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Is Creatine Supplementation Safe and Effective? – A Review

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Abstract

Background:

Creatine is one of the most commonly used dietary supplements among athletes and physically active individuals. Due to its role in energy metabolism and ATP resynthesis, creatine supplementation is widely applied to improve physical performance, muscle strength, and recovery processes. In recent years, increasing attention has also been directed toward the safety of creatine supplementation and its potential applications beyond sports.

Aim:

This narrative review aimed to summarise current evidence regarding the effectiveness and safety of creatine supplementation, with particular emphasis on its effects on muscle strength, muscle mass, physical performance, recovery, and potential clinical applications.

Material and methods:

The review was based on an analysis of scientific literature retrieved from PubMed, Scopus, and Google Scholar databases. The search included studies published mainly between 2015 and 2025 using keywords such as “creatine supplementation”, “creatine monohydrate”, “muscle strength”, “physical performance”, and “creatine safety”. The review included clinical trials, systematic reviews, meta-analyses, and narrative reviews concerning the effects and safety of creatine supplementation in humans.

Results:

The available evidence indicates that creatine supplementation effectively improves muscle strength, increases lean body mass, and enhances performance during high-intensity exercise. The most consistent effects are observed when creatine supplementation is combined with resistance training. Studies also suggest beneficial effects on post-exercise recovery and repeated high-intensity efforts. Current evidence indicates that creatine monohydrate is safe for healthy adults when used in recommended doses, with no confirmed harmful effects on kidney or liver function. Emerging studies additionally suggest potential benefits of creatine supplementation in older adults, cognitive function support, rehabilitation, and selected neurological conditions.

Conclusions:

Creatine remains one of the best-researched and most effective dietary supplements used in sports nutrition. Current scientific evidence supports its efficacy in improving exercise performance and muscle adaptations, as well as its safety in healthy individuals. Despite promising findings regarding non-sport applications, further long-term and well-designed clinical studies are needed to better understand the broader therapeutic potential of creatine supplementation.

Key words:

creatine supplementation; creatine monohydrate; muscle strength; muscle mass; physical performance; recovery; sports nutrition; supplementation safety.

1. Introduction

Creatine is one of the most commonly used dietary supplements among physically active individuals and athletes. It occurs naturally in the human body, mainly in skeletal muscles, where it plays an important role in energy metabolism. Its primary function is to participate in the resynthesis of adenosine triphosphate (ATP), which is the main source of energy during short-term and high-intensity physical exercise (R. B. Kreider et al. 2017; Hall i Trojian 2013; Casey i Greenhaff 2000).

Due to its properties, creatine is widely used primarily in strength, speed, and strength-endurance sports. Studies indicate that creatine supplementation may increase phosphocreatine stores in muscles, which translates into improved performance during high-intensity exercise (Clark 1997; Bird 2003).

In recent years, creatine supplementation has gained significant popularity not only in professional sports but also among recreationally active individuals. The most commonly used form is creatine monohydrate, which is considered the most thoroughly researched and effective form of this supplement. Numerous studies indicate that regular creatine supplementation may contribute to increased muscle strength, improved physical performance, greater muscle mass, and accelerated post-exercise recovery (Burke et al. 2023; Wang et al. 2024).

Despite the widespread popularity of creatine, the issue of its safety continues to attract attention both in the scientific community and among consumers. Public opinion often includes concerns regarding the potential negative effects of creatine supplementation on kidney and liver function. At the same time, an increasing number of scientific publications indicate that creatine supplementation used according to recommendations is safe for healthy individuals (Johnson et al., b.d.; Antonio et al. 2021). The most commonly recommended doses range from 3 to 5 g per day, while adverse effects are mainly associated with excessive supplementation (Hall i Trojian 2013; Antonio et al. 2021).

Currently, research is also being conducted on the potential use of creatine beyond sports, including the prevention of muscle mass loss in older adults, support of cognitive functions, and rehabilitation (R. B. Kreider et al. 2017; R. B. Kreider i Stout 2021).

Due to the growing interest in creatine supplementation and the large number of available scientific studies, it is justified to conduct a review of the current literature regarding its effectiveness and safety.

The aim of this study is to analyze current research concerning the effects of creatine supplementation on physical performance, muscle strength, and muscle mass, as well as to evaluate the safety of its use in physically active individuals.

2. Methodology of the Literature Review

This study has a review character and was developed based on an analysis of current scientific literature concerning the effectiveness and safety of creatine supplementation. In order to collect the research material, electronic databases such as PubMed, Google Scholar, and Scopus were used. The literature search was conducted between March and May 2026.

During the search process, English keywords such as “creatine supplementation”, “creatine monohydrate”, “muscle strength”, “physical performance”, “sports nutrition”, “creatine safety”, and “muscle mass” were applied. To obtain more precise results, combinations of the above phrases using logical operators AND and OR were also used.

Scientific articles available in full text and concerning the effects of creatine supplementation on the human body were included in the analysis. The review primarily included clinical studies, review articles, and meta-analyses related to the effects of creatine on physical performance, muscle strength, recovery processes, and the safety of supplementation.

Publications that did not meet quality criteria, articles without full-text access, studies conducted exclusively on animals, and papers not directly related to creatine supplementation were excluded. Particular attention was paid to publications originating from peer-reviewed scientific journals with high credibility.

The analysis of the collected literature made it possible to assess the current state of knowledge regarding the effectiveness and safety of creatine supplementation in physically active individuals and to identify the most important directions for future research.

3. Mechanism of Creatine Action

Creatine is an organic compound that naturally occurs in the human body. The largest amounts are found in skeletal muscles, where it exists mainly in the form of free creatine and phosphocreatine. Phosphocreatine serves as a rapid energy reservoir, particularly during short-term and high-intensity physical activities such as sprinting, weightlifting, or interval training (R. B. Kreider et al. 2017; Candow et al. 2015).

The primary mechanism of creatine action involves supporting the resynthesis of adenosine triphosphate (ATP). ATP is the main source of energy for muscle cells. During intense physical exercise, ATP stores are rapidly depleted, while the presence of phosphocreatine enables faster ATP regeneration. As a result, muscles are able to maintain a high level of work intensity for a longer period of time (Clark 1997; R. B. Kreider 2003).

Creatine supplementation leads to an increase in creatine and phosphocreatine stores in the muscles. In practice, this may result in improved ability to perform short, high-intensity exercises and faster recovery between successive sets of exercise. For this reason, creatine is particularly commonly used in strength and speed sports, as well as in disciplines requiring repeated bouts of high-intensity effort (Wax et al. 2021).

Creatine may also contribute to an increase in muscle mass. This effect is partly due to increased hydration of muscle cells, but also to the ability to perform a greater training volume. A person supplementing with creatine may train more intensely or perform a higher number of repetitions, which in the long term promotes training adaptations and the development of muscle strength (R. B. Kreider et al. 2017; Randell et al. 2011; Firth et al. 2018).

It is worth emphasizing that the effects of creatine are not immediate in a stimulating sense, as is the case with caffeine. Creatine does not act as a stimulant, but rather through the gradual increase of phosphocreatine stores in the muscles. Therefore, its effectiveness depends primarily on regular supplementation combined with properly planned training.

In summary, the main mechanism of creatine action is based on increasing the availability of phosphocreatine in muscles, which enables faster ATP resynthesis during intense physical effort. As a result, creatine may support muscle strength, anaerobic performance, recovery between exercise sets, and training adaptations.

4. Effects of Creatine Supplementation on the Body

4.1. Effects on Muscle Strength

One of the most frequently described effects of creatine supplementation is an increase in muscle strength. Numerous studies have shown that individuals using creatine in combination with resistance training achieve better strength performance compared to those who do not supplement with this compound. This effect is particularly noticeable during high-intensity and short-duration exercises (Antonio et al. 2021; Pescatello et al. 2004; Moore et al. 2007; Roschel et al. 2021).

The increase in muscle strength is primarily associated with greater ATP availability during exercise, which enables performing a higher number of repetitions and training with heavier loads. Regular creatine supplementation may lead to improvements in strength parameters both in professional athletes and recreationally active individuals (Wax et al. 2021).

4.2. Effects on Muscle Mass

Creatine supplementation may also contribute to an increase in muscle mass. In the initial phase of use, the observed increase in body weight is mainly associated with greater water retention within muscle cells. In the long term, however, creatine may support the development of muscle tissue by improving training capacity and increasing exercise volume (R. B. Kreider et al. 2017; Branch 2003).

Studies indicate that individuals supplementing with creatine during resistance training more often achieve greater increases in lean body mass compared to those relying on training alone. This effect may be particularly beneficial for athletes involved in strength and physique sports (Bonilla et al. 2021; Stares i Bains 2020).

4.3. Effects on Physical Performance

Creatine demonstrates the greatest effectiveness in high-intensity anaerobic exercise. Supplementation may improve the ability to perform short-term, repeated efforts such as sprints or interval exercises. By increasing phosphocreatine stores, the body is able to regenerate ATP more rapidly, which translates into improved physical performance (Sewell et al. 2008; Cooper et al. 2012).

In the case of long-duration and typically endurance-based exercise, the effects of creatine are less pronounced. However, some studies suggest that supplementation may support recovery and improve the ability to perform high-intensity phases of exercise also in endurance sports (R. B. Kreider et al. 2017; Antonio et al. 2021; Valiño-Marques et al. 2024).

4.4. Creatine and Recovery Processes

An increasing number of studies indicate that creatine may support the body's recovery processes after physical exercise. Supplementation may reduce muscle damage, decrease inflammation, and accelerate the restoration of energy stores following intense training (Wax et al. 2021).

Additionally, some publications suggest that creatine may positively affect nervous system recovery and reduce feelings of fatigue after exercise. For this reason, creatine supplementation is increasingly used not only in professional sports but also in recreational training and rehabilitation processes.

5. Safety of Creatine Supplementation

5.1. Recommended Dosage

The most commonly used form of supplementation is creatine monohydrate, considered the most thoroughly researched and the most effective form of this compound. The standard supplementation protocol includes a loading phase consisting of approximately 20 g of creatine per day for 5–7 days, followed by a maintenance phase with a dose of 3–5 g per day. In practice, however, many individuals skip the loading phase and use only continuous supplementation with lower doses, which also leads to increased creatine stores in the muscles (Antonio et al. 2021; Allen 2012; Dalbo et al. 2008).

Studies indicate that regular creatine supplementation used according to recommendations is well tolerated by healthy adults. The effectiveness of supplementation depends primarily on consistency of use and the proper combination of supplementation with physical training (R. B. Kreider et al. 2017; Gutiérrez-Hellín et al. 2024; Yang et al. 2019).

5.2. Possible Side Effects

Despite the widespread popularity of creatine, concerns regarding possible side effects of its use still exist. The most commonly reported adverse effects include temporary weight gain associated with water retention, a feeling of bloating, and occasional gastrointestinal discomfort, particularly when high doses of the supplement are used (R. B. Kreider et al. 2017; Sandkühler et al. 2023; Balestrino i Adriano 2019).

Some individuals are also concerned about the occurrence of muscle cramps or dehydration during creatine supplementation. However, current scientific studies do not clearly confirm an increased risk of such disorders in healthy individuals using creatine according to recommended guidelines (Antonio et al. 2021).

5.3. Effects of Creatine on the Kidneys and Liver

One of the most frequently discussed issues regarding creatine safety is its potential effect on kidney and liver function. However, many available studies indicate that creatine supplementation in healthy individuals does not cause damage to these organs (Antonio et al. 2021; Barsotti i Lundberg 2018; Kley et al. 2013).

The increase in creatinine concentration observed during supplementation does not always indicate impaired kidney function, as creatinine is a natural byproduct of creatine metabolism. Therefore, the interpretation of laboratory test results in individuals supplementing with creatine requires appropriate caution (Vega i Huidobro E 2019).

At the same time, it is emphasized that individuals suffering from chronic kidney or liver diseases should consult a physician before starting creatine supplementation.

5.4. Safety of Long-Term Supplementation

Available studies suggest that long-term creatine supplementation may be safe for healthy adults. Many publications have not demonstrated significant negative changes in health parameters even after several months of supplement use (Antonio et al. 2021; Williams i Branch 1998; Forbes et al. 2023).

International organizations involved in sports nutrition recognize creatine as one of the most thoroughly researched dietary supplements used in sports. The current state of knowledge indicates that the use of creatine in recommended doses is safe and may provide benefits for both athletes and physically active individuals.

6. Applications of Creatine Beyond Sports

6.1. Creatine in Older Adults

In recent years, an increasing number of studies have focused on the use of creatine in older adults. The aging process is associated with a gradual decline in muscle mass, strength, and physical performance, a condition referred to as sarcopenia. Studies indicate that creatine supplementation, particularly when combined with resistance training, may support the maintenance of muscle mass and improve functional capacity in older individuals (Li 2026; Candow et al. 2025).

Regular creatine supplementation may contribute to improved muscle strength, enhanced ability to perform daily activities, and a reduced risk of falls in older adults. Many publications also emphasize the beneficial effects of creatine on recovery processes and quality of life in the elderly (Antonio et al. 2021; Asikainen et al. 2004; Walter et al. 2026).

An important aspect is also the safety of supplementation in this age group. Current data suggest that the use of creatine monohydrate in recommended doses is well tolerated by healthy older adults (Candow et al. 2025).

6.2. Creatine and Cognitive Functions

Growing interest has emerged regarding the potential effects of creatine on brain function and cognitive abilities. Creatine is involved in energy metabolism not only in muscle cells but also in nerve cells; therefore, it is believed that it may support brain function under conditions of increased energy demand (Roschel et al. 2021; Pratt et al. 2026).

Studies suggest that creatine supplementation may positively affect memory, information processing speed, and concentration, particularly in older adults and in situations of physical fatigue, such as sleep deprivation or intense mental effort (Gordji-Nejad et al. 2024; Xu et al. 2024).

Meta-analyses indicate that the greatest cognitive benefits are observed in older adults and in individuals with lower baseline levels of creatine in the body. At the same time, some authors emphasize that further research is still needed to clearly determine the effectiveness of creatine in improving cognitive functions (Machado 2026; Marshall et al. 2026).

6.3. Potential Clinical Applications

Research is currently being conducted on the use of creatine in various fields of medicine. Due to its role in cellular energy metabolism, creatine is being considered as a supportive therapy in neurological disorders, rehabilitation, and the treatment of conditions associated with muscle mass loss (Roschel et al. 2021; Candow et al. 2025).

Some studies suggest potential benefits of creatine use in patients with neurodegenerative diseases such as Alzheimer’s disease and Parkinson’s disease. Preliminary findings indicate the possibility of improving brain energy metabolism and reducing neurodegenerative processes; however, the current state of knowledge does not yet allow for clear clinical recommendations (Roschel et al. 2021; Smith et al. 2025).

Creatine is also being investigated as a potential supportive element in post-injury rehabilitation and the treatment of chronic fatigue. Despite promising results, the need for further clinical studies involving larger patient groups and longer observation periods is strongly emphasized (Pratt et al. 2026; Eckert 2025).

7. Limitations of Available Studies

Despite the large number of publications concerning creatine supplementation, there are still certain limitations in scientific studies analyzing its effectiveness and safety. Many available studies involve relatively small research groups, which may affect the ability to generalize the results to the entire population. Additionally, a significant proportion of studies have been conducted mainly on young, healthy, physically active men, which means that data regarding women, older adults, and individuals with chronic diseases remain limited (R. B. Kreider et al. 2017; R. B. Kreider 2003).

An important issue is also the diversity of research methodologies. Individual publications differ in terms of supplementation duration, creatine doses used, type of physical activity, and the training level of participants. Some studies applied a creatine loading phase, whereas others used only constant maintenance doses. This makes direct comparison of results and clear evaluation of the optimal supplementation model more difficult (R. B. Kreider et al. 2017; Huang et al. 2024; Silva et al. 2007).

Another limitation is the fact that many studies focus primarily on the short-term effects of supplementation. Although available data suggest that creatine is safe even during long-term use, further observations involving longer time periods and larger study groups are still needed. Monitoring the safety of supplementation in individuals with metabolic diseases, kidney disorders, and older adults appears to be particularly important (R. B. Kreider et al. 2017; Johnson et al., b.d.).

Some publications also point to the possibility of errors resulting from the self-reported nature of the data. Certain studies were based on questionnaires or participants' self-assessment of supplementation effects, which may lead to subjective evaluation of the results. Additionally, study participants often used other dietary supplements simultaneously or followed different training programs, making it difficult to clearly determine the specific effects of creatine alone on the obtained outcomes (R. B. Kreider et al. 2017; Roschel et al. 2021).

Another limitation of some studies is the varying quality of the creatine preparations used. Although creatine monohydrate is considered the most thoroughly researched form of the supplement, many other forms of creatine with weaker scientific support are available on the market. Some publications indicate that supplement manufacturers often promote new forms of creatine despite the limited number of studies confirming their superiority over creatine monohydrate (R. B. Kreider et al. 2017; González-Ravé et al. 2023; Dawson et al. 2002).

In recent years, an increasing number of studies have focused on the use of creatine beyond sports, including neurology, geriatrics, and rehabilitation. However, these areas still require further well-designed clinical studies. Current results are promising, but the number of randomized controlled trials remains limited (R. B. Kreider i Stout 2021; R. Kreider et al. 2025).

In summary, despite the large number of scientific publications concerning creatine, there is still a need for further research involving diverse population groups, longer observation periods, and standardized research methodologies. This would allow for an even more accurate assessment of the effectiveness and safety of creatine supplementation both in sports and in medicine.

8. Conclusions

Creatine is one of the most thoroughly researched dietary supplements used in sports and physical activity. An analysis of the current scientific literature indicates that creatine supplementation may effectively support the development of muscle strength, increase muscle mass, and improve performance during high-intensity exercise. Particularly beneficial effects are observed when supplementation is combined with regular resistance training.

Available studies confirm that creatine monohydrate is the most effective and best-researched form of supplementation. Regular use of creatine according to recommended doses leads to increased phosphocreatine stores in muscles, which enables faster ATP resynthesis and improves the body's exercise capacity.

The current state of knowledge also indicates that creatine supplementation is safe for healthy adults. Most studies do not demonstrate negative effects of creatine on kidney or liver function when used in recommended doses. The most commonly observed side effects are mild and mainly include temporary weight gain associated with water retention.

An increasing number of studies also point to the potential use of creatine beyond sports. Supplementation may support the maintenance of muscle mass in older adults, improve recovery processes, and positively affect cognitive functions. Preliminary findings also suggest the possibility of using creatine in rehabilitation and selected neurological disorders; however, these areas require further clinical research.

Despite the large number of available publications, there is still a need for further research involving different population groups and long-term observation of supplementation effects. Expanding research involving women, older adults, and individuals with chronic diseases appears to be particularly important.

In conclusion, current scientific evidence indicates that creatine is an effective and safe supplement supporting physical performance. Due to its broad range of applications and growing popularity, creatine remains one of the most important and best-documented dietary supplements in modern sports nutrition.

Disclosure

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Conflict of Interest Statement

The authors declare no conflict of interest.

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