability before competition. Clinical application of such a strategy requires competent supervision and is not indicated for athletes with signs of LEA.

Protein. Dietary protein provision occupies a special place in the nutritional support of athletes. High-protein

SSNPs are most justified in situations of energy deficit, high training loads, detraining, injury, and the need to preserve muscle mass¹⁷ [8, 15]. At the same time, the choice of an appropriate strategy should be based primarily on dietary analysis, rather than on empirical use of high-protein SSNPs.

According to the position stand of the American College of Sports Medicine, the daily protein requirement for physically active individuals is 1.2–2.0 g/kg body weight¹⁸. For muscle hypertrophy and strength adaptation, a meta-analysis by Morton et al. recommends protein intake in the range of 1.6–2.2 g/kg. The authors also note that increasing protein intake above 2.2 g/kg does not lead to further gains in muscle mass [16]. Other authors have reported protein requirements in trained athletes of up to 2.3–3.1 g/kg FFM/day under conditions of energy deficit and body mass reduction [10]. Russian specialists emphasize the need for further research into the possible safe use of high-protein diets (> 2.0 g/kg/day) in highly qualified athletes without chronic kidney or liver diseases [17].

An important aspect of protein provision is the distribution of protein intake throughout the day, rather than only its total amount: for each meal (with 4–6 meals per day evenly distributed throughout the day), 0.3–0.4 g/kg body weight (~ 20–40 g) is recommended, with a leucine content of at least 2–3 g [9, 15]. In addition, supplementary intake of 30–40 g of slowly absorbed protein (casein) 30 min before sleep enhances overnight muscle protein synthesis without interfering with circadian rhythms.

Food-based protein sources (dairy products, eggs, meat, fish, legumes) in an athlete's diet are preferable, whereas SSNPs in the form of whey protein isolates are justified in cases of logistical constraints and within the first hour after resistance exercise.

Laboratory diagnostics and clinical interpretation

Laboratory parameters in sports medicine have high informative value only when interpreted in a clinically correct manner [18]. Physical exercise, dehydration, inflammatory response, menstrual cycle, competition period, and specific features of training regimen can significantly affect biochemical markers (Table 1) [19–22]. The most frequently identified deficiencies among professional athletes concern iron metabolism parameters and vitamin D levels [4, 5] (Table 1).

Iron. Iron deficiency remains one of the most frequently encountered problems, particularly among

¹³ IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update. <https://doi.org/10.1136/bjsports-2018-099193>; 2023 International Olympic Committee's (IOC) consensus statement on Relative Energy Deficiency in Sport (REDs). 2023. <https://doi.org/10.1136/bjsports-2023-106994>

¹⁴ Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. 2016. <https://doi.org/10.1016/j.jand.2015.12.006>

¹⁵ International Society of Sports Nutrition position stand: nutrient timing. 2017. <https://doi.org/10.1186/s12970-017-0189-4>

¹⁶ Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. 2016. <https://doi.org/10.1016/j.jand.2015.12.006>; International Society of Sports Nutrition position stand: nutrient timing. 2017. <https://doi.org/10.1186/s12970-017-0189-4>

¹⁷ International Society of Sports Nutrition position stand: protein and exercise. 2017. <https://doi.org/10.1186/s12970-017-0177-8>

¹⁸ Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. 2016. <https://doi.org/10.1016/j.jand.2015.12.006>; International Society of Sports Nutrition position stand: protein and exercise. 2017. <https://doi.org/10.1186/s12970-017-0177-8>

female athletes, endurance sport athletes, and individuals with restrictive eating patterns. [6]. A decrease in ferritin should not be viewed in isolation from the clinical picture, hemoglobin (Hb) levels, iron transport, and inflammatory markers. Ferritin is an acute-phase protein; therefore, at a C-reactive protein (CRP) level > 5 mg/L, its value is elevated, potentially masking underlying iron deficiency. Ferritin changes should be interpreted only together with CRP; in the presence of inflammation, transferrin saturation (TSAT) and soluble transferrin receptor (sTfR) levels are added to the assessment [4].

A three-stage classification of iron deficiency in athletes is used [4, 19]:

- Stage I — depletion of stores: ferritin < 35 µg/L with normal Hb and TSAT;
- Stage II — iron-deficient erythropoiesis: ferritin < 20 µg/L and/or TSAT < 16%, elevated sTfR with preserved Hb level;
- Stage III — iron deficiency anemia: Hb < 130 g/L (males) or < 120 g/L (females).

The meta-analysis by Burden et al. [21] showed that correction of latent iron deficiency in athletes moderately improves aerobic performance, with the greatest effect observed in individuals with initially low ferritin levels. It is important to consider that hepcidin levels increase 3–6 h after physical exercise, blocking iron absorption in enterocytes; therefore, iron supplementation during this period is of low efficacy [19].

Unjustified prescription of iron supplements in the absence of clear indications may lead to adverse reactions and may not resolve the underlying problem of decreased performance. The study by Stoffel et al. [20] demonstrated that 100 mg of elemental iron every other day provides greater fractional absorption and fewer side effects than daily intake.

Vitamin D. Correction of vitamin D status should be carried out individually, taking into account seasonality, insolation, sport-specific characteristics, history of stress-related bone tissue injuries, and laboratory results [5]. Routine prescription of high doses without confirmed deficiency does not comply with the principles of rational therapy.

Clinically significant serum vitamin D (25(OH)D) ranges [5, 22]:

- deficiency — < 30 nmol/L (< 12 ng/mL);
- insufficiency — 30–50 nmol/L (12–20 ng/mL);
- sufficiency — > 50 nmol/L (> 20 ng/mL);
- optimal range for athletes (especially with a history of stress injuries and during winter period) — 75–125 nmol/L (30–50 ng/mL);

- upper safety threshold — < 250 nmol/L (< 100 ng/mL).

Vitamin D deficiency is defined as a 25(OH)D concentration < 20 ng/mL (50 nmol/L), insufficiency as a 25(OH)D concentration 20–30 ng/mL (50–75 nmol/L), and adequate levels as > 30 ng/mL (75 nmol/L). The recommended target 25(OH)D values when correcting vitamin D deficiency are 30–60 ng/mL (75–150 nmol/L)¹⁹.

The maintenance dose of cholecalciferol for athletes is typically 1000–2000 IU/day. In cases of confirmed deficiency, 3000–4000 IU/day is prescribed for 8–16 weeks with monitoring of blood vitamin D levels. In severe and confirmed deficiency, a physician may prescribe short-term high doses (50,000 IU/week or more) [5, 22]. Routine prescription of vitamin D without laboratory verification is not justified, as evidence of its efficacy in individuals with initially normal levels is contradictory, and excessive intake above the upper threshold may be associated with hypercalcemia.

Use of ergogenic aids

Previous research has shown that only a limited number of ergogenic aids possess sufficient evidence base supporting their effectiveness in improving sports performance (Table 2). Among the most extensively studied are caffeine, nitrates, and certain carbohydrate strategies²⁰ [23–25]. Their use must meet a number of conditions: a proven mechanism of action relevant to the specific type of exercise; absence of contraindications; prior testing during the training process; assessment of tolerability; and exclusion of the risk of contamination with prohibited substances²¹ [3].

Contamination with prohibited substances (anabolic steroids, selective androgen receptor modulators, stimulants) is recorded in 12–58% of non-certified products, predominantly in the categories of “pre-workout complexes,” “fat burners,” and “testosterone boosters”²². In a practical clinical decision-making model, anti-doping verification of SSNPs and dietary supplements (batch, certificate, ingredient status according to the WADA Prohibited List, 2026²³) for the absence of prohibited substances is a necessary step. Athletes of the Russian national teams receive dietary supplements and SSNPs from the “Formulary of Medicines, Dietary Supplements, Specialized Food Products, and Medical Devices of the FMBA of Russia Used for Medical and Biomedical Support of Athletes of the Sports National Teams of the Russian Federation”²⁴, which undergo testing for the absence of doping substances. In cases where an athlete is not a member of a Russian national

¹⁹ Clinical guidelines of the Russian Association of Endocrinologists for the diagnosis, treatment, and prevention of vitamin D deficiency in adults. 2016. <https://doi.org/10.14341/probl201662460-84>

²⁰ IOC consensus statement: dietary supplements and the high-performance athlete. 2018. <https://doi.org/10.1136/bjsports-2018-099027>; International Society of Sports Nutrition position stand: caffeine and exercise performance. 2021. <https://doi.org/10.1186/s12970-020-00383-4>

²¹ IOC consensus statement: dietary supplements and the high-performance athlete. 2018. <https://doi.org/10.1136/bjsports-2018-099027>; World Anti-Doping Agency. The World Anti-Doping Code International Standard Prohibited List 2024. <https://www.wada-ama.org>

²² IOC consensus statement: dietary supplements and the high-performance athlete. 2018. <https://doi.org/10.1136/bjsports-2018-099027>

²³ World Anti-Doping Agency. The World Anti-Doping Code International Standard Prohibited List 2024. <https://www.wada-ama.org>

²⁴ Order No. 275 of the Federal Medical and Biological Agency dated 29.12.2021 “On Approval of the Formulary of Medicines, Biologically Active Food Additives, and Medical Devices Used by the Federal Medical and Biological Agency of Russia for the Medical and Biological Support of Athletes of the Russian Federation’s National Teams”.

Table 1. Optimal laboratory panel for assessing the nutritional status of athletes

Parameter	Recommended values	Monitoring frequency	Comment
Complete blood count: hemoglobin (Hb), mean corpuscular volume (MCV)	Hb $\geq$ 130 g/L (males), $\geq$ 120 g/L (females); MCV 80–100 fL	2–4 times per year	Basic screening for anemia and microcytosis
Ferritin together with C-reactive protein (CRP)	Ferritin $>$ 35 μ g/L; if CRP $>$ 5 mg/L, correction for inflammation is required	2–4 times per year	It is not interpreted in isolation; use together with TSAT and sTfR in the presence of inflammation [4]
Serum iron, transferrin saturation coefficient (TSAT), soluble transferrin receptor (sTfR)	TSAT $\geq$ 20%	When iron deficiency anemia is suspected	For staging according to Peeling / Sim [4, 19]
Vitamin D (25(OH)D)	$>$ 50 nmol/L — mandatory; 75–125 nmol/L — target range	2 times per year	Assessment together with Ca ²⁺ , P, alkaline phosphatase [5, 22]
Total protein, albumin	Albumin 35–50 g/L	1–2 times per year	Protein metabolism markers
Glucose, glycated hemoglobin (HbA1c)	HbA1c $<$ 5.7%, glucose 3.9–5.5 mmol/L	Once per year	Exclusion of dysglycemia, especially in restrictive diets and/or suboptimal protein intake
Lipid profile	According to general population reference norms	Once per year	Assessment of metabolic background
Urea, creatinine, estimated glomerular filtration rate (eGFR)	eGFR $>$ 90 mL/min/1.73 m ²	1–2 times per year	Reference values in athletes may differ due to high muscle mass
Alanine aminotransferase (ALT), aspartate aminotransferase (AST), creatine kinase (CK)	Interpretation with adjustment for exercise load	As indicated	Isolated elevation of CK after exercise is not pathological
Electrolytes (Na ⁺ , K ⁺ , Ca ²⁺ , Mg ²⁺)	Within reference ranges	1–2 times per year	Mandatory in the presence of symptoms of cramps, cardiac rhythm disturbances
Thyroid-stimulating hormone (TSH), free thyroxine (free T4)	TSH 0.4–4.0 mIU/L	Once per year; more frequently in LEA	Individual negative dynamics of T3/T4 — an early marker of LEA ²⁵ [12]
Sex hormones	Within reference ranges; in females — taking into account the phase of the cycle	In cases of menstrual cycle disorders, libido disturbances; when REDs is suspected	LH, FSH, estradiol in females; total and free testosterone, SHBG in males ²⁶
Vitamin B ₁₂ , folate	B ₁₂ $>$ 200 pg/mL; Folate $>$ 3 ng/mL	Once per year	Especially in vegans and vegetarians
Zinc, magnesium	Within reference ranges	As indicated	Not prescribed routinely

Table prepared by the authors based on data from sources [4, 5, 12, 19, 22] and regulatory documents^{25,26}

Note. The panel may be expanded depending on the kind of sport (e.g., D-dimer, BNP — brain natriuretic peptide, etc., in sports with high cardiac load), training phase, and specific clinical task. Interpretation of any parameters in an athlete is performed taking into account the training cycle phase, hydration status, inflammation, and menstrual cycle phase (in females). LH — luteinizing hormone; FSH — follicle-stimulating hormone; SHBG — sex hormone-binding globulin.

²⁵ 2023 International Olympic Committee's (IOC) consensus statement on Relative Energy Deficiency in Sport (REDs). <https://doi.org/10.1136/bjsports-2023-106994>

²⁶ 2023 International Olympic Committee's (IOC) consensus statement on Relative Energy Deficiency in Sport (REDs). <https://doi.org/10.1136/bjsports-2023-106994>; Review of the scientific rationale, development and validation of the International Olympic Committee Relative Energy Deficiency in Sport Clinical Assessment Tool: V. 2 (IOC REDs CAT2). 2023. <https://doi.org/10.1136/bjsports-2023-106914>

Table 2. Characteristics of some ergogenic aids

Substance	Group (A / B / C / D)	Working doses and regimen	Practical remarks
Caffeine	A	3–6 mg/kg 45–60 min before exercise	Enhancement of endurance; used for team, strength, and sprint performance; individual response depends on CYP1A2 genotype ²⁷
Creatine monohydrate		Loading: 20 g/day (4 × 5 g) for 5–7 days, followed by 3–5 g/day; or immediately 3–5 g/day	Increases power and high-intensity performance; safe with long-term use at the specified doses ²⁸
β-alanine		4–6 g/day in 2–4 divided doses for at least 4 weeks	Paresthesia is managed by splitting the dose; effect is seen in exercise lasting 1–4 min ²⁹
Nitrate (beetroot juice)		5–9 mmol NO ₃ ⁻ (140–280 mL of standardized juice) 2–3 h before exercise or as a course for 6–15 days	More effective in non-elite athletes; avoid antiseptic mouthwashes (they negate the effect) [23]
Sodium bicarbonate		0.2–0.3 g/kg 60–180 min before exercise	Dividing the dose and taking it with carbohydrate-containing food reduce gastrointestinal symptoms; for high-intensity exercise lasting 1–7 min ³⁰
Carbohydrates during exercise		30–60 g/h for 1–2.5 h; up to 90 g/h for > 2.5 h (glucose:fructose 2:1)	Requires preliminary assessment of gastrointestinal tolerability [1]
Sports drinks / gels / isotonic solutions		According to an individualized hydration and carbohydrate supply strategy	Certified products are preferred
Iron, vitamin D, calcium		According to clinical and laboratory indications	They are used as medicinal products, not as dietary supplements [4, 5]
Collagen + vitamin C	B	15 g of collagen hydrolysate + 50 mg of vitamin C 30–60 min before rehabilitation exercise	Promising in tendon and ligament injuries [8, 24]
Omega-3 (EPA + DHA)		2–4 g/day	Inflammation control; potential support of muscle protein synthesis in aging athletes [8]
Probiotics		Strain-specifically	Reduce the frequency of upper respiratory tract infections in endurance-trained athletes
Curcumin, cherry juice		Variable	Limited data on reduction of post-exercise myalgia and markers of muscle damage
β-hydroxy-β-methylbutyrate (HMB)	C	3 g/day	Possible effect for beginners in strength training or during immobilization periods
BCAA (branched-chain amino acids) (in isolation)		–	With an adequate daily protein intake, it provides no additional effect
Glutamine		–	Insufficient evidence of ergogenic benefit in healthy athletes

²⁷ International Society of Sports Nutrition position stand: caffeine and exercise performance. 2021. <https://doi.org/10.1186/s12970-020-00383-4>

²⁸ International Society of Sports Nutrition position stand: safety and efficacy of creatine supplementation in exercise, sport, and medicine. 2017. <https://doi.org/10.1186/s12970-017-0173-z>

²⁹ International Society of Sports Nutrition position stand: Beta-Alanine. 2015. <https://doi.org/10.1186/s12970-015-0090-y>

³⁰ International Society of Sports Nutrition position stand: sodium bicarbonate and exercise performance. 2021. <https://doi.org/10.1186/s12970-021-00458-w>

Table 2 (continued)

Substance	Group (A / B / C / D)	Working doses and regimen	Practical remarks
L-carnitine, tyrosine, immuno- modulators	C	–	The evidence base is contradictory or weak
Testosterone boosters, plant sterols	D	–	Recommended for exclusion: high risk of contamination with prohibited substances [3]

Table prepared by the authors based on data from sources. [1, 3–5, 8, 23, 24] and regulatory documents^{27–30}

Note. A — reliable evidence of benefit in the appropriate context; B — accumulating evidence, possible benefit in specific scenarios; C — evidence is contradictory or insufficient; D — not recommended due to ineffectiveness or risks; GI — gastrointestinal tract; “–” — absence of an established dosage and regimen.

team, the minimum conditions when selecting dietary supplements and SSNPs should be the presence of a state registration certificate for these products and the “Honest Sign” (Chestny Znak) labeling. In addition, dietary supplements and SSNPs should be purchased only from the manufacturers’ official websites, which reduces the likelihood of purchasing counterfeit products. However, the risk of contamination of dietary supplements with prohibited substances remains high.

Typical errors in clinical practice

The literature analysis enabled the systematization of key errors in clinical decision-making regarding nutritional support for athletes:

- prescription of supplements without a clinical goal³¹;
- lack of analysis of the actual diet³²;
- overdiagnosis of deficiencies based on single parameters;
- ignoring RED’s signs³³;
- lack of anti-doping safety assessment [3];
- lack of efficacy criteria for nutritional support and monitoring timelines [3].

These errors are particularly common under conditions of high competitive load, when clinical decision-making is replaced by the pursuit of rapid pharmacological enhancement of performance.

The key issue in modern sports nutritionology does not lie in a lack of nutritional support options, but rather in insufficient clinical precision in their application. Despite the wide availability of SSNPs and dietary supplements, the majority of practical decisions should begin with an assessment of the baseline diet, energy balance, and the actual physiological objective [2].

The concept of energy availability is of particular importance, as it provides a framework for integrating decreased performance, recurrent injuries, menstrual dysfunction, reduced bone mineral density, and chronic fatigue into a single model [6]. In this context, a clinical error may involve attempts to eliminate individual symptoms, such as low ferritin levels or fatigue, without restoring adequate energy intake.

From a practical standpoint, this implies that the correction of nutritional status should be structured according to a stepwise approach [25]. At the first stage, issues of total caloric intake and dietary structure are addressed. At the second stage, the need for SSNPs that facilitate adherence to the diet under conditions of high training loads is assessed. Only at the third stage should the targeted use of dietary supplements be considered [3].

The problem of laboratory interpretation deserves special attention. Sports medicine requires a cautious approach to biomarkers, since exercise-induced shifts are often interpreted as pathological. This results in overdiagnosis, especially regarding iron deficiency states and vitamin insufficiency [4, 5, 21, 26, 27]. Therefore, laboratory diagnostic results should be considered not as an independent basis for prescription, but as part of the entire clinical context.

Another significant aspect is anti-doping safety. Even a potentially beneficial dietary supplement should not be recommended unless its quality, origin, and composition are reliably confirmed³⁴. This makes the inclusion of an anti-doping assessment mandatory in any clinical decision-making algorithm involving SSNPs and dietary supplements. Thus, the optimal model of nutritional support for

³¹ Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. 2016. <https://doi.org/10.1016/j.jand.2015.12.006>; International Society of Sports Nutrition position stand: protein and exercise. 2017. <https://doi.org/10.1186/s12970-017-0177-8>

³² Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. 2016. <https://doi.org/10.1016/j.jand.2015.12.006>; International Society of Sports Nutrition position stand: protein and exercise. *Journal of the International Society of Sports Nutrition*. 2017. <https://doi.org/10.1186/s12970-017-0177-8>

³³ IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update. <https://doi.org/10.1136/bjsports-2018-099193>

³⁴ IOC consensus statement: dietary supplements and the high-performance athlete. 2018. <https://doi.org/10.1136/bjsports-2018-099027>; World Anti-Doping Agency. The World Anti-Doping Code International Standard Prohibited List 2024. <https://www.wada-ama.org>

athletes requires a shift from the routine prescription of agents to a multi-stage algorithm based on evidence, individual risk assessment, and dynamic monitoring.

Practical recommendations

1. Before prescribing any nutritional intervention for an athlete, it is necessary to assess the actual diet and calculate energy availability; when EA is individually low or signs of problematic LEA are identified, the IOC REDs CAT2 should be applied.
2. In cases of complaints of fatigue, decreased performance, recurrent injuries, or menstrual cycle disorders,

first rule out REDs and non-nutritional causes, rather than prescribing dietary supplements.

3. Baseline carbohydrate intake levels are 3–12 g/kg/day depending on the volume and intensity of training; protein — 1.6–2.2 g/kg/day with a distribution of 0.3–0.4 g/kg per meal.

4. A ferritin level < 35 µg/L requires clinical evaluation with simultaneous measurement of CRP; correction of latent iron deficiency may be justified in cyclic sports and in cases of fatigue symptoms [4, 21].

5. The optimal blood vitamin D level in athletes is in the range of 75–125 nmol/L.

6. It is recommended that ergogenic aids be used only from the IOC group A category, at evidence-based

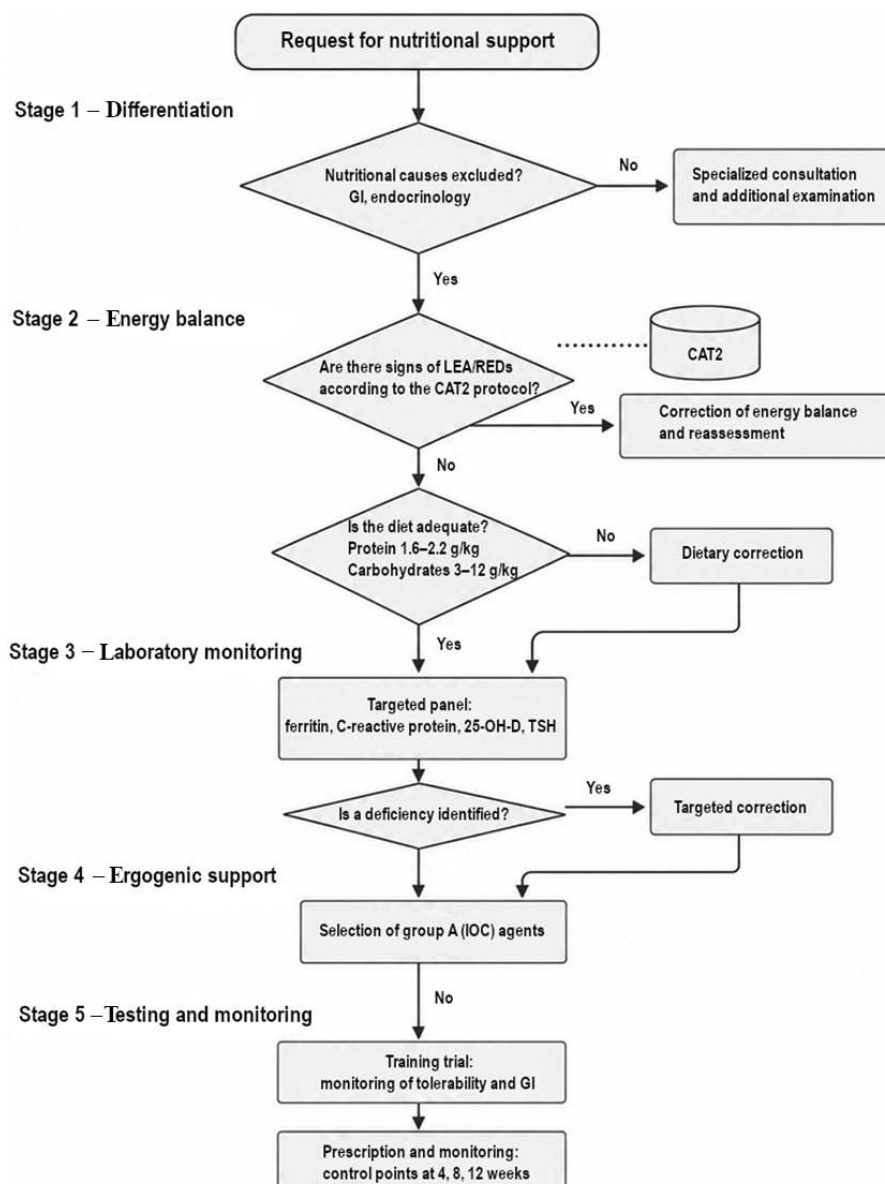


Figure prepared by the authors using the service <https://mermaid.ai/web/>

Fig. Algorithm for clinical decision-making regarding nutritional support. GI — gastrointestinal tract; EA — energy availability; FFM — fat-free mass; LEA — low energy availability; REDs — relative energy deficiency in sport; CAT2 — multifactorial scoring scale for REDs assessment, integrating clinical, laboratory, and psychometric data; IOC — International Olympic Committee; WADA — World Anti-Doping Agency

doses, after an individual training trial, and with a valid state registration certificate for the product.

7. Any dietary supplement and SSNP should be evaluated for individual tolerability and the absence of doping substances.

8. The effectiveness of the intervention is monitored according to predefined clinical and laboratory criteria with fixed timeframes (typically 6–12 weeks).

The algorithm for clinical decision-making regarding nutritional support is depicted in the figure.

CONCLUSION

Rational nutritional support for athletes does not imply expanding the regimen of SSNP and dietary supplement intake; rather, it should follow a sequential clinical decision-making algorithm. This algorithm begins

with defining the specific task, continues with an assessment of the baseline diet and energy adequacy, relies on targeted laboratory diagnostics taking into account training load, and concludes with a minimally sufficient intervention and monitoring based on predefined success criteria. Priority should be given to the correction of nutrition and energy balance, whereas dietary supplements should be applied in a targeted manner, only when their benefit for a specific type of exercise is proven, and with confirmed anti-doping status of the product. The review of current literature sources on nutrition and nutritional support for elite athletes has shown that a personalized approach in sports nutritionology is not associated with an increase in the number of prescribed SSNPs and dietary supplements, but rather by greater precision in their selection.

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Authors:

Zhanna V. Grishina, Cand. Sci. (Biol.), ORCID: <https://orcid.org/0000-0002-9051-9580>

Anastasia I. Kadykova, ORCID: <https://orcid.org/0000-0003-2996-6194>

Nikita S. Gladyshev, ORCID: <https://orcid.org/0000-0003-2732-5676>

Evgeniy D. Kopylov, ORCID: <https://orcid.org/0009-0008-9927-5608>

Vladimir S. Feshchenko, Cand. Sci. (Med.), ORCID: <https://orcid.org/0000-0002-4574-6506>

Andrey V. Zholinsky, Cand. Sci. (Med.), ORCID: <https://orcid.org/0000-0002-0267-9761>

Roman V. Deev, Cand. Sci. (Med.), ORCID: <https://orcid.org/0000-0001-8389-3841>