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DECODING THE SCIENCE OF ELITE HUMAN PERFORMANCE

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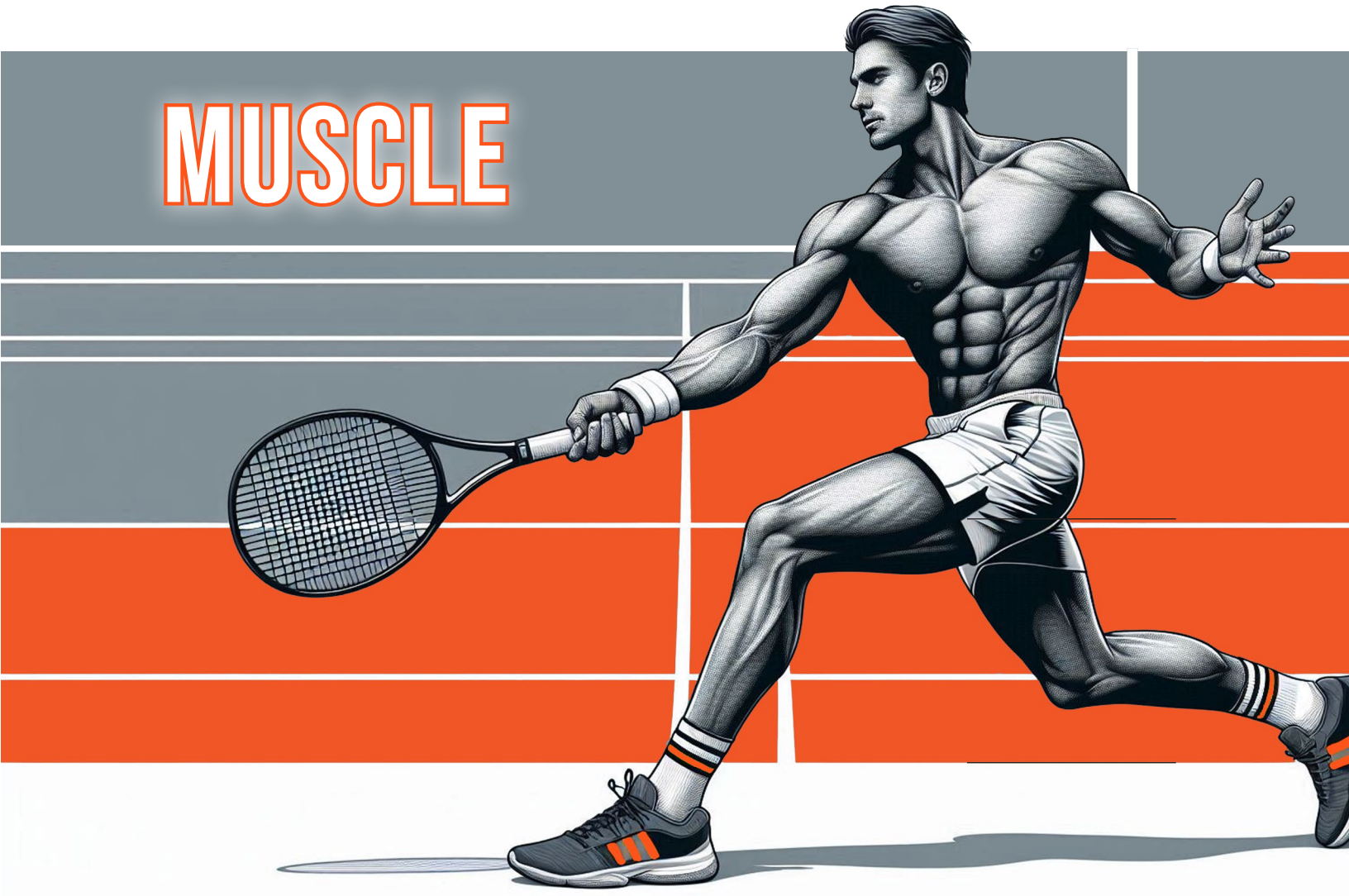

Protein – What Every Sports Medicine rofessional Needs to Know!

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Why Personalised Wellness Outperforms the Standard

MESSAGE FROM THE EDITOR

Welcome to the September 2025 issue of Sports Pharmacy Magazine. This month, our theme is one of the most visible cornerstones of performance: muscle.

Inside, you'll find practical and timely articles designed to strengthen both your knowledge and your clinical practice. We explore foundational topics like protein, a nutrient every sports medicine professional should be fluent in, and creatine, one of the most studied yet misunderstood supplements in sport. You'll also read about the surprising role of rest in building strength, how dietitians and pharmacists can collaborate to optimize recovery, and why personalized wellness strategies increasingly outperform the standard, one-size-fits-all approach.

As the field of sports pharmacy continues to grow, so too does our opportunity to lead in education and advocacy. That's why we're thrilled to announce that planning for the 2026 Sports Pharmacy Summit is already underway and registration is now officially open. This follows our successful inaugural Summit last year, designed to unite pharmacists, clinicians, and athlete health care professionals worldwide in advancing athlete-centered care.

If you're new to the Sports Pharmacy Network, now is the perfect time to join our movement. Membership tiers are available for students, practicing pharmacists, and allied health professionals alike. Find your place at sportsrxnetwork.com.

Thank you for your continued support. Together, we are building stronger athletes, stronger teams, and a stronger future for sports pharmacy.

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Protein

What Every Sports Medicine Professional Needs to Know!

By Sean Casey, RD CSCS

AUTHOR BIO:

Sean Casey is a registered dietitian and physical preparation coach who works with everyone from middle/high school athletes to Olympians, including an Olympic Gold Medalist. His expertise is sought after on the international level, where he has traveled to over 15 countries, helping clients reach their athletic potential through nutrition, physical training, and recovery techniques. Sean's passion for optimizing performance health extends into the business world, where he has hosted workshops for various organizations. Sean currently serves as the Director of Applied Human Performance at the Sports Pharmacy Network.

Introduction

Protein. Protein. Protein. If I ask 1,000 athletes or fitness enthusiasts, "What is the #1 nutrient you need to build muscle?", I'm quite confident the answer would be an emphatic "Protein!" Protein is no longer a nutrient that just grabs the attention of muscle lovers only. As one can see by taking a stroll down the aisles of their favorite grocery store, the word "protein" seemingly excites everyone, as evidenced by protein-infused ice creams, breakfast bars/cereals, potato chips, and more! The word protein has seemingly become the "easy button" to win the hearts and souls of food shoppers.

But behind the marketing buzz of the word "protein" lies real biochemistry and decades of sports nutrition research that every sports medicine professional should understand so they can answer common questions they may hear from their patients/clients. As a sports dietitian, the most common questions I receive include, "Are high protein diets harmful to my bones and kidneys? Is protein consumed in amounts greater than 20 grams (g) at one meal wasted? What's the best type? Does timing really matter?" and more.

With that being said, let's dig into the science, cut through the confusion, and get the straight scoop on what protein really does for the body—and what sports professionals need to know in supporting athletic care!

Protein Biochemistry: A Quick Primer

Proteins are built from 20 amino acids: 9 essential (EAAs) and 11 non-essential (NEAAs).[1] EAAs must come from the diet, while NEAAs can be synthesized internally, provided there are enough EAAs around to support the conversion. Now, you may be wondering, "Aren't there more than 20 amino acids?"

Technically, yes. Many non-proteinogenic amino acids exist in nature. They don't build proteins but still serve key physiological functions. Take the NEAA citrulline, for example. This amino acid plays a crucial role in both the urea cycle and the production of nitric oxide, making it a popular amino acid supplement for athletes and those seeking to lower blood pressure when used in doses of ~6g.[2] For a more detailed look at citrulline, please refer to the Sport Pharmacy Network's "Citrulline JTE" sheet.

Dietary Protein & Skeletal Muscle: Leucine is King

When it comes to supporting skeletal muscle, not all proteins are created equal. Animal-based proteins generally win the lean muscle-building race thanks to their higher EAA content, especially leucine, the "anabolic trigger" that kicks the mTOR pathway into high gear, initiating muscle protein synthesis (MPS).[3,4] This is not to say that plant proteins don't support MPS. Rather, one must consume more plant protein to have similar effects as animal protein.

The one exception to this "animal vs. plant protein" rule is collagen, which falls short when it comes to MPS. Despite being an animal-derived protein, the leucine content of collagen is low, making it a poor stimulator of MPS. Still, it shines in other areas, such as joint, tendon, skin, and connective tissue health, likely due to its high concentration of the amino acids glycine and hydroxyproline.[5,6] To learn more about collagen protein, please see the Sport Pharmacy Network's Collagen JTE sheet.

The Leucine Benchmark

So, how much leucine is needed? To maximally stimulate MPS, around 6g of EAAs, including ~2g of leucine, is required per meal.[7] For older adults who

As long as protein is spread evenly throughout the day in adequate doses (generally 25–40g per meal) to hit one's daily protein needs, athletes can recover, adapt, and grow.

experience anabolic resistance, higher leucine thresholds (>2g) may be necessary.[8]

Table 1. Leucine content per 100g of Protein.[9,10]

Protein Source	Leucine per 100g Protein
Whey	10.3g
Beef	8.4g
White Fish	8.1g
Egg	7.9g
Oat	7.5g
Soy	7.1g
Chickpea	6.8g
Peanuts	6.2g
Quinoa	4.5g
Collagen	3.4g

Complementary Plant Proteins: The Dynamic Duo Approach

Most plant proteins are incomplete—they lack one or more EAAs. Grains, for example, are low in lysine. Legumes? Low in methionine and cysteine.[9]

The solution? Pair them. Combining grains and legumes, such as beans and rice, over the course of the day yields a complementary amino acid profile that supports MPS. Although it was once thought that these complementary proteins had to be consumed in the same meal, research indicates this practice is not necessary as long as complementary proteins are consumed daily.[11]

Protein Timing: The "Anabolic Window" Revisited

For years, the *anabolic window* - the mythical 30–60 minute post-workout period - was touted as sacred. If one failed to consume 20-30g of protein during this time period, all their training gains were lost to the abyss! However, more recent research suggests a different story.[7] In short, one can "relax", your gains will not be lost if you fail to consume protein within the first 30-60 minutes post workout!

Total daily protein intake is a far more critical determinant of muscular adaptation than the immediate timing of protein intake. As long as protein is spread evenly throughout the day in adequate doses (generally 25–40g per meal) to hit one's daily protein needs, athletes can recover, adapt, and grow.

Still, for those training multiple times per day or with short recovery windows, strategic timing can significantly ease the task of meeting daily protein needs, supporting both short-term and long-term muscular adaptation. Daily protein requirements for various populations are listed in Table 2.

Table 2. Recommended Daily Protein Intakes Based on Sport Type, Age, and Sex.[12-16, 25,26]

Population	Recommended Intake (g/kg/day)	g/lb/day
Endurance Athletes	1.2 – 2.2	0.54 – 1.0
Strength/Power Athletes	1.6 – 2.2	0.7 – 1.0
Female Athletes (General)	1.4 – 2.2	0.63 – 1.0
Pregnancy – Early (Week 16)	1.2	0.54
Pregnancy – Late (Week 36)	1.52	0.69
Lactation (Daily Reference Intakes' Recommended Daily Allowance)	71g/day	
Lactation (2020 Pilot Study)	1.7 – 1.9	0.77 – 0.86
General Healthy Aging	1.2 - 1.6g	0.54 - 0.7

Female-Specific Protein Considerations

It's well established that protein needs increase during pregnancy and lactation. However, recent research has expanded our understanding of protein requirements for females across the entire lifespan—not just during these reproductive phases.[17]

While more studies are needed to pinpoint optimal dosing, evidence suggests that maintaining intake at the upper end of the recommended protein range may be particularly important during the following life stages:

- Luteal Phase of Menstrual Cycle: Higher progesterone levels promote catabolism, potentially increasing protein needs.
- Peri- and Post-Menopause: Higher daily intakes may help combat anabolic resistance and preserve lean muscle mass.

Protein Supplements: Whey, Casein, and Plants

As a sports medicine professional, a common question you may receive is, "Do I need to consume a protein supplement?"

The answer to this question is "no." One does not *need* to consume a protein supplement if they're meeting their daily requirements through food alone. However, from a pragmatic standpoint, protein supplements can really help individuals reach their protein needs. For instance, for those with busy lifestyles or high daily needs, the convenience of a protein supplement makes things easier.

Based on 20 years of experience working in the field as a sports dietitian, I often find that many individuals struggle to consume solid food immediately following intense training sessions in hot and humid environments. In these situations, protein shakes can make all the difference.

The next most common question, as it relates to dietary protein supplements, is often "what type should I choose?" and "Does the 'speed' of protein absorption matter?"

Let's start with whey and casein, two common animal-based protein powders which have very different absorption kinetics.[18] Whey is rapidly digested - making it a popular post-workout protein powder. Casein, on the other hand, digests slowly, releasing amino acids over several hours, leading many to suggest that it may be an ideal pre-bed protein powder.

Interestingly, a recent study found that when consumed before bed, 45g of whey or casein led to similar overnight muscle and mitochondrial protein synthesis, provided aerobic exercise was completed earlier in the day.[19] Thus, suggesting that casein may not hold the upper hand as once thought.

In relation to consuming whey versus other animal-based protein sources, such as chicken and beef, research indicates that the differences are relatively negligible in terms of muscle adaptation.[20,21]

Plant proteins generally fall in the slow to medium digestion range.[18] As aforementioned, they're still effective in supporting muscle recovery; however, slightly higher doses may be needed to stimulate MPS sufficiently.

Recovery Bonus: Protein + Carbohydrates = Glycogen Rebound

It's well-established that dietary protein helps stimulate MPS, reduce muscle breakdown, and support repair. However, it also has a synergistic effect when paired with carbohydrates after exercise.

Research shows that adding protein to a carb-rich drink enhances glycogen resynthesis.[22] Although enhanced speed at which glycogen is replenished benefits all athletes, this is especially beneficial for individuals with multiple training bouts per day.

The recommended post-workout ratio of protein to carbs varies significantly depending on the type, duration, and intensity of training, but generally speaking, a 1:1 to 1:4 (Protein:Carbohydrate) ratio covers most situations.

Common Protein Myths

As it relates to protein, there are many common myths that, as sports medicine professionals, it is essential to recognize and correct when we hear them propagated. Let's look at the science behind four of the most common myths I hear regarding protein as a sports dietitian.

Myth: High-protein diets can damage one's kidneys.
Fact: For individuals with pre-existing renal issues, protein restriction may very well be necessary. But for healthy individuals? Despite popular belief, high protein intakes (2–4 times the recommended daily allowance, or RDA) have not been shown to harm kidney function.[7]

> Protein isn't just about "gains" for the gym rats. It's about performance, recovery, long-term health, and resilience across the lifespan for all.

Myth: High protein weakens bones.
Fact: Actually, higher protein diets are associated with *improved* bone density. This may potentially be attributed to protein's ability to stimulate insulin-like growth factor-1 (IGF-1).[7,23]

Myth: Meat increases the risk of various diseases and negatively impacts health.
Fact: The jury is still out. Processed meats? Likely problematic. But unprocessed red meats? Appears fine overall, but may be influenced by overall diet, cooking methods, and lifestyle factors. White meat, such as poultry, appears to pose no issues according to the research.[7]

Myth: The body can't digest more than 20g of protein in one meal.
Fact: Digestion and utilization for muscle-building purposes are different. The body can digest more than 20g of protein from a meal, but it may not utilize all of it for muscle-building purposes. The amount of protein used for muscle building from one meal depends on a variety of factors, including age, exercise stress, metabolic stress, and others.[7] All of these factors may increase the amount of protein utilized from one meal for muscle building purposes beyond 20g. Amino acids that are not directly used for muscle building purposes still support overall whole-body nitrogen balance.

Protein & General Health

When it comes to protein, most individuals naturally think of it being used to support athletic and fitness performance. However, it's important to remember that protein serves more purposes than simply supporting muscle recovery. When consumed in recommended doses (Table 2), it has been shown to support weight management and satiety, assist with the management of symptoms of metabolic syndrome, sarcopenia, and, in the case of collagen protein, provide reinforcement for connective tissue and reduce osteoarthritis symptoms.[5, 25-27]

Wrapping Things Up

Protein isn't just about "gains" for the gym rats. It's about performance, recovery, long-term health, and resilience across the lifespan for all. As sports medicine professionals, our job is to cut through the noise and deliver real value.

Whether you're working with elite athletes, everyday exercisers, or aging populations, understanding the nuances of protein quality, timing, dosing, and individual needs allows you to deliver smarter, science-backed care.

So next time a client asks if 20 grams is the upper limit of protein digestion or whether protein will wreck their kidneys, smile and drop some science. Now that you know better, they will too!

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Stronger While You Sleep:

The Hidden Role of Rest in Muscle Growth

By Bailey Harkins, Larkin University PharmD Candidate 2026

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Bailey is a PharmD Candidate at Larkin University College of Pharmacy and a Tampa, Florida native. Her passion for health, fitness, and longevity drives her work both inside and outside of pharmacy. With a strong interest in how nutrition and supplements can optimize performance, she is dedicated to helping patients maintain their health as they age and achieve their fitness goals. She hopes to bridge the gap between pharmacy, lifestyle, and performance science by promoting evidence-based strategies that support overall wellness.

Training stresses the body, but recovery is where progress truly happens. Sleep is more than simply shutting down at night. It is an active, highly regulated biological process in which the hormonal and cellular mechanisms are essential for skeletal muscle growth and repair, known as hypertrophy. Hypertrophy is defined as the enlargement of muscle fibers through a combination of training and recovery. During sleep, the body releases anabolic hormones, such as growth hormone and testosterone, which stimulate muscle protein synthesis and repair of training-induced damage. At the same time, sleep regulates inflammation and maintains hormone balance. When sleep is insufficient or poor in quality, the balance shifts toward catabolism. Elevated cortisol levels, suppressed protein synthesis, and reduced insulin sensitivity characterize a state of catabolism. For athletes and individuals engaged in any training, sleep is not optional; it's a cornerstone. l. Prioritizing adequate and consistent rest enhances performance, accelerates recovery, and supports long-term muscle growth progress.[1234]

Why Sleep Matters for Skeletal Muscles

Recovery refers to the coordinated restoration of damaged muscle fibers and their remodeling, a process in which muscle protein synthesis (MPS) exceeds muscle protein breakdown (MPB).[5] This balance determines whether the muscle environment is anabolic (building) or catabolic (breaking down). Recovery is tightly regulated by circadian biology, meaning that both the timing and structure of sleep strongly influence how effectively muscle repair and adaptation occur after training.

Sleep quality is defined by the architecture of sleep stages, particularly slow-wave sleep (SWS) and rapid eye movement (REM). Sleep quantity refers to the total duration of sleep. SWS, often called "deep sleep," provides a hormonal and metabolic environment that is favorable for tissue repair.[5] REM sleep, in contrast, is crucial for neural recovery and motor learning processes that enhance skill acquisition and performance.[6] When total sleep time is shortened, even if the sleep stages occur in normal sequence, the body spends less time in these critical phases of recovery, limiting both muscular and neural adaptation

Evidence supports these mechanisms. For example, a study in *Current Sports Medicine Reports* highlights that acute sleep deprivation reduces postprandial MPS, impairs muscle recovery, and shifts the hormonal environment toward catabolism, characterized by elevated cortisol and decreased testosterone.[5] The same review also emphasizes that chronic or repeated sleep restriction undermines recovery, leading to anabolic resistance, impaired glycogen repletion, and increased muscle protein degradation.[5] Collectively, these findings illustrate that both sleep quality and quantity of sleep are essential to align recovery with circadian rhythms and maintain muscle health.

Anabolic Endocrine Window at Night

Sleep creates an anabolic "window" when hormones critical for muscle repair and adaptation are released at the highest levels. For athletes, these nocturnal hormonal surges are crucial; they directly support recovery between training sessions and long-term performance gains.

Growth hormone (GH) is the clearest illustration. The largest daily GH pulse occurs shortly after sleep onset and is tightly linked to SWS. In healthy adults, 60 to 70% of daily GH secretion takes place during early-night SWS.[7] GH stimulates tissue repair, promotes amino acid uptake, and activates insulin-like growth factor 1 (IGF-1) pathways, all of which stimulate muscle protein synthesis and structural remodeling.[8] When SWS is shortened or disrupted, GH release declines, slowing recovery and limiting hypertrophy.

Testosterone is also strongly dependent on sleep. A study demonstrated that restricting sleep to five hours per night for one week significantly decreased daytime testosterone levels in healthy young men. Because testosterone drives muscle protein accretion, neuromuscular performance, and even training motivation, inadequate sleep undermines both recovery and athletic progression. Broader evidence links chronic sleep loss and poor sleep quality to reduced testosterone across diverse populations. [10]

Together, GH and testosterone illustrate how sleep itself acts as a natural performance enhancer. For athletes, protecting deep and consolidated sleep is essential to maximize anabolic signaling and optimize training outcomes.

Catabolic Drift with Sleep Loss

While sleep promotes an anabolic environment, insufficient or poor-quality sleep shifts the body towards a catabolic state, impairing muscle growth and recovery. For athletes, this "catabolic drift" can reduce the benefits of training, increase injury risk, and limit long-term adaptation.

Cortisol, the body's primary stress hormone, is highly sensitive to sleep loss. A study found that partial sleep restriction elevates evening cortisol levels and delays the normal decline that occurs overnight.[11] Chronically elevated cortisol tilts the balance toward muscle protein breakdown, interferes with glycogen replenishment, and increases the perception of fatigue. In athletes, these hormonal disruptions not only slow recovery but also compromise readiness for subsequent training or competition.

Sleep loss also undermines insulin sensitivity, a key determinant of nutrient partitioning and glucagon storage. Research shows that even one week of restricted sleep reduces whole-body insulin sensitivity, limiting glycogen storage and blunting anabolic signaling through the insulin–mTOR pathway.[12] For athletes facing heavy training loads demanding repaid restoration of muscle glycogen, this metabolic inefficiency can hinder both recovery and performance

Appetite regulation is also affected. Restricted sleep decreases leptin (the satiety hormone) and increases ghrelin (the hunger hormone), driving heightened hunger and cravings. A landmark study demonstrated that these hormonal shifts occur after only two nights of restricted sleep, creating a nutritional environment that promotes excess caloric intake and poorer dietary choices.[13] For athletes aiming to optimize body composition, these changes can complicate fueling strategies and undermine dietary goals.

Collectively, elevated cortisol, impaired insulin sensitivity, and dysregulated appetite hormones illustrate how inadequate sleep shifts the hormonal balance toward catabolism. Protecting sleep is therefore essential for recovery, as well as for maintaining an anabolic environment and safeguarding training adaptations.

Direct Effects on Muscle Protein Turnover

Sleep directly influences the balance between muscle protein synthesis (MPS) and muscle protein breakdown (MPB), the fundamental process that determines whether training leads to hypertrophy or muscle loss.

Even a single night of total sleep deprivation significantly reduces myofibrillar MPS compared to regular sleep.[14] This acute disruption suppresses the anabolic response and promotes catabolism, creating an unfavorable environment for recovery. Repeated nights of short sleep compound these effects; the cumulative reduction in protein synthesis limits the ability of muscle fibers to remodel and grow.

Some evidence suggests that high-intensity interval training during sleep restriction can partially restore MPS, but not enough to counteract the negative impact of inadequate rest.[15] For athletes, this reinforces a critical point: no amount of rigorous training can fully compensate for poor sleep.

Ultimately, sleep is not just a hormonal regulator but also a direct modulator of skeletal muscle protein turnover. Adequate, consistent sleep is therefore essential for athletes to activate the molecular machinery that translates training stimuli into gains in strength and muscle mass.

Circadian Alignment and Muscle

Sleep is more than a period of hormonal recovery and protein turnover; it is also a key regulator of circadian rhythms, the internal 24-hour cycles that coordinate biological processes across nearly every tissue. These rhythms are driven by molecular "clocks" located in the central nervous system and peripheral tissues, including skeletal muscle. These clocks regulate metabolism, energy utilization, and the timing of anabolic and catabolic processes. When sleep is insufficient, misaligned, or disrupted, these circadian systems become disrupted, impairing muscle recovery and overall performance capacity.[16]

Skeletal muscle contains its own circadian machinery that governs gene expression related to protein metabolism, mitochondrial function, and glucose handling. Inadequate sleep or circadian misalignment, such as that caused by shift

> By treating sleep as an active part of the training plan, athletes can unlock their full potential and transform effort into measurable gains in strength, performance, and long-term progress.

work or frequent travel, disturbs these peripheral clocks and reduces the efficiency of muscle metabolism.[16] For athletes, these disruptions can blunt the ability of muscle to repair damaged fibers, reduce glycogen storage, and weaken anabolic signaling.

Misalignment also compromises coordination between muscle and systemic physiology. When the skeletal muscle clock becomes desynchronized from the brain's central pacemaker, nutrient metabolism loses efficiency, hormonal rhythms drift out of phase, and recovery after exercise slows.[16] This phenomenon is particularly relevant to athletes who frequently train at varying times of day, travel across time zones, or balance training schedules with demanding academic or occupational responsibilities.

Maintaining circadian alignment through regular sleep-wake cycles, consistent meal timing, and structured light exposure patterns helps synchronize these biological clocks. For athletes, protecting this alignment ensures that training stimuli are supported by an optimal internal environment, thereby enhancing both adaptation and performance outcomes.[16]

Practically Leveraging the Night for Hypertrophy

While science is clear that sleep is an indispensable factor for muscle growth, athletes can take deliberate steps to maximize its benefits. Key strategies include maintaining adequate duration, optimizing pre-sleep nutrition, managing stimulant use, and practicing consistent sleep hygiene.

The American Academy of Sleep Medicine and the Sleep Research Society recommend that adults get at least seven hours of sleep per night, with athletes often benefiting from extended sleep or strategic naps to offset increased training demands.[17] Sleep extension, aiming for nine or more hours, has shown improvements in performance, reaction time, and mood.[18] Strategic naps can also help offset fatigue during a period of heavy training or travel.

Nutrition before sleep also influences recovery. Consuming 30 - 40 grams of slow-digesting casein protein before bed provides a sustained release of amino acids overnight, elevates nocturnal muscle protein synthesis, and enhances training-induced hypertrophy over time.[19] For athletes, this adjustment can transform sleep into a powerful extension of the anabolic environment during sleep.

Caffeine management is equally important. While caffeine boosts alertness and exercise capacity, consuming it too late in the day delays sleep onset, reduces sleep efficiency, and diminishes restorative slow-wave sleep.[20] Athletes are therefore advised to avoid high doses of caffeine in the six to eight hours before bedtime to balance performance benefits with recovery needs.

Ultimately, sleep hygiene practices establish the foundation for consistency and quality. Evidence supports maintaining a regular sleep-wake schedule, a dark and cool environment, limited light exposure before bedtime, and strategic naps when nighttime sleep is insufficient.[21] Athletes who adhere to these practices create a recovery framework that allows training and nutrition to be expressed fully in muscular adaptations.

Sleep Plan for Hypertrophy

Translating research into practice means giving athletes a framework they can realistically follow. A sleep plan for hypertrophy emphasizes consistency, timing, and strategies to offset the demands of training and competition.

1. **Bedtime and Wake Anchors** Keeping a consistent sleep-wake schedule, even on weekends, reinforces circadian rhythms. This stability enhances restful sleep and promotes improved recovery.[22]
2. **Caffeine Cut-Offs** Caffeine is a powerful ergogenic aid, but its use can be sabotaged by poor timing, which can disrupt sleep. Athletes should cut off caffeine six to eight hours before bedtime, thereby preventing delays in sleep onset and ensuring sufficient time in SWS.[20]
3. **Pre-Sleep Protein** Consuming 30-40 grams of casein protein approximately 30 minutes before bed provides a sustained amino acid supply overnight. Research demonstrates this practice enhances muscle protein synthesis and augments training-induced gains when maintained over several weeks.[19]
4. **Training Timing** Finishing an intense training session at least two to three hours before bedtime allows body temperature, heart rate, and sympathetic activity to normalize. High-intensity training performed too close to bedtime can delay sleep onset and compromise recovery.[22]

5. **Strategic Naps and Sleep Banking** When sleep loss is unavoidable (e.g., travel, competition), "sleep banking" by getting extra sleep beforehand helps preserve performance. Additionally, 20 to 30-minute naps can boost alertness and motor performance without impairing nocturnal sleep.[23]

By weaving these strategies into daily routines, athletes can transform sleep from a passive activity into an active recovery tool. Consistent, high-quality sleep amplified the effects of training and nutrition, ultimately driving greater gains in strength and maximizing hypertrophy.

Conclusion

Sleep is not just downtime; it is the hidden variable that determines whether training and nutrition translate into actual growth. It is a critical determinant of skeletal muscle growth, functioning as both an anabolic window and a regulator of circadian alignment. Quality sleep enhances anabolic hormones, supports muscle protein synthesis, regulates metabolism, and maintains the balance of appetite and stress hormones. This makes sleep the cornerstone of hypertrophy. In contrast, inconsistent or insufficient sleep undermines these processes, leading to elevated cortisol, impaired insulin sensitivity, reduced protein synthesis, and diminished recovery. Blunting adaptation and slowing the progress, no matter how hard an athlete trains.

For athletes, sleep should be approached with the same discipline as lifting, training, or nutrition. Anchoring bed and wake times, Strategies such as consistent sleep-wake schedules, fueling with pre-sleep protein, strategically timing caffeine, and leveraging naps or sleep banking are practical, evidence-based tools that elevate recovery and maximize training gains.

In the end, muscle isn't built only in the gym or the kitchen; actual growth occurs at night. By treating sleep as an active part of the training plan, athletes can unlock their full potential and transform effort into measurable gains in strength, performance, and long-term progress.

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Lauren Ha is a recent graduate from USC Alfred E. Mann School of Pharmacy and Pharmaceutical Sciences, where she earned her Doctor of Pharmacy (PharmD) degree. She is beginning her journey in healthcare with a vision to bridge the gap between pharmacy and athletic performance.

Currently, Lauren is expanding her knowledge and experience at 986 Pharmacy, an outpatient community pharmacy where she's learning the importance of patient-centered care. She's involved in everything from counseling patients on medication use to identifying ways to optimize their overall health.

Before her PharmD journey, she was deeply rooted in the world of sports. At California State University, Monterey Bay, she worked as a Game Operations Supervisor surrounded by athletes from all sports including baseball, golf, water polo, and more. She developed a deep appreciation for the unique physical and mental demands that come with athletic performance.

With her clinical training and athletic background, Lauren is passionate about shifting the focus in sports medicine from treatment to prevention. Her goal is to optimize athlete care by promoting injury prevention strategies, performance enhancement, and overall wellness. By working closely with healthcare providers, trainers, and athletes, she hopes to create a more proactive, collaborative approach to athlete health.

Author Bio:

Elizabeth is a recent graduate of the USC Mann School of Pharmacy, where she earned her Doctor of Pharmacy (PharmD). She is currently completing her PGY1 pharmacy residency at Henry Mayo Newhall Hospital. Prior to residency, Elizabeth spent four years as a pharmacy intern at Cedars-Sinai, an experience that deepened her passion for patient-centered care. Before entering the world of pharmacy, Elizabeth was a dedicated competitive swimmer. Her years in the pool, training and competing in numerous swim meets, instilled in her a deep appreciation for discipline, resilience, and the importance of whole-body wellness. This lifelong connection to sports continues to influence her professional journey today. Elizabeth is passionate about bridging her pharmacy expertise with her personal understanding of the athletic experience. She is particularly interested in athlete health, including injury prevention, recovery, and performance optimization. She believes pharmacists have a vital role in supporting athletes' well-being and is excited to contribute her unique perspective to the conversation around athlete wellness.

The Interplay of Nutrition and Medication in Muscle Recovery:

A Collaborative Approach Between Dietitians and Sports Pharmacists

By Lauren Ha, PharmD & Elizabeth, PharmD

Background

There's a growing shift in sports medicine, and pharmacists are no longer seen as bench players but as essential members of the athlete care team.

While dietitians have long been central to performance and recovery, optimizing fuel for endurance, strength, and repair, pharmacists bring a critical and often overlooked lens : the pharmacological one, which can also improve the same areas and goals a dietitian is working toward.

From medication therapy management and birth control consultations to anti-doping compliance and individualized pharmacologic support, pharmacists fill a critical gap in athlete care. This article explores the synergy between dietitians and pharmacists, two disciplines that, when working together, create a powerful team that goes far beyond calories, protein timing, or macro ratios. At the cellular level, nutrients and medications interact constantly, and only through interdisciplinary collaboration can we ensure those interactions are optimized for athlete health and performance. Together, pharmacists and dieticians create a high-performance team that extends beyond calories and macros, all the way down to the cellular level.

Understanding Muscle Recovery Beyond Nutrition

Muscle recovery is crucial for sustaining peak athletic performance and preventing injuries. Nutrition is undeniably a cornerstone, fueling muscle repair and hypertrophy[1]. But nutrition is only part of the equation. Often overlooked is how medications, hormone cycles, and individual physiology can also shape how an athlete recovers. This is where the collaboration between the sports pharmacist and sports dietitian comes into play.

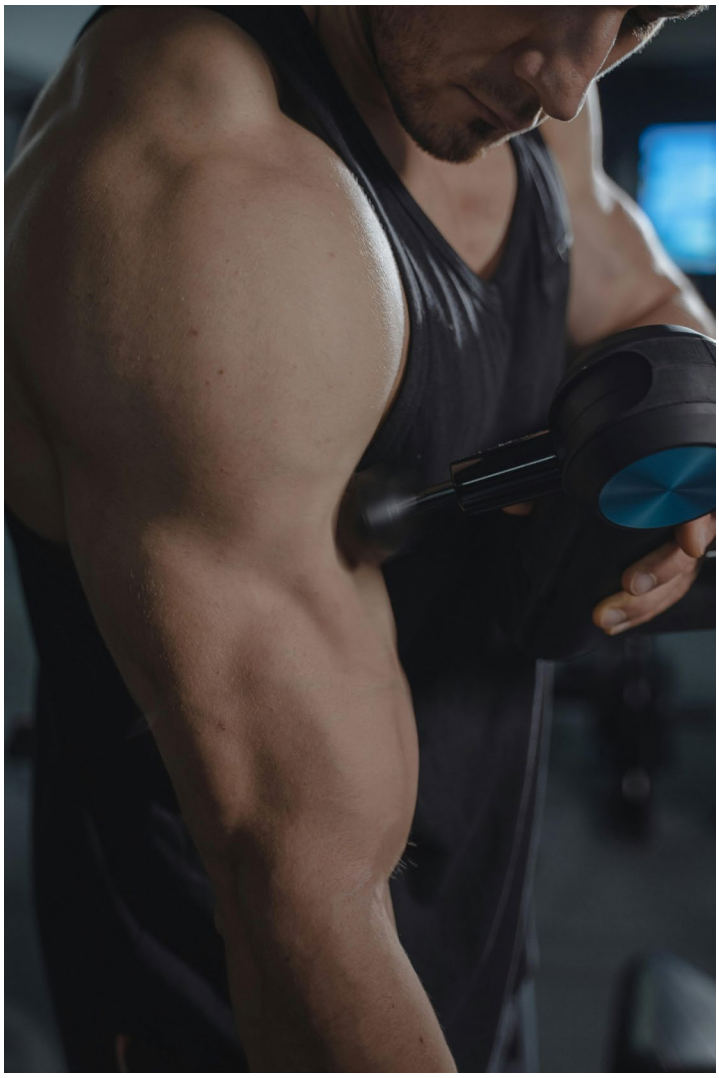
Consider a collegiate distance runner prescribed an NSAID for knee pain during peak training season. While the medication may ease inflammation in the short term, chronic use can impair muscle regeneration by dampening the natural inflammatory signaling required for tissue repair and have negative impacts on the gastrointestinal tract.[7] In this case, coordination between a dietitian and a sports pharmacist could optimize both the athlete's recovery and long-term adaptation. This may involve testing omega-3 levels and adjusting medication, timing, dosage, or recommending alternative strategies, such as omega-3s or curcumin, in conjunction with a protein-rich post-training meal.

Female athletes, for instance, face cyclical hormonal fluctuations that influence muscle adaptation. Estrogen, which peaks during the late follicular phase, aids muscle repair through its anti-inflammatory effects and activation of satellite cells. Conversely, progesterone, elevated in the luteal phase, may impair protein synthesis and reduce training efficiency[1].

This hormonal rhythm can be further altered by medications commonly used by female athletes, particularly hormonal contraceptives. Combined oral contraceptives (COCs), used by nearly half of elite female athletes for menstrual regulation or symptom control, suppress the body's natural hormone cycles, and some may lower androgen levels necessary for muscle development[2]. Meta-analyses report up to a 10% reduction in muscle hypertrophy and a 7% decrease in strength gains in COC users compared to non-users, alongside diminished type II muscle fiber hypertrophy, which is crucial for power and endurance[2].

Some COCs increase sex hormone-binding globulin, which reduces the amount of free testosterone available in circulation. This decrease in bioavailable testosterone can negatively impact muscle protein synthesis and strength adaptations. Additionally, other medications used to suppress menstruation, such as progestin-only agents or gonadotropin-releasing hormone analogs , can further reduce estrogen and testosterone levels, potentially affecting muscle tone, performance, and recovery capacity.

This is where collaboration between a sports pharmacist and a dietitian becomes crucial. The pharmacist brings insight into how medications may alter hormonal balance, nutrient absorption, and anabolic signaling, while the dietitian can adjust macronutrient timing and composition to help offset these effects. For instance, if an athlete is using a COC and experiencing reduced strength gains, a pharmacist might recommend reviewing the specific formulation and its androgenicity. At the same time, the dietitian can ensure that protein intake is optimized, especially after training, to support lean mass retention. For example, imagine a young competitive weight lifter, Anna, who starts a COC and notices her squat strength has plateaued despite consistent training. The pharmacist would review the prescription and determine that a higher progestin formulation of birth control may slightly blunt muscle protein synthesis by lowering free testosterone levels. Meanwhile, the dietitian would design a recovery plan that bumps her daily protein intake from 1.6 g/kg to 1.8 g/kg, prioritizes 25-30 g of protein within 30 minutes post-training, and incorporates iron-rich foods to support oxygen transport.



COC & Drug-Induced Nutrient Depletion

Let's go back to Anna. Oral contraceptives can deplete key nutrients such as vitamin B6, magnesium, folate, and zinc. These nutrients are essential for energy metabolism and recovery as well as neuromuscular function. Besides increasing this athlete's protein intake, the dietitian could recommend incorporating nutrient-rich foods, such as leafy greens, legumes, pumpkin seeds, beef, and fish. Each of these nutrients, when depleted, has its unique consequences. Low folate can impair red blood cell production and oxygen delivery, leading to early muscle fatigue. Inadequate vitamin B6 may reduce neurotransmitter synthesis and affect mood and focus. Low magnesium can increase muscle cramping and reduce endurance while low levels of zinc can decrease immune function and diminish testosterone activity.

In men, muscle growth is closely tied to testosterone, a key anabolic hormone that stimulates protein synthesis and promotes strength gains. Unlike women, who experience a

Athletic performance is as much a mental game as it is a physical one. For professional athletes, hormonal fluctuations and medication use can significantly influence mood, motivation, focus, and overall mental well-being.

complex daily-and-montly rhythm of hormone shifts, men have relatively stable levels aside from small daily testosterone surges at night, though aging, stress, and certain medications can still hinder muscle recovery. However, other factors such as aging, chronic stress, underlying medical conditions, and certain medications can significantly disrupt hormonal balance and impair muscle recovery.

Medications that suppress testosterone, such as those often used to manage prostate cancer, endocrine disorders, or gender-affirming care, can create a low-testosterone environment that makes muscle hypertrophy and recovery more difficult. For instance, GnRH agonists, such as leuprolide and goserelin, initially cause a surge in testosterone but lead to a sharp decline by suppressing the hypothalamic-pituitary-gonadal axis. GnRH antagonists, such as degarelix, reduce testosterone even more rapidly, bypassing the initial hormonal surge. Medications like abiraterone, an antiandrogen medication, inhibit key enzymes required for testosterone production altogether, creating a profoundly low-androgen state. In these scenarios, athletes may experience slowed muscle growth, increased fat mass, reduced endurance, and prolonged recovery times, all of which can negatively affect performance. Additionally, anti-androgens such as bicalutamide or spironolactone work by blocking testosterone at a cellular level, limiting its availability to stimulate muscle repair. In these scenarios, when testosterone is suppressed or blocked, muscle growth slows down, fat tends to accumulate, and strength and endurance decline. For athletes, this hormonal shift can make gaining muscle or recovering after workouts much more difficult.

This is where collaboration between the sports pharmacist and the dietitian becomes invaluable. Pharmacists and dietitians can team up by looking at lab results together and connecting the dots between medication effects and nutrition needs. Let's say Anna has low hemoglobin. The pharmacist knows that oral contraceptives can deplete folate, while the dietitian spots low folate foods in the diet. Together, they add leafy greens, legumes, and a supplement that works with the medication. Suppose magnesium is borderline low and the athlete is cramping. In that case, the pharmacist checks for other medications that deplete magnesium, and the dietitian recommends pumpkin seeds, spinach, or a magnesium supplement such as magnesium glycinate. Now, how about low zinc? The pharmacist considers whether her COC is part of the problem, and the dietitian adds foods like oysters or lean beef. With the ability to review and interpret labs, the pharmacist brings the medication expertise and the dietitian turns it into a unique performance-focused nutrition plan.

The Overlooked Role of Medications in Muscle Growth

While many medications are prescribed to reduce inflammation, manage chronic conditions, or support mental health, their unintended impact on muscle development is often overlooked in athletic care. For instance, long-term use of corticosteroids such as prednisone, commonly prescribed for autoimmune conditions or inflammatory flare-ups, can lead to muscle catabolism, fat redistribution, and bone demineralization. These effects make it significantly more challenging for athletes to gain or maintain muscle mass, particularly when training intensity is high or during the recovery from injury.

Mental health is critical to address in athletes, and thus, psychiatric medications also deserve attention. Certain antipsychotics and antidepressants can raise prolactin levels, which may suppress testosterone production as a side effect. This hormonal disruption can blunt an athlete's ability to build muscle and recover effectively and might even add another obstacle to an athlete's mental health. But having this open discussion and a game plan with the athlete, prescriber, pharmacist, and dietician can mitigate.

Metabolic medications like metformin or semaglutide, frequently used in diabetes management and polycystic ovarian syndrome (PCOS), can subtly impact anabolic hormones and energy availability, two critical factors in optimizing strength gains. Metformin can make it difficult to absorb vitamin B12 from food. It changes how the gut works and can interfere with the normal process your body uses to take in B12. Over time, this can cause a vitamin B12 deficiency. B12 is essential for nerve health and red blood cell production. This can cause fatigue and weakness. Similarly, treatments for rare conditions such as acromegaly (excess growth hormone), which work by reducing insulin-like growth factor 1 (IGF-1), can also reduce the body's capacity for muscle synthesis. As for semaglutide, a medication in the GLP-1 class, has its effects to suppress appetite which can unintentionally lead to reduction in overall food intake including protein. Since protein is essential for preserving muscle mass, especially during weight loss, not consciously monitoring protein intake may result in muscle loss.

This is where the partnership between the sports pharmacist and dietitian becomes vital. The pharmacist identifies medications with catabolic or hormone-suppressing effects and collaborates closely with the medical team to monitor and adjust treatment as needed. At the same time, the dietitian can tailor nutrition strategies to support muscle retention, such as prioritizing adequate protein, creatine, and anti-inflammatory nutrients, or adjusting energy intake based on metabolic changes.

Psychological Implications

Athletic performance is as much a mental game as it is a physical one. For professional athletes, hormonal fluctuations and medication use can significantly influence mood, motivation, focus, and overall mental well-being. In female athletes, the menstrual cycle brings natural hormonal changes that can affect psychological states. The late luteal and early menstrual phases often coincide with increased irritability, mood swings, sleep disturbances, fatigue, and heightened perception of effort[3]. These symptoms can un-

dermine motivation, concentration, and confidence, making it challenging to maintain peak performance, especially during competitions or intense training blocks.

Hormonal contraceptives, used by nearly 50% of elite female athletes to manage cycle-related symptoms, add another layer of complexity[8]. While they regulate menstrual symptoms, specific formulations have been linked to increased risks of depressive symptoms, anxiety, and emotional blunting in some women[2]. This emotional impact can reduce training adherence and affect an athlete's ability to cope with the psychological demands of sport. Beyond hormonal contraceptives, corticosteroids can cause mood swings, anxiety, and even depressive symptoms when used long-term or at high doses. Statins, for hypercholesterolemia, lower cholesterol by blocking Co-enzyme Q10 and vitamin K2 and are known to cause fatigue and muscle weakness, but some users also report cognitive fog and low mood. Lower vitamin K2 may impact how the body handles calcium, which is vital for bone and health. Antidepressants, though essential for mental health, sometimes have side effects such as fatigue, emotional blunting, or decreased motivation, factors that athletes must carefully manage. Finally, beta-blockers, used for cardiovascular conditions or anxiety, can blunt physical response and reduce exercise capacity, which may indirectly impact mood and motivation.

For male athletes, medications that suppress testosterone or endocrine therapies can trigger mood disturbances, including irritability, depression, and decreased libido. Reduced testosterone not only impairs muscle growth but also diminishes the mental drive essential for rigorous training and competition. Addressing these psychological effects is critical, and sports pharmacists play a vital role.

Treatment Considerations/Challenges

Managing muscle hypertrophy in athletes, especially female athletes, requires a coordinated, interdisciplinary approach. The complex interactions between the menstrual cycle, hormonal contraceptives, and muscle recovery necessitate collaboration among sports pharmacists, dietitians, physicians, and mental health professionals to support athletes in training, competition, and recovery, with long-term health considerations in mind.

A key first step is hormonal monitoring and contraceptive selection. Assessing menstrual health and hormone profiles helps identify issues affecting muscle adaptation. When contraceptives are necessary, choosing those with minimal impact on muscle metabolism and mood, such as low-androgenic progestins, is critical [2]. Sports pharmacists guide medication choices, dosing, and monitor side effects or drug-nutrient interactions. Training periods should align with hormonal fluctuations. Higher intensity and hypertrophy-focused workouts are best during the follicular phase when anabolic hormones peak, while the luteal phase calls for recovery-focused training to reduce fatigue and injury risk[3]. Of course, nutrition must also be tailored to optimize protein intake, micronutrients such as vitamin D and magnesium, and adjust macronutrients according to hormonal cycles to support muscle synthesis and mood stability[4].

Selective androgen receptor modulators, commonly called SARMs and testosterone replacement therapy, as known as TRT, are sometimes prescribed under medical supervision to address low testosterone levels in men, which can enhance muscle protein synthesis, strength, and hypertrophy[2]. Similarly, growth hormone and IGF-1 have anabolic effects that promote muscle repair and increase muscle fiber size. However, their use is strictly regulated due to potential health risks and anti-doping rules.

Additionally, anti-inflammatory medications such as NSAIDs can help reduce exercise-induced inflammation, improving recovery times and enabling athletes to train more consistently. However, their long-term use should be carefully monitored to avoid impairing muscle regeneration. Medications, such as beta-2 agonists (e.g., clenbuterol), have been shown to have muscle-building properties by increasing protein synthesis and fat breakdown;

Creating the right support system for athletes means truly understanding how menstrual health, nutrition, medications, and muscle recovery are all connected.

Together, they maintained close communication and crafted a nutrition strategy and medication regimen for Anna. Ultimately able to fine-tune her regimen and tailor interventions.

however, they are listed on the World Anti-doping Agency Prohibited List.

Sports pharmacists play a crucial role in helping athletes navigate these options safely, ensuring medications are used appropriately, comply with anti-doping policies, and align with individual health needs. By collaborating with dietitians and medical teams, sports pharmacists help optimize medication use to complement nutrition and training, supporting the athlete's muscle growth goals responsibly and effectively.

Challenges Managing Muscle Recovery in Athletes

Sports pharmacists often face barriers to fully integrating into athletic care teams. Despite their expertise in medication management and anti-doping compliance, their role is still emerging, and gaining full recognition among coaches, trainers, and medical staff can be a slow process. Building trust and demonstrating clear value through collaboration is essential, but it takes time.

The pressure on athletes to perform consistently at high levels can push them to overlook or downplay recovery needs, further complicating treatment. Managing muscle recovery successfully requires ongoing communication, personalized care, and a collaborative approach that involves pharmacists, dietitians, mental health professionals, and coaches working together to support the entire athlete.

Building a Better Support Network

Creating the right support system for athletes means truly understanding how menstrual health, nutrition, medications, and muscle recovery are all connected. It takes an interdisciplinary team to provide care that's tailored to each athlete's unique needs. Anna, our weight-lifter, who started taking oral contraceptives, noticed her strength gains plateaued and she was feeling more fatigued. Recognizing these concerns, the pharmacist conducted a thorough medication review and ordered labs and changed the formulation. The dietician reviewed Anna's dietary intake and identified inadequate consumption. These two providers both reviewed the lab results with their specialized lenses. Together, they maintained close communication and crafted a nutrition strategy and medication regimen for Anna. Ultimately able to fine-tune her regimen and tailor interventions. A few months later, the pharmacist and dietician read an article that their patient won FIRST PLACE in a lifting competition! Yay!

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What Do Athletes Need to Know About Creatine?

By TrueSport

Most athletes have heard of creatine, but many also question its status under the anti-doping rules. Is creatine prohibited? Does creatine enhance performance? Athletes can find answers to these questions and more below.

What is creatine?

Creatine (*cree*-uh-*TEEN*) is a molecule stored in muscles that can help create energy. It is made naturally in the body from amino acids, and then a phosphate is added to the creatine molecule to create phosphocreatine. Phosphocreatine is the key component of the body's "immediate" energy system and provides enough energy for about 10 seconds of high intensity activity. Once the phosphocreatine in the muscles has been used up, the body must switch to a different energy system while more phosphocreatine is formed.

During repeated high-intensity efforts (such as team sport), the demand for phosphocreatine is greater than the supply, and this limits physical performance. Theoretically, increasing the amount of creatine in your muscles will increase the speed at which phosphocreatine is formed between efforts and improve your overall performance.

Where can I get creatine?

Creatine is produced naturally in the liver, and is also present in many foods, including milk, fish and mollusks, and red and white meat.

Creatine is also available as a supplement and is often used by athletes during a specific period of training. Most supplementation protocols consist of a loading phase lasting approximately one week, followed by a maintenance phase. Some research suggests better uptake when creatine is consumed with protein and/or carbohydrates.

Is creatine performance enhancing?

Consuming creatine, either in foods or supplements, can increase muscle creatine stores. Research has also shown that with the right training, creatine loading can enhance an athlete's ability to perform tasks that require short bursts of power (less than 30 seconds in duration). However, not all athletes benefit from creatine since the training program itself remains the key component of success.

Is there a medical use for creatine?

Yes, there are some rare conditions of creatine deficiency that may require additional creatine through diet or over-the-counter medications.

Is creatine prohibited?

No, creatine is not prohibited. Although creatine can have a small effect on performance, the effects are not guaranteed and the specific training program remains most influential.

Are creatine supplements safe?

To date, no long-term health risks have been reported with extended use (up to four years), however, some people report short-term water retention and decreased urinary volume, resulting in bloating and temporary weight gain (2 -5 pounds). In addition, a potentially increased risk of compartment syndrome and muscle cramps has been reported.

In terms of anti-doping risks, athletes should be careful about using creatine supplements because all supplements come with some level of risk due to the post-market regulatory process, which means that products contaminated with banned substances make it onto store shelves. Before using any dietary supplement, please read more about the risks of using supplements and take note of USADA's recommendation for third-party certified supplements.

More questions?

For questions about specific products, substances, and methods, contact USADA's Drug Reference Line at drugreference@USADA.org or call (719) 785-2000, option 2.

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AUTHOR BIO:

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Why Personalised Wellness Outperforms the Standard

By Dickie Okochi, Pharmacist

AUTHOR BIO:

Dickie Okochi is a practicing pharmacist and founder of Capsule Consultants, a service that supports athletes and high performers with evidence-based guidance on medication, supplements and precision tools like blood and genetic testing. With a Master's in Pharmacy from the University of Lincoln and experience across both primary and secondary care, Dickie combines clinical expertise with personal athletic insight- having represented the university's first team in football and currently competing as an amateur boxer. He holds a Certificate in Drugs in Sport from the International Olympic Committee, bringing a unique, athlete centred perspective to performance and recovery.

There are hundreds of millions of athletes in the world, from weekend warriors to elite Olympians. For every sport there is to participate in, there are a set of repeated movements performed by muscles to excel. This could be throwing consistent straight shots as a boxer or repeatedly making full use of the shoulders range of motion when performing a backstroke as a swimmer. When training across most sports, the standard approach is widely accepted and used as a guideline for programs. This entails training 2-3 times a week for general muscle conditioning, making sure you get at least 8 hours of sleep every night, and having a balanced diet with enough protein, carbohydrates and vegetables.

However, the success stories from world champions all include having their own personalised plan that helped to get the best out of them. These plans take into consideration the type of sports they compete in, their lifestyle, genetic advantages, such as the length of their limbs and more. Recognising the power of tailored improvements is what makes personalised wellness outperform standard approaches for muscle health.

In this article we are going to look at 5 ways in which personalized wellness plans can enhance athlete outcomes and pragmatic ways they can be implemented by a sports medicine professional.

Targeted Nutrient Support

Athletes need the right amount of protein to support muscle growth and maintenance.[1]

Muscles also play a role as a metabolic engine. They not only burns more calories at rest than fat tissue, but they are also involved in the metabolism of other micronutrients such as the B-vitamins, as well as vitamins C and D.[2,3]

An example where targeted nutrients comes into play is when working with athletes following a strict vegan diet. They tend to be deficient in vitamin B12 (commonly found in meat and is crucial to nerve function and red blood cell formation) and iron (plant-based iron is not as readily absorbed compared to animal sources) [4]. In this context, supplementing with iron and vitamin B12 will give the micronutrient support that was lacking from the diet, leading to improved red blood cell production and nerve function.

Nutrients like Omega 3 and anti-oxidants reduce inflammation and oxidative stress after intense training [5,6]. Vitamin D and collagen strengthen connective tissue, and support immune response [7,8]. I would recommend combat athletes to take 1-3g of Omega 3 daily while athletes who spend a lot of time indoors take a very minimum of 1,000 International Units (IU) of Vitamin D with food, to maximise absorption.[9] Incorporating foods like bone broth, fish, and beef cuts with connective tissue will also help maintain higher collagen intake without having to purchase supplements. Whether the goal is to lose a few pounds to make it below a weight limit for a fight or trying to put on muscle mass to look beach ready, it is essential to adjust nutrient intake according to training goals. This ensures that the athlete meets their targets safely and effectively, while also maintaining strong, healthy and high-quality muscle tissue.

Customised Exercise Program

Getting a cyclist to mostly train their shoulders during a training camp is counterproductive to their goals as most of the work during a race is done with their legs. In the same manner, long distance runners focusing on power lifting exercises increase the energy demand if this leads to excessive muscle bulk, which in turn makes them less efficient when running

Many athletes have subclinical deficiencies that don't show obvious physical symptoms but can still reduce energy, endurance and recovery.

long distances. It is crucial to tailor training to the sport to achieve the best results. This can be taken a step further by personalising training towards biomechanical advantages and body composition. One needs to take into consideration limb length (i.e. longer vs. shorter legs) or differentiating fast-twitch and slow twitch muscle fibres. This is where having sports scientists and strength and conditioning experts supporting athletes is essential. They design programs that build strength, speed and resilience while monitoring workload, ensuring recovery and reducing injury risk leading to long term athletic development.

A customised exercise plan also helps to integrate nutrition and recovery needs that are specific to the athlete. Goal-oriented periodisation supports consistent improvements in strength and performance. Ensuring the athlete is in the best possible shape when it is time to compete.

Genetic and Biomarker Insights

DNA testing and blood work can reveal how a person reacts to strength training, inflammation, and muscle fatigue allowing for smarter interventions. A 2016 study of Turkish football players found that individuals with a variant of the MTHFR gene (a gene responsible for folate and homocysteine metabolism) had lower folate and Vitamin B12 levels but also higher homocysteine levels, which correlated with reduced aerobic and anaerobic thresholds[10]. To compensate, supplementing athletes with the active form (methylated) of folate and vitamin B12 can help reduce homocysteine levels and thus improve muscle repair, recovery and overall performance[11].

Blood biomarkers give real time information on how your body responds to training, hormone balance and nutrient status. For example, creatine kinase and hs-CRP are markers of muscle breakdown and inflammation. Constantly elevated levels for both can be an early sign of overtraining, even if the athlete does not experience fatigue or injury. With every athlete being very different, having this information at hand helps to know what readings are normal for the specific athlete. The data can not only help to adjust training but also recovery protocols to get the best out of the athlete.

Genetic and blood biomarker testing can also give insights on nutrient deficiencies. Many athletes have subclinical deficiencies that don't show obvious physical symptoms but can still reduce energy, endurance and recovery. For example, a runner with low iron may struggle with fatigue and shortness of breath while training before anaemia symptoms appear outside of practice. Other nutrients like Vitamin D, to muscle function and recovery. Testing for these nutrients confirms if they are at an optimal level for the athlete - not just "within range".

Below is a table comparing reference ranges for blood biomarkers in the general population compared to what would be considered optimal for an athlete.

Biomarker	Reference Range (adults 18yrs+) [12]	Athlete Optimal Target
Homocysteine	5-15 µmol/L	<10µmol/L [13]
Vitamin D (25-OH)	<25ngl/ml= deficiency 25-50ng/mll= suboptimal 50>ngl/ml = sufficient in most individuals	50-80nmol/L [14]
Vitamin C	26-85µmol/L	Roughly 50-80µmol/L especially around intense training and recovery [15]
Vitamin B12	197-771ng/L	400-700ng/L [16]
Ferritin	Males: 30-400µg/ml Females: 30-330µg/ml	65-150ng/ml[17, 18]

Being conscious of inherited weaknesses in nutrient processing or absorption coupled with knowing real time nutrient status allows for athletes to correct deficiencies that would otherwise limit muscle health, performance and recovery.

Injury Prevention & Recovery

A personalised approach factors in past injuries or biomechanical weaknesses. This supports better technique and reduces re-injury risk. Early in his career, Usain Bolt experienced a lot of injuries because he suffered from scoliosis. In a 2011 ESPN interview he revealed that he adapted his training to strengthen his back and his core[19]. He also had a massage therapist and chiropractor alongside him during training and competitions, who helped him reduce the number of injuries he suffered throughout the rest of his career.

It is not only the work he put in while training that allowed him to achieve his goals. Mindfulness beyond the gym played a key role in his progress.

Deep sleep also plays a key role in injury prevention and recovery. It is when growth hormones (essential for recovery and training adaptations) are released[20]. Since it can take several days to fully recover from intense sessions, quality sleep is the athlete's most powerful recovery tool. Quality sleep does not only mean sleeping for 8 hours everyday. Quality sleep entails sleep latency, how many awakenings one has at night, the amount of time you are awake after sleep onset, and sleep efficiency[21]. This can be measured by wearable technology e.g smart watches or hybrid shirt devices. The following questions can help athletes measure their quality of sleep.

Working smarter coupled with hard work will give you a competitive edge and your muscles will thank you for it not just now, but in the future.

1. Did you fall asleep within 30mins or less?
2. Did you wake up 1 time or less during the night?
3. In total were you awake for 20mins or less after falling asleep
4. Were you mostly asleep while in bed? (e.g. 7 out of 8 hours)

Answering "yes" to most of these questions means they are likely to have good sleep quality. If not, it is good to start adjusting habits during the day and before going to bed in order to improve sleep e.g. less blue light before going to bed, reducing caffeine intake during the day etc. This also highlights the significant impact sleep coaches bring to athlete health[21].

By allowing the body the time and space it needs to recover, true performance enhancing adaptations can take place [20]. Hydration, individualised sleep and stress management were all major contributing factors to Usain Bolt's recovery and adaptation to his scoliosis. The adjustments he made eventually led him to become the greatest sprinter of all time. This sort of conscious effort and decision making is paramount to sustaining healthy muscles and maximising performance.

Behavioural and Lifestyle Alignment

While it is important to look at the science and numbers when personalising wellness, a crucial and overlooked aspect of this is adjusting to an athlete's daily habits, mindset, motivation, and stress patterns. Doing this offers a significant edge over standard training, protocols by addressing real world factors that influence performance and recovery.

The most robust training and nutrition plans fail if the athlete does not follow them. For example, adjusting training times to match an athlete's natural energy rhythm elevates the quality and consistency of the training. Tailoring motivation strategies has an impact on mental resilience. Some athletes thrive from visualisations and social accountability while others benefit on data and metrics. Nutrition, training and stress management plans built around work, travel, or school demands are essential to prevent injuries by skipping warm up or overtraining when fatigued. This behavioural alignment strengthens adherence which helps to create sustainable long-term results.

Here is an example of a client that I had. He is a professional boxer who still worked full time as a scaffolder. He presented with complaints including difficulty sleeping as well difficulty maintaining focus and energy during the day and when he is training. I decided he needed a sports blood profile to get an idea of what is happening internally. I also gave him a detailed questionnaire to fill out for me to get an idea of his diet, lifestyle, eating and sleeping habits, full medical history. but also his goals and what he wants to achieve from boxing; win his next fight and winning major titles. The questionnaire helps to give context to the blood profile. When the whole process was finished I discovered the following. He slept on average 5 hours a night, his ferritin was 30µg/ml and he had difficulty finishing meals. It was evident that his lack of sleep and difficulty in finishing meals was due to his high caffeine intake. He drank around 6 cups of coffee a day, with the last few cups in the evenings closer to bedtime. Caffeine can not only keep you awake but also curbs appetite, which in turn explains him not finishing meals. I advised him to reduce the coffee intake by at least half and to make sure he did not drink any coffee after 3pm. I also advised him to take in more red meat (he really appreciated that), in order to help improve the iron stores without the need of taking supplements.

Three months later, we went through the whole process and found the following results: his ferritin was 60µg/ml(not yet in the optimal range but an improvements from before), he sleeps 7 hours a day, and is a lot more focussed when he is training. Most importantly, personalising his health and wellness helped him to feel better. He not only has reached his goal to defeat his next opponent, but he did it in a manner which got him signed with an international promoter. He is well on his way to winning titles in the sport.

Conclusion

As athletes and support personnel, your plan needs to evolve as you develop in your craft. Working smarter coupled with hard work will give you a competitive edge and your muscles will thank you for it not just now, but in the future. One size does not fit all (quite literally). So, it is important to understand what works and what doesn't to get the things you want from your muscles: resilient muscles that support your physical performance, metabolic health and long-term viability.

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