Sports Pharmacy

DECODING THE SCIENCE OF ELITE HUMAN PERFORMANCE

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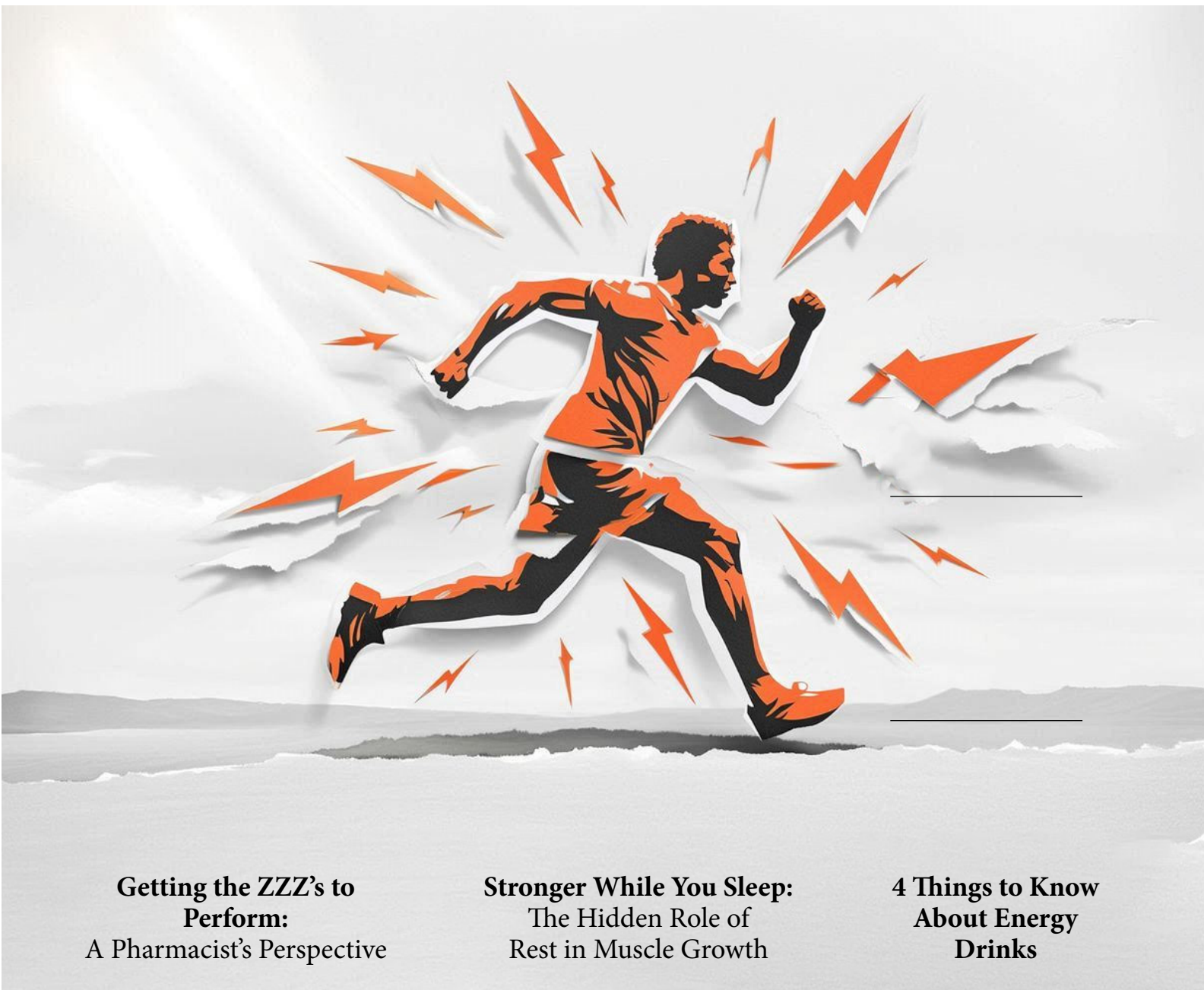

Getting the ZZZ's to Perform:
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Stronger While You Sleep:
The Hidden Role of Rest in Muscle Growth

4 Things to Know About Energy Drinks

MESSAGE FROM THE EDITOR

As we wrap up an exciting fall season, Sports Pharmacy Magazine continues to build momentum around one of the most dynamic topics in our field, energy.

Following the success of our Energy Drinks and Prework Symposium in October, this issue explores how athletes generate, sustain, and restore energy.

You'll find timely discussions on the role of caffeine and other stimulants in performance, as well as evidence-based insights on how sleep, recovery, and rest cycles impact endurance and muscle growth. Together, these articles highlight the balance between fueling performance and supporting long-term health, a balance pharmacists are uniquely positioned to guide.

And in other exciting news, registration for the Sports Pharmacy Summit is live! We look forward to bringing our community together once again to share knowledge, advance the practice, and shape the future of sports pharmacy.

As we head into the holiday season, I hope you take time to recharge and enjoy moments of rest and recovery with family and friends. Just as athletes depend on recovery to perform at their best, we too benefit from slowing down and resetting. Here's to entering the new year restored, focused, and full of energy for all that's ahead.

Thank you for your continued engagement and enthusiasm. Let's keep the energy high as we head into a new season of learning and growth.

Kristal Potter, PharmD
Editor-in-Chief, Sports Pharmacy Magazine
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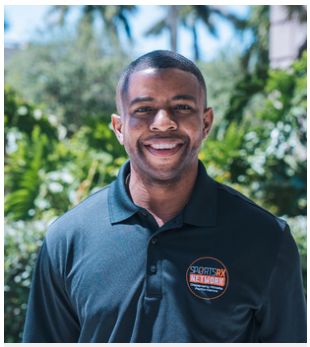
Meet the Team



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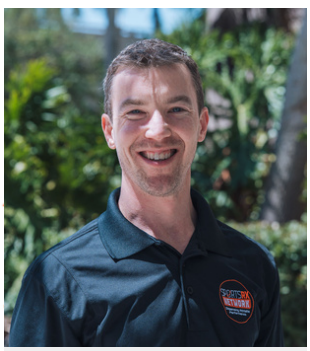

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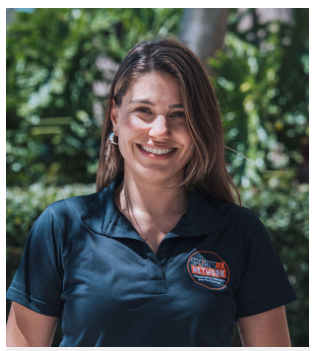

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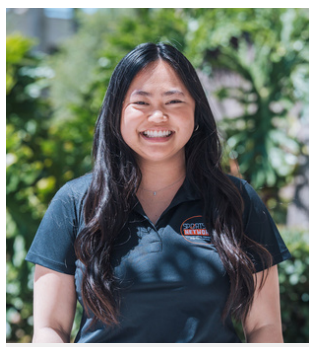

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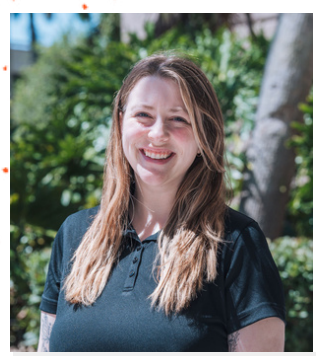

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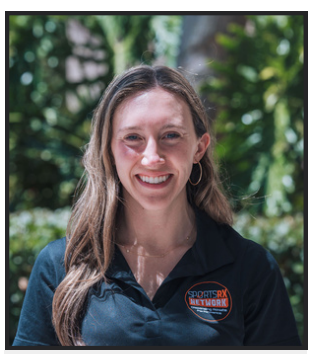

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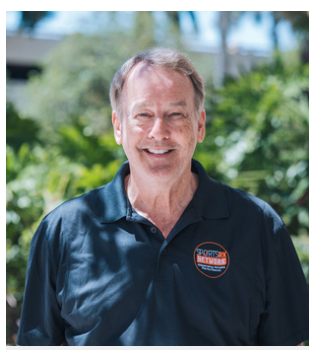

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SPORTSRXNETWORK
DISPENSING THE SCIENCE OF ELITE HUMAN PERFORMANCE

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DISPENSING THE SCIENCE OF ELITE HUMAN PERFORMANCE

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Exploring Sports Pharmacy

If you're curious about sports pharmacy, the Sports Pharmacy Network is the perfect place to start. Our network brings together a diverse array of professionals, from clinical pharmacists specializing in sports medicine, athletic trainers and dietitians, to athletes seeking optimal health solutions. Join us at the Sports Pharmacy Network and elevate your knowledge and performance in the realm of sports pharmacy.

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Clinical Case: Energy Overload

By Alexis Shook, PharmD, Director of Clinical Education

AUTHOR BIO:

Dr. Alexis Shook is a Clinical Pharmacist Practitioner at UNC Campus Health Services, PGY1 Community-based Pharmacy Residency Site Coordinator, and Assistant Adjunct Professor for the UNC Eshelman School of Pharmacy. She attended undergrad at UNC – Chapel Hill and pharmacy school at the UNC Eshelman School of Pharmacy. Alexis completed both the PGY1 Community-based Pharmacy Residency Program and Community-based Mental Health Fellowship through UNC at the Campus Health site, then stayed on for a full time position. Clinical areas of interest include mental health, asthma, sports medicine, and contraception. In her free time she loves to spend time with her husband, puppy, and cats, reading anything she can get her hands on, watching sports, and traveling as much as she can.

CC: "I'm so jittery, my heart is racing, and I've been feeling exhausted after workouts."

HPI: HS is a 21-year-old male college baseball player who presents to the clinic with recent palpitations, increased fatigue, and occasional headaches over the past week. He especially notices a higher heart rate and lightheadedness during and after exercise. HS denies any chest pain or shortness of breath accompanying the palpitations/increased heart rate. Upon further questioning, he admits to consuming three energy drinks daily for the past few weeks to help him keep up with team responsibilities and the end of the academic semester. Each energy drink HS has been drinking is listed as containing 200mg of caffeine, but it also includes additional stimulants, such as taurine, guarana, and green tea extract.

PMH: No chronic illness

SH: 2-3 energy drinks a day, occasional vaping and nicotine pouch use, social drinking (3-4 beverages per weekend), denies illicit drug use.

FH: Father is diagnosed with hypertension, and Mother is diagnosed with ADHD. No family history of arrhythmia or sudden cardiac death in the family.

Current Medications:
Cetirizine as needed for seasonal allergies
Ibuprofen as needed for pain
Diphenhydramine as needed to help with sleep

Allergies:
NKDA

Physical Examination
General: Alert, mildly anxious
Vital Signs: BP: 148/92mmHg, HR 110 bpm, RR 18 breaths/min, Temp 98.6 F, SpO2 98% on room air
System-Specific Findings:
Abdomen, HEENT, Skin: No specific findings noted
Psychological: Restlessness
Cardiovascular: Tachycardic, regular rhythm, no murmurs
Respiratory: Clear to auscultation bilaterally
Neurological: No focal deficits
Musculoskeletal: Mild muscle tenderness in the thighs and calves

Symptoms and Factors

Major Symptoms

Self-reported: Increased heart rate, palpitations, lightheadedness during and after exercise. Notes increased anxiety and stress with academic and athletic workload. Reports sleeping around 5 hours a night for the past few weeks

ROS: Positive for palpitations, fatigue, lightheadedness, anxiety, insomnia, and muscle soreness; all other negative.

Aggravating factors: Exercise, increased energy drink consumption, thinking about deadlines and exams

Easing factors: Time, hydration

Lab Values
SCr: 1.4 mg/dL
CK: 950 U/L (reference: <200 U/L)
Electrolytes: WNL
Troponin 1: WNL
TSH: WNL
Urine drug screen: Negative
ECG: Sinus tachycardia, no ischemic changes

Case Questions

1. After reviewing HS's lab results, you notice that his creatine kinase (CK) level is almost 5 times the reference level. What part of HS's presentation could contribute to this lab abnormality? *(Select all that apply.)*

A. Dehydration from an increase in caffeine intake
B. Recent sleeping difficulty
C. High blood pressure reading
D. Frequent exercise

All of the above could contribute to the increased CK levels seen. With increased levels of caffeine being consumed daily, this can work as a diuretic in the body, and if not correctly supplemented with increased fluid intake, can lead to dehydration, reduced blood volume, and increased CK. Difficulty with sleep can also increase CK levels, due to the negative impact on muscle tissue, as sleep is usually a time for muscle recovery and repair. Increased blood pressure has also been linked with increased CK levels. Although the full mechanism is unclear, altered contractility of the heart muscles that can happen with long-term increases in blood pressure may be the cause. Frequent and intensive exercise can easily increase CK levels, which is generally a marker of muscle fatigue and stress.

2. As an NCAA athlete, HS asks if his increased caffeine consumption could be risky if he is screened for a drug test during competition. What would be an appropriate response?

A. Because WADA does not have a set maximum level of caffeine that an athlete can have in their system in or out of competition, HS would not be at risk
B. The NCAA limits athletes to a caffeine concentration of less than 15 mcg/mL for competition. HS should be careful with his consumption before events due to this protocol
C. There are no limitations from any anti-doping agency on caffeine use in athletes
D. USADA limits athletes to a caffeine concentration of less than 15 mcg/mL for competition. HS should be careful with his consumption before events due to this protocol

The correct answer is (B). WADA and USADA do not currently list any restrictions for caffeine in athletes, although they are monitoring this. The NCAA does limit athletes to a caffeine concentration of less than 15 mcg/mL for competition. This is roughly equivalent to consuming 500mg of caffeine 2-3 hours before an event for most people. It is essential to know that every person metabolizes caffeine differently, which could impact the amount of caffeine that it would take for an individual to meet the prohibited level. Energy drinks can contain up to 420mg of caffeine per can depending on the brand, and can also contain additives such as taurine and guarana, which can add to the total caffeine content of the beverage often without being listed. Because HS consumes multiple energy drinks daily, he should be concerned about possibly exceeding the NCAA threshold, which can result in a penalty of up to a year's suspension.

3. After discussing the importance of decreasing caffeine intake, increasing hydration, and focusing on a well-balanced diet to help manage energy and stress levels, HS asks if there are other changes he can make to help with his sleep difficulties. What would you recommend? (Select all that apply.)

A. No changes needed at this time
B. Institute good sleep hygiene
C. Stop using diphenhydramine for sleep initiation
D. Increase the intensity of exercise so he is more tired at the end of the day.

The correct answers are (B,C). In this case, we want to make sure that HS is working on sleep hygiene, and when possible, trying to stay on a set sleeping schedule. Making sure that he has set up his bedroom as a calm, dark, and quiet space conducive to sleep is a critical step. Making sure he limits screen time before bed and eliminating distracting noises or interruptions before sleep can also be helpful. Limiting caffeine use later in the day helps break the cycle of caffeine interrupting sleep. Sleep disruption due to caffeine consumption can lead to continued or increased caffeine intake the following day in an attempt to overpower fatigue. Stopping diphenhydramine as a sleep aid will also help get HS to a better sleep schedule overall. Long-term use of diphenhydramine for sleep is not recommended and has been linked to health impacts over time, including increased risk for dementia. At this time, we would not want to recommend increased exercise based on HS's elevated CK levels, and we prefer to find a more sustainable and long-term plan for sleep improvement.

Energy Drink Tips for Athletes	
Hydration	• Pair with water or electrolyte solution to stay hydrated • Choose options that support hydration (electrolytes, no excess sugar)
Timing	• Avoid using caffeine in the afternoon/evening to help limit sleep disruption • Don't make drastic changes the day of a big game/competition, find out what works for you during practices
Label Literacy	• Ensure athletes can read nutrition labels of energy drinks so they are cognizant of how much caffeine and other stimulating ingredients are included • Avoid products with "proprietary blends" or undisclosed caffeine levels
Additional Screenings	• If using caffeine to cover fatigue, consider screening for other conditions or a diagnosis that the caffeine is being used to self-treat
Choices	• Look for energy drinks that have chosen to be FDA-regulated as a food and not a dietary supplement • Look for NSF Certified for Sport or Informed-Sport logos if possible

4. Reviewing HS's medical history and presentation, besides reducing caffeine intake, which of the following would be appropriate counseling on how HS can help decrease feelings of anxiety, jitteriness, and increased heart rate that he has been experiencing?

A. Suggest that HS use an albuterol inhaler after exercise to help him maintain a normal respiratory rate
B. Ask that HS take acetaminophen for pain instead of ibuprofen, as this could be contributing to his anxiety
C. Help HS come up with a plan to limit the use of vaping and nicotine pouches
D. Only caffeine use is contributing to HS's symptoms, so no other guidance is needed

The correct answer is (C). When someone is consuming excess caffeine, make sure to assess other medications or supplements in their regimen that may also be stimulating. You would not want to add albuterol, as this may worsen anxiety and jitters, and there is no appropriate clinical indication in this case. Altering OTC pain medication selection would not have a meaningful impact on jitters or anxiety. Because nicotine is also a stimulant, limiting its use will help reduce increased heart rate, jitters, and anxiety. Nicotine can be consumed in a variety of forms, including cigarettes, vaping, chewing tobacco, and oral pouches. Working together with HS to find a way to limit or eliminate nicotine use will help reduce his symptoms.

5. HS plans to reduce his energy drink consumption, but feels that he still needs to consume caffeine to complete all his daily tasks. Which of the following would be an appropriate next step for HS? (Select all that apply).

A. Suggest that caffeine is okay in moderation, and that staying hydrated with water or electrolyte beverages during the day is also essential
B. Order additional labs for HS to check for nutrient depletion or other potential causes of fatigue
C. Consider screening for ADHD due to HS's positive family history and possible self-treatment for undiagnosed ADHD with caffeine and other stimulants (nicotine)
D. Consider screening for anxiety due to HS's symptom presentation if anxiety and jitteriness continue after a reduction in caffeine

All of the above are reasonable next steps! Stopping caffeine cold turkey can lead to headaches and other side effects, and caffeine is okay in moderation. Ensuring proper hydration with caffeine use is key. Drawing other labs to check for nutrient depletion could result in finding other explanations for fatigue, and allow for adequate supplementation through the diet or medications. Looking into other possible diagnoses for the symptoms and presentation of jitters and anxiety, such as ADHD and anxiety, would be reasonable. This could be done with a referral to sports psychology where assessment for anxiety and ADHD can be completed, then the pharmacist can help with medication management tailored to the patient if needed.

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Getting the ZZZ's to Perform:

A Pharmacist's Perspective

By Jake Ballagh, PharmD Candidate, Fatima Jaff, PharmD Candidate, Erin Dorval, PharmD

Jake Ballagh, PharmD Candidate

Originally from Buffalo, NY, Jake Ballagh played college hockey at SUNY Cortland before moving to FL to pursue his Doctor of Pharmacy degree at Palm Beach Atlantic University. With a passion for fitness and health & wellness, Jake is also deeply interested in oncology pharmacy and hopes to make an impact on both athletic performance and cancer care.

Fatima Jaff, PharmD Candidate

Fatima Jaff is a non-traditional Pharm.D. student at Palm Beach Atlantic University with a previous career and a master's degree in business. Her love for pharmacy and drug research has drawn her to the science behind sports performance. Jaff currently trains in resistance and weightlifting.

Erin Dorval, PharmD

Dr. Erin Dorval completed her Pharm.D. and PGY1 Community Pharmacy Residency at Albany College of Pharmacy in New York. As an associate professor at Palm Beach Atlantic University, she advises students in independent pharmacy, over-the-counter medications/ self-care conditions and disease prevention. Being an avid runner and yoga enthusiast, she counsels patients daily on ways to incorporate healthy lifestyle habits. Dorval is a member of the Sports Pharmacy Network and the US Sports Pharmacy Group.

Introduction

Sleep is a complicated process where the body is in an active state of unconsciousness. Although the purpose of sleep has yet to be fully understood, theories propose the necessity of sleep to benefit many activities of the body. [1] Sleep is a predictable pattern of phases, each offering specific benefits to the body's restoration process. The amount of sleep needed for an individual varies as they age, with most people needing at least seven hours of sleep per night. In the world of athletic performance, training intensity, nutrition, and recovery are often prioritized, with sleep being overlooked. For athletes, quality sleep is not just about rest. Sleep is a critical component of physical and mental recovery, muscle repair, cognitive function, and injury prevention. Poor sleep, whether due to shortened duration, fragmentation, or irregular schedules, compromise both physical and cognitive domains. Whether the athlete is a professional competitor or dedicated amateur, the hours spent asleep are just as important as the hours spent training. In this article, we'll explore how pharmacists can educate athletes on sleep and why prioritizing sleep is one of the powerful ways athletes can gain an edge on and off the field.

Understanding Sleep And Athletic Performance

Muscle Repair and Recovery

The deepest stages of sleep are when the body does most of its repair work. During this time, the brain signals the release of growth hormone, which rebuilds muscle, strengthens bones, and repairs tissues after intense exercise. When athletes don't get enough quality sleep this process is disrupted. Poor sleep increases inflammation and slows muscle recovery, making athletes feel sore for longer. Not sleeping enough can make it harder for muscles to refuel properly, leaving the body low on energy for the next workout. Over time, these effects can throw off the body's natural balance and increase the risk of overtraining and burnout. [2]

Cognitive and Physical Performance

Athletic performance is influenced as much by the mind as the body and sleep can play a vital role in optimizing both. Inadequate sleep slows reaction time, reduces focus, and impairs decision-making that can determine the outcome of a competition.[2] Even a single night of sleep loss can lead to measurable decreases in attention and accuracy, while prolonged restriction amplifies these effects by disrupting the brain's ability to consolidate new motor skills and maintain adaptability during training or gameplay. In contrast, sleep extension studies have shown that adding extra hours of rest can enhance speed, precision, and alertness, highlighting the direct performance benefits of sufficient recovery.[3] Although most research focuses on the negative effects of insufficient sleep, there is limited evidence that shows excessive sleep duration, defined as more than nine hours per night, may correlate with feelings of sluggishness or reduced alertness in individuals. However, these findings are inconsistent and

appear less relevant to athletes, who generally benefit from slightly longer sleep durations to support recovery and training adaptation. [2]

Sleep shapes endurance and perceived effort. Poor sleep elevates heart rate, breathing rate, and oxygen demand during physical activity, forcing the body to work harder to maintain normal intensity.[2] Athletes often describe their workouts as feeling more difficult after nights of poor rest, a perception that can accelerate fatigue and diminish consistency across training or competitions. Research has documented that restricted sleep decreases maximal oxygen uptake and time to exhaustion, while also impairing coordination and technical skills such as serve or sprint accuracy.[2]

What To Consider About Supplements For Sleep

Melatonin Use in Athletes

Ideally, athletes should first focus on sleep hygiene techniques to promote sleep as described in Table 1. If these approaches are ineffective, melatonin supplementation can be considered. Melatonin is a hormone naturally produced by the pineal gland that plays a key role in regulating the body's circadian rhythm and sleep-wake cycle. Athletes who frequently travel across time zones, compete at irregular hours, or have a hard time falling asleep, supplementing with melatonin can be a tool to help realign the body's internal clock and improve sleep quality.

Start with the lowest effective dose (0.5 – 3 mg) taken 1–2 hours before the desired bedtime. Dosing and timing should be individualized, as taking melatonin too late or in excessive amounts can impair daytime alertness, cognitive performance, and natural sleep patterns. Studies show melatonin can improve sleep quality, reduce jet lag symptoms, and enhance recovery. [4] Melatonin supplementation at the correct time and correct dosage can be an option for athletes to offset negative performance associated with travel or to improve sleep quality.[5]

Herbal Supplement Use

Valerian and chamomile are two herbal supplements for improving sleep and reducing anxiety, but there is mixed evidence regarding the efficacy of these products.[6] Valerian root appears to exert mild sedative effects by increasing levels of gamma-aminobutyric acid (GABA), promoting relaxation and shortening the time it takes to fall asleep. [7] A meta-analysis of randomized controlled trials found that valerian was associated with modest improvements in sleep quality, with few reported side effects, making it generally well tolerated even with long-term use.[7] Valerian is taken orally in capsules or tablets ranging from 400 - 900mg, but other formulations such as liquid extracts and teas exist.[7] Chamomile is consumed as tea or extract and contains apigenin, a flavonoid that binds to GABA receptors and produces calming effects.[8] Research suggests chamomile can improve subjective sleep quality and reduce mild anxiety. However, results on objective sleep measures like sleep latency and total sleep time are mixed and

inconclusive.[9] Both supplements are considered safe for most individuals when used appropriately, but their effects can vary depending on dose, formulation, and individual response. For athletes, valerian and chamomile may serve as helpful short-term adjunct to good sleep hygiene practices, particularly in managing pre-sleep anxiety or occasional insomnia.[8]

Prescription Sleep Medications in Athletes

Prescription sleep medications may be considered in athletes when nonpharmacological strategies or supplement use are insufficient to address sleep disturbances. Agents such as zolpidem (Ambien), eszopiclone (Lunesta), and temazepam (Restoril) act by enhancing GABA activity to promote sleep onset and maintenance, while trazodone modulates serotonin pathways and may be useful for sleep continuity. These medications should be used cautiously and under medical supervision, as prolonged or improper use can lead to dependence, tolerance, next-day sedation, and impaired cognitive or motor performance, which all compromise athletic safety and outcomes. Athletes should only take these medications when they can obtain at least eight hours of uninterrupted sleep to minimize residual effects. Because of potential risks, prescription sleep aids are best reserved for short-term or situational use, such as periods of jet lag or acute insomnia, and should be incorporated into a comprehensive, individualized sleep management plan.[10]

Antidoping Regulations

Although prescription sleep medications and over-the-counter herbal supplements are not included on the 2025 WADA Prohibited List, they should be used with caution due to their potential to impair cognition, alter recovery, or be misused. Additionally, OTC products may contain hidden ingredients that breach WADA regulations. Athletes prescribed or considering sleep aids should consult a pharmacist or physician prior to use to avoid compliance or safety issues. [11]

Sleep Considerations For Athletes

Impact of Travel and Jet Lag on Sleep

Travel and jet lag can significantly disrupt an athlete's sleep and performance by throwing off their internal body clock. One effective strategy to combat this is strategic light exposure. Seeking morning light and avoiding evening light when traveling east and doing the opposite traveling west can help reset circadian rhythms.[12] Digital tools such as Timeshifter Jet Lag® app can help athletes plan personalized light exposure and sleep schedules to minimize jet lag. Another strategy when traveling through different time zones is adjusting sleep and mealtimes a few days before travel. This prepares the body for the new time zone and reduces jet lag symptoms such as fatigue and digestive discomfort.[5] By combining these approaches, with or without melatonin supplementation, athletes can better align their bodies with new environments, allowing them to recover faster, sleep better, and perform at their peak despite the challenges of travel.

Stress and Sleep

Many psychological factors, including anxiety and stress, play a role in sleep quality. Elevated stress levels activate the hypothalamic-pituitary-adrenal (HPA) axis, increasing cortisol production, delaying sleep onset and reducing overall sleep duration and quality.[13] These disturbances not only impair recovery but negatively affect cognitive function, reaction time, and overall performance. Practical approaches that have been shown to reduce anxiety-related sleep disruption and manage stress include mindfulness meditation or deep breathing exercises.[13] Sauna bathing has shown lower stress levels by reducing sympathetic nervous system activity, promoting muscle relaxation, and enhancing parasympathetic tone, which support improved sleep onset and quality.[14] Incorporating these techniques into a regular recovery routine, athletes can regulate their stress response, support consistent sleep patterns, and ultimately enhance their physical recovery and performance.

Nutrition and Hydration's Role in Sleep

Proper nutrition and hydration play a crucial role in promoting quality sleep and supporting athletic performance. Research shows that diets rich in whole, minimally processed foods such as fruits, vegetables, whole grains, along with adequate protein intake and healthy fats were consistently linked to better sleep quality. On the other hand, diets high in processed foods and added sugars were associated with more frequent sleep disturbances.[15] Maintaining adequate hydration is important as dehydration can disrupt thermoregulation and increase sympathetic activity, making it harder to fall asleep. Research shows that individuals who stay well-hydrated tend to experience higher sleep efficiency and spend more time in restorative deep sleep compared to those who are not properly hydrated. Even mild dehydration has shown to delay sleep onset and decrease sleep quality, highlighting the importance of consistent fluid intake throughout the day.[16] For athletes, focusing on balanced nutrition and proper hydration are key factors that contribute to sleep quality, recovery, and performance.

Sleep Hygiene Techniques - Nonpharmacological treatment options

No matter the type of athlete or the sleep issue, educating the individual on techniques to promote sleep without the use of supplements or medications is a simple way to encourage quality sleep. Highlights education that can be provided to athletes for good sleep hygiene.

Table 1 [17, 18, 19]

Sleep Hygiene Technique	Education explained
Sleep on average 7-9 hours per night	The amount of sleep may increase depending on training or competition, and type of sport.
Encourage daytime naps when necessary	As an athlete's schedule changes, naps may be needed to offset insufficient nighttime sleep and boost alertness.
Avoid stimulants (e.g., caffeine)	Stimulants can increase the time it takes to fall asleep and decrease sleep duration, efficiency, and quality. Avoid consumption too close to bedtime.
Avoid alcohol	Alcohol can disrupt sleep quality and cause frequent awakenings. Recommended to avoid consumption before bedtime.
Avoid heavy meals close to bedtime	Try to eat meals that are higher in carbohydrates 3-4 hours before bedtime to reduce the time to fall asleep.
Get adequate natural light in the morning	When athletes travel through time zones, exposure to morning light and limiting nighttime light exposure can help support their circadian rhythm.
Incorporate a relaxing bedtime routine	This helps prepare the body for bed making it easier to fall asleep.
Create a sleep environment that promotes sleep (e.g., dark room, cool temperature, quiet)	To minimize noise, athletes can wear noise-canceling earphones or earplugs. Light can disrupt the circadian rhythm so athletes can use blackout curtains or eye masks to control or block the light when sleeping.
Adjust sleep and training according to chronotype	When possible, avoid training too early in the morning or too late at night to allow for ample sleep and recovery.
Bank sleep when necessary	Getting more sleep prior to a competition may reduce anxiety or stress and improve confidence or mood. Banking sleep can be used 1 week before a competition.
Incorporate mindfulness, meditation, or deep breathing techniques	These techniques can help to reduce athletes' stress response and promote consistent sleep patterns
Limit blue-light exposure at night	Avoid blue light emitted from screens or devices at least 2 hours before bed as blue light can suppress melatonin production that is needed to induce sleep.
Create a consistent sleep-wake schedule	This provides a consistent routine for the body and allows for maintenance of the circadian rhythm.

Pharmacist's Role In Sleep Hygiene For Athletes

Identifying & Assessing Sleep Issues

Identifying and addressing sleep issues early is crucial for maintaining peak performance and overall health in athletes. Pharmacists, when incorporated into the athlete's team, can play a role in this process. By asking targeted questions about sleep and nighttime symptoms (e.g., loud snoring, frequent awakenings), as well as daytime behaviors (e.g., training, caffeine), pharmacists can identify warning signs of underlying conditions such as sleep apnea or chronic insomnia, while also uncovering lifestyle contributors that disrupt sleep. This can lead to timely referral to physicians or sleep specialists for a comprehensive plan.

Pharmacists can review an athlete's medication and supplement use to identify agents that contribute to insomnia or daytime sleepiness, and provide counseling on sleep hygiene and stress management.[20] Through proactive assessment, education, and collaboration with other healthcare professionals, pharmacists can help identify sleep issues early, guide athletes toward appropriate care, and play an important role in improving recovery, reducing injury risk, and supporting peak physical and mental performance.

OTC Sleeping Aids

Pharmacists can play a role in guiding athletes on safe and effective use of OTC sleep aids when lifestyle changes are insufficient. In addition to melatonin, valerian, and chamomile previously discussed, other OTC sleep aids containing antihistamines like diphenhydramine or doxylamine may help with short-term sleep difficulties. However, these products often cause next-day drowsiness, impaired coordination, or tolerance with repeated use, which negatively impact athletic performance. [21] Pharmacists are well positioned to guide athletes on when and how to use

OTC products safely. Most importantly, pharmacists can help integrate these tools into a broader plan that prioritizes sleep hygiene and recovery strategies, ensuring that any product used supports rather than hinders performance.

Medication Misuse

Another role for pharmacists is educating athletes about the misuse of sleep medications and supplements. Even when used with good intentions, improper dosing, frequent use, or reliance on these products can lead to tolerance, dependence, or withdrawal symptoms. Overuse of sleep aids may mask underlying sleep disorders that require medical evaluation, delaying proper diagnosis and treatment.[22] Pharmacists should also place emphasis on caffeine use as it is one of the most common stimulants athletes rely on for performance, focus, and training. Many athletes consume preworkout supplements or energy drinks, which can contain on average 150 - 300mg of caffeine or caffeine-like substances. Although caffeine can enhance cognitive function and performance, excessive intake or use later in the day can significantly delay sleep onset, reduce sleep quality, and shorten total sleep time. Educating athletes to limit afternoon and evening caffeine consumption, ideally avoiding it at least six hours before bedtime, can help protect sleep and optimize recovery.[23] Lastly, pharmacists must remind athletes that some sleep-related or performance supplements may contain banned substances or undisclosed ingredients and can assist the athlete by reviewing products for safety and appropriate use.

But first, Non-Pharm

It is very important for pharmacists to emphasize the importance of implementing nonpharmacological strategies as the first line for improving sleep before recommending medications or supplements. As discussed in Table 1, these techniques can significantly improve sleep quality. Incorporating relaxation techniques can help reduce pre-sleep anxiety and promote a smoother transition into rest. For athletes, additional strategies such as timing training sessions earlier in the day, avoiding heavy meals or stimulants close to bedtime, and using light exposure to regulate circadian rhythms can be particularly effective for athletic performance. Pharmacists are well positioned to educate athletes on these evidence-based techniques and tailor recommendations to their schedules and performance goals.

Conclusion

The importance of sleep goes well beyond simply feeling rested. Sleep is necessary for athletes striving to perform at their best and can impact many areas of athletic performance including muscle recovery and mental focus. Pharmacists have the ability as a member of the athlete's care team to promote safe and effective use of sleep aids when appropriate, ensure quality of the supplement, and provide education on sustainable techniques to promote sleep. Better sleep doesn't just mean better rest – it means better results.

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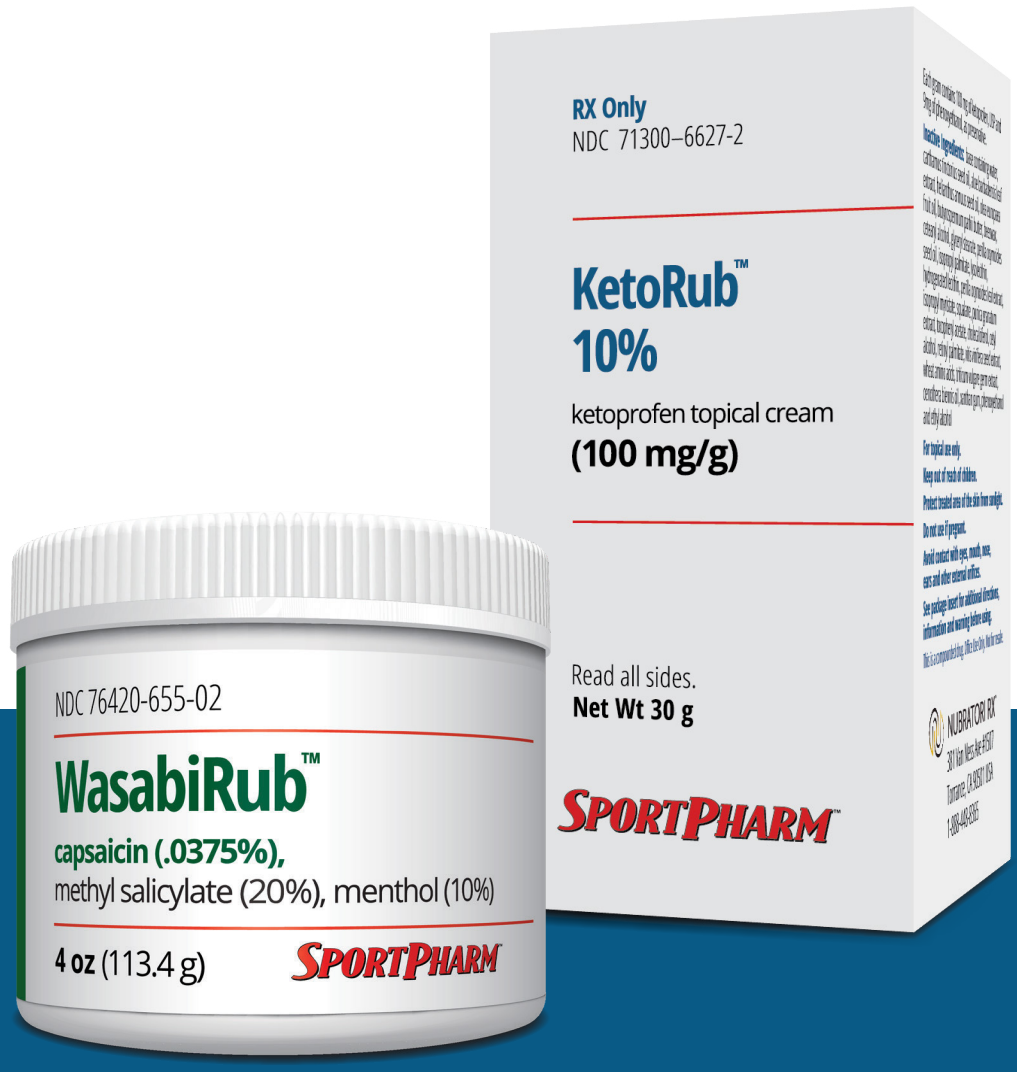

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Stronger While You Sleep:

The Hidden Role of Rest in Muscle Growth

By Bailey Harkins, PharmD Candidate

AUTHOR BIO:

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.

The Hidden Role of Rest in Muscle Growth

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. Prioritizing adequate and consistent rest enhances performance, accelerates recovery, and supports long-term muscle growth progress.[1,2,3,4]

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]

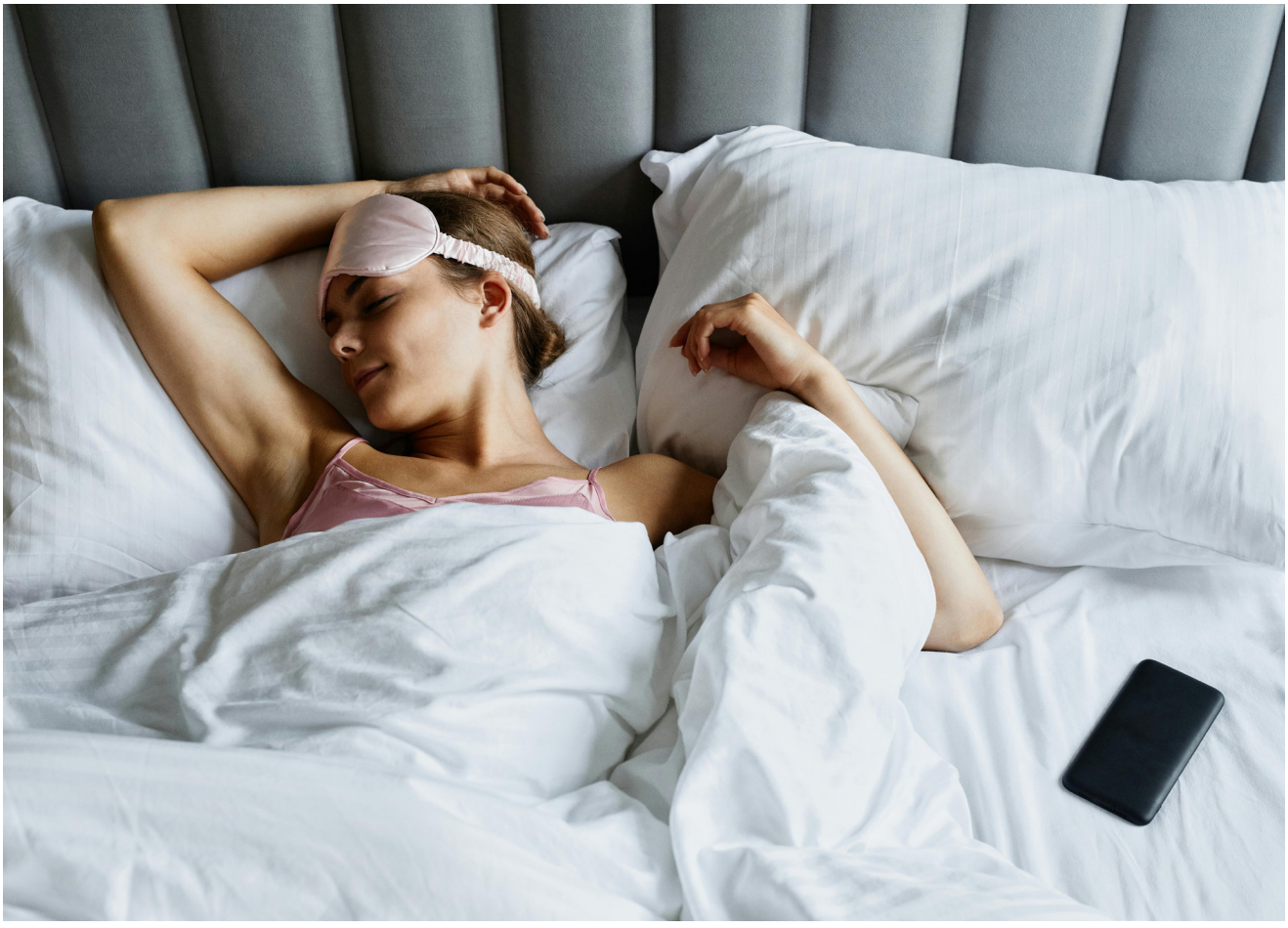
Together, GH and testosterone illustrate how sleep itself acts as a natural performance enhancer. For athletes, protecting deep and consolidated sleep is essential to maximize anabolic signaling and optimize training outcomes.

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 rapid 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 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 mus-

Sleep is not just downtime; it is the hidden variable that determines whether training and nutrition translate into actual growth.

cle 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 amplifies 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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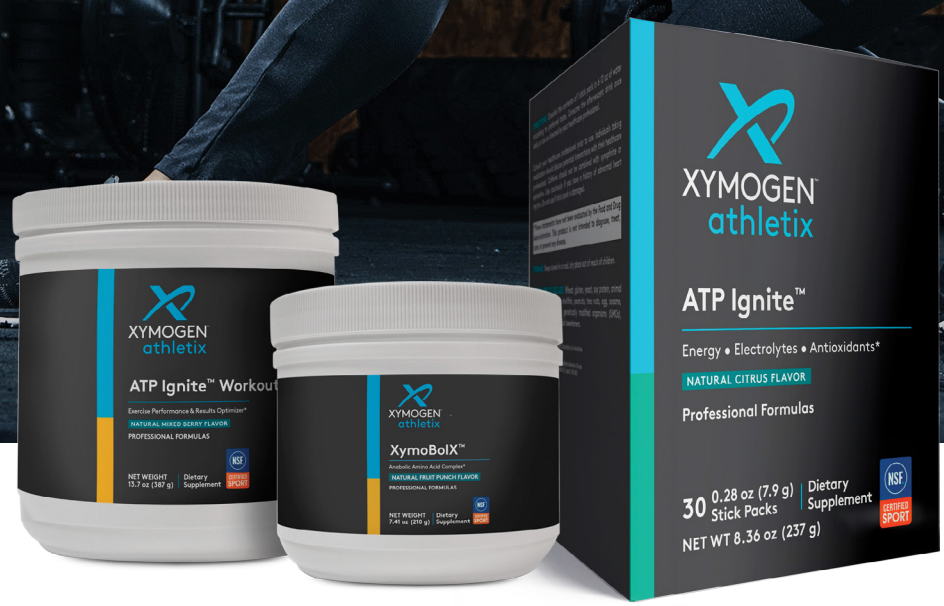

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4 Things to Know About Energy Drinks

By USADA

AUTHOR BIO:

Dr. Amy Eichner received her PhD in Neuroscience from Australian National University in 2001 and continued in neuromedical research at various places including Harvard University and Massachusetts General Hospital. In 2008, she joined the Therapeutic Goods Administration in Australia to lead a laboratory in biocompatibility testing of medical devices. She has worked with the U.S. Anti-Doping Agency in the Drug Reference Department since 2009 on the Drug Reference Hotline, Global Drug Reference Online database, Therapeutic Use Exemptions, and Supplement Connect (formerly Supplement 411), and she is now the Special Advisor on Drugs and Supplements for USADA.

It's easy to be tempted by the marketing schemes of energy drinks, especially when athletes are trying to stay fueled and hydrated. However, it's important to know that energy drinks are not necessarily a healthy, or even safe, way to hydrate.

In the following, USADA's Special Advisor on Drug Reference and Supplements, Amy Eichner, PhD, shares four things you should know about energy drinks.

1. Energy drinks are not the best choice for hydration.

According to numerous studies, water is simply the best fluid for hydration and thirst is really the best guide as to how much someone needs to drink in order to stay properly hydrated. The high sugar and caffeine (or other stimulant) content of energy drinks is detrimental to hydration and poses additional health risks, including adverse effects from caffeine and extra calories that contribute to weight gain. In general, energy drinks should not be used for hydration before, during, or after physical activity.

2. Feeling a "rush" is a warning sign of stimulant or vitamin overdose.

Contrary to popular marketing, the presence of high doses of vitamins, such as niacin, do NOT actually make a beverage healthy. Because some energy drinks tout high concentrations of vitamins and warn users about a skin flush or other sudden rush, people may drink an energy drink with the expectation that they will "feel something" and when they do, they think the product must be working.

However, consumers should be aware that foods and drinks should never cause side effects. As such, a niacin overdose resulting in skin flushing, increased heart rate, or sweating due to stimulants is actually considered an adverse event by health care providers. These effects are NOT considered good!

3. Energy drinks can contain more caffeine than soda.

Contrary to popular belief, there is no legal limit to the amount of caffeine that companies can put into energy drinks, and it's been found that energy drinks can contain up to 10 times as much caffeine as soda drinks. You should not assume that the amount of caffeine in an energy drink is on par with soda beverages and it's important to recognize that the effects of caffeine are dose-dependent. The higher the dose, the more likely you are to get the jitters, suffer insomnia, have irregular or racing heart beats, sweating, nervousness, or seizures.

For more evidence of the risks of highly caffeinated energy drinks, take a look at the story of Dakota Sailor, a high school football player who suffered a seizure and stopped breathing after consuming just two energy drinks.

4. Don't rely on energy drink labels to know whether they're safe or not.

Energy drinks can be sold as foods (beverages are considered conventional foods under the law) and labeled with a Nutrition Facts panel, or they can be sold as dietary supplements and labeled with a Supplement Facts panel. To evade food labeling and marketing laws, companies sometimes switch back and forth between the two labeling options.

An energy drink sold as a food is no safer than an energy drink sold as a supplement, and vice versa. Both can contain large amounts of caffeine or other ingredients that can be harmful, and many of these products evade labeling laws, which is why it can be difficult to know exactly what is in an energy drink.

Additional Resources

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What Do Athletes Need to Know About Caffeine?

By United States Anti-Doping Agency (USADA)

AUTHOR BIO:

The U.S. Anti-Doping Agency (USADA) is recognized by the United States Congress as the official anti-doping organization for all Olympic, Paralympic, Pan American, and Parapan American sports in the United States. USADA began operations on October 1, 2000, as an independent, non-profit organization governed by a Board of Directors. USADA was given full authority to execute a comprehensive national anti-doping program encompassing testing, results management, education, and research while also developing programs, policies, and procedures in each area.

What is Caffeine?

Caffeine (1,3,7-trimethylxanthine) is a chemical compound found naturally in many plants such as coffee and tea, yerba mate leaves (also known as "mate," "terere," and "chamirrao"), kola nuts, guarana seeds, and cacao. Caffeine is a stimulant that increases wakefulness, improves concentration, and can also raise heart rate and body temperature. In addition to coffee and tea, caffeine is found in chocolate, and is sometimes added to ("infused" into) various items like breath mints, gum, beef jerkies, sunflower seeds, or other energy products such energy drinks and pre-workout supplements.

Is Caffeine Prohibited in Sport?

No, caffeine is permitted in sports governed by the World Anti-Doping Agency (WADA). It is currently on WADA's monitoring list which means it is not prohibited but WADA is monitoring it in case it becomes an anti-doping issue in the future. However, there are limits to the amount of caffeine athletes can use in NCAA sanctioned events. Please check directly with the NCAA for the relevant anti-doping rules.

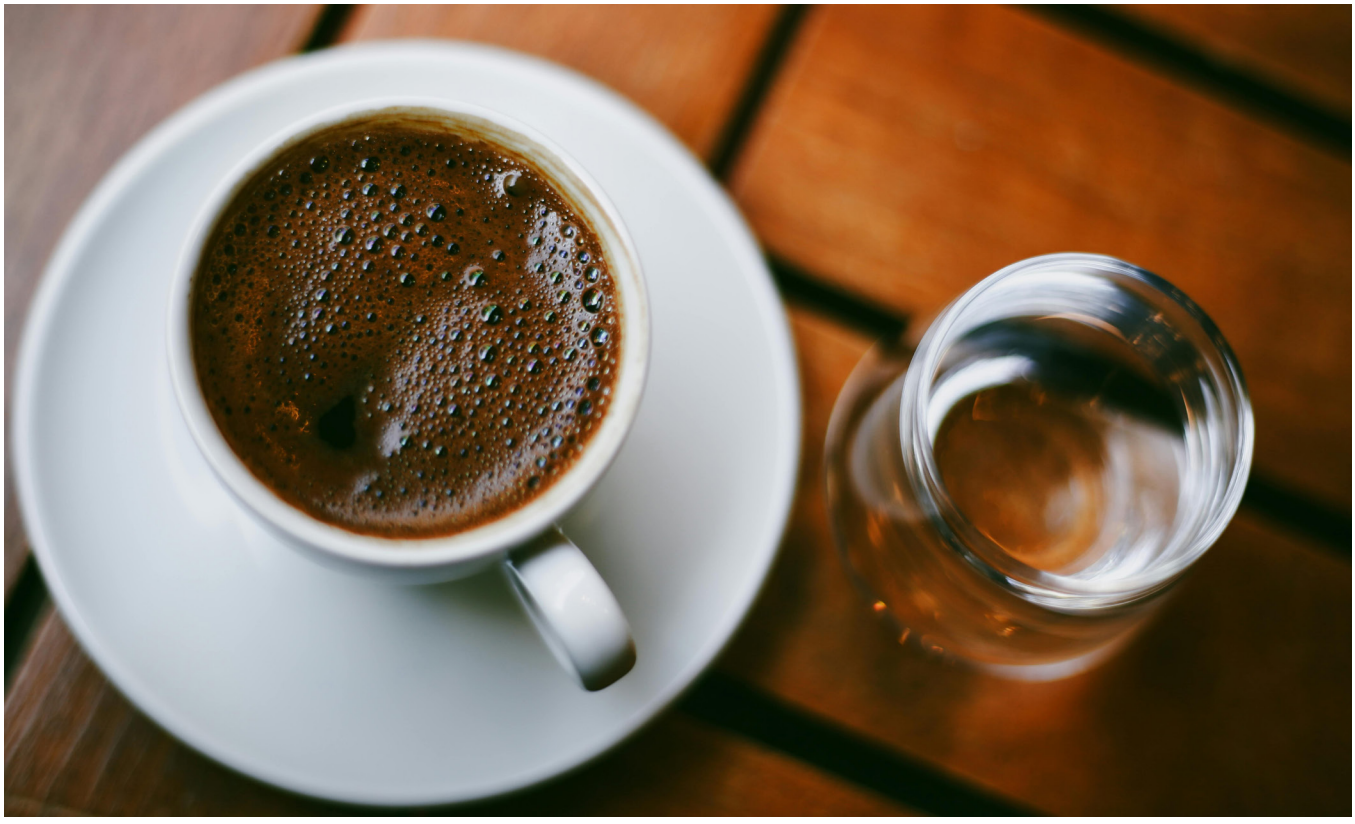
Are there medical uses for caffeine?

Yes, there are medications which contain caffeine such as certain painkillers (aspirin and acetaminophen) and a substance called ergotamine to treat migraine headaches, or headaches that occur after surgery or in response to tension. It is also used to treat neonatal apnea, a breathing issue common in very premature infants. Caffeine pills are also available over the counter to temporarily counteract drowsiness.

Are there risks associated with caffeine?

A range of side effects have been reported with the use of caffeine including insomnia, jumpiness/hyperactivity, anxiety, nausea and lack of appetite, headache,

> Dietary supplements that advertise themselves as pre-workout or weight loss products often contain large quantities of caffeine and possibly other stimulants.



tremor, or dizziness. Given how many foods, beverages, and supplements contain caffeine, it is possible to consume too much. Signs of an overdose of caffeine include irritability and mood problems, increased stress hormone levels, and difficulty sleeping. Long term overuse can result in cravings and withdrawal symptoms such as tiredness, mood changes, and problems concentrating. Severe caffeine toxicity can lead to cardiac arrest and requires urgent medical care.

Are energy drinks and pre-workout supplements with caffeine safe for athletes to use?

Even though caffeine itself is not prohibited, energy drinks are not recommended for any athletes and can be especially harmful for junior athletes. Most adults can safely consume 400mg per day of caffeine, but the American Academy of Pediatrics does not recognize ANY safe level of caffeine for youth or adolescents.

Dietary supplements that advertise themselves as pre-workout or weight loss products often contain large quantities of caffeine and possibly other stimulants. All dietary supplements come with the inherent risk of contamination with performance enhancing substances. Even though caffeine is not prohibited in sport, there is the risk that a pre-workout or weight loss product will contain other prohibited stimulants (in addition to the caffeine). If athletes choose to use dietary supplements in spite of the known risks, USADA recommends using only third-party certified supplements. Please read USADA's recommendation for third party certification.

Can I get a Therapeutic Use Exemption (TUE) for caffeine?

No, since caffeine is not prohibited, a TUE is not required to use caffeine.

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