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Creatine as an Answer to the Challenges of Aging? Mechanisms, Benefits, and Safety in Older Adults

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Abstract

Background. Age-related decline in muscle mass, strength, metabolic health and cognitive function is a major contributor to reduced functional independence in older adults. Creatine supplementation has emerged as a potential nutritional intervention due to its role in cellular energy metabolism; however, its efficacy and safety in aging populations remain topics of ongoing investigation.

Aim. To critically evaluate, in a narrative review format, the current evidence regarding the efficacy and safety of creatine supplementation in older adults, with particular emphasis on outcomes related to skeletal muscle function, bone health, cardiometabolic outcomes, cognitive performance, neuroprotection and reported adverse effects.

Material and methods. A narrative synthesis of literature indexed in PubMed was conducted, focusing on studies examining creatine supplementation in adults aged ≥55 years. Particular attention was given to randomized controlled trials, systematic reviews, and meta-analyses published in recent years.

Results. Evidence consistently indicates that creatine supplementation, particularly when combined with resistance training, improves lean body mass, muscle strength, and selected functional performance measures in older adults. The effects on bone health appear limited and are likely indirect, mediated through enhanced muscle function. Emerging findings suggest potential benefits for cognitive performance, especially in memory-related domains. However, current evidence is insufficient to confirm clinically relevant neuroprotective effects. Safety data from controlled trials and large-scale adverse event analyses demonstrate a favorable tolerability profile, with no increase in clinically significant adverse events compared to placebo in healthy older adults.

Conclusions. Creatine supplementation may be considered a safe and effective adjunct strategy for supporting musculoskeletal health and functional capacity in aging populations. Its broader effects require further long-term studies in diverse older populations.

Keywords: creatine, older adults, sarcopenia, resistance training, cognitive function, supplementation, safety

1. Introduction

Population aging represents one of the most significant demographic challenges of the twenty-first century. The growing proportion of older adults worldwide is accompanied by an increasing prevalence of age-related functional decline, chronic diseases, and disability, placing substantial pressure on healthcare systems. Aging affects multiple biological systems and is driven by several interconnected mechanisms, including impaired energy metabolism, oxidative stress, and chronic low-grade inflammation. Together, these processes contribute to progressive declines in physiological function, reduced functional capacity, and a lower quality of life among older adults. [1].

Among the various strategies proposed to promote healthy aging, nutritional interventions have attracted considerable attention because of their accessibility, safety, and potential to target multiple biological pathways. One of them is creatine, a naturally occurring compound that plays a vital role in cellular energy homeostasis through the phosphocreatine system, which enables rapid regeneration of adenosine triphosphate (ATP) [2]. Although creatine is endogenously synthesized, its levels may decline with age due to reduced dietary intake, decreased muscle mass, and alterations in metabolism. This has led to increasing interest in creatine supplementation as a potential strategy to counteract age-related physiological decline.

To date, creatine supplementation has been extensively studied in the context of exercise performance and muscle physiology, with consistent evidence supporting its efficacy in enhancing muscle mass, strength, and functional performance [3] particularly among athletes

and physically active individuals. More recently, attention has shifted toward its potential role in other populations and systems relevant to aging, including bone health, brain cognition and metabolic function. However, findings in these areas remain less consistent, and the extent of its clinical relevance is still under investigation. In addition to its potential benefits, the safety of creatine supplementation in older adults is an important consideration, particularly given the high prevalence of comorbidities and polypharmacy in this population.

Given these considerations, the aim of this narrative review is to provide a comprehensive overview of the current evidence on creatine supplementation as a strategy for addressing common age-related conditions and physiological declines in older adults. Specifically, this review examines its effects on musculoskeletal health, bone metabolism, cognitive function, neurodegenerative processes, metabolic processes as well as its safety profile. By integrating mechanistic insights with clinical findings, this review seeks to clarify the role of creatine as a potential strategy to support healthy aging.

2. Creatine: metabolism and mechanisms of action

Creatine is both endogenously synthesized and obtained from the diet. It is produced from glycine, arginine, and methionine in a two-step process involving L-arginine:glycine amidinotransferase (AGAT) and guanidinoacetate N-methyltransferase (GAMT), occurring primarily in the kidneys and liver [4]. Dietary creatine is derived mainly from meat and fish [2].

After synthesis or ingestion, creatine is transported via the sodium- and chloride-dependent creatine transporter (SLC6A8) to tissues with high energy demands, particularly skeletal muscle and the brain, but also to the heart and testes [2]. In skeletal muscle, creatine is stored in both free form (approximately one-third) and as phosphocreatine (PCr) (approximately two-thirds), formed through the reversible action of creatine kinase (CK). PCr serves as a rapid phosphate reservoir for ATP resynthesis from ADP during periods of increased energy demand [5]. Creatine is converted to creatinine via a non-enzymatic reaction and excreted by the kidneys [6].

Beyond its well-established role in energy metabolism, ongoing research is exploring additional mechanisms through which creatine may support healthy aging, including its effects on various cellular pathways.

2.1 Antioxidant properties

The antioxidant activity of creatine is considered one of its possible secondary mechanisms of action. This effect is thought to occur mainly indirectly, through improved cellular energy availability, stabilization of cell membranes, and support of mitochondrial integrity. By enhancing the phosphocreatine system and ATP resynthesis, creatine may reduce metabolic stress during repeated muscle contractions and thereby limit excessive reactive oxygen species production [5,7]. Experimental studies also suggest that creatine may exert some direct antioxidant effects by scavenging selected reactive species, such as superoxide anions and peroxynitrite [8,9]. However, these direct effects have been demonstrated mainly in vitro, while their clinical relevance in humans remains uncertain.

In older adults, the antioxidant potential of creatine appears to be most relevant when supplementation is combined with resistance training. Amiri et al. reported that resistance training with creatine supplementation was associated with reductions in markers of lipid peroxidation and oxidative DNA damage, such as malondialdehyde **(**MDA) and 8-hydroxy-2′-deoxyguanosine **(**8-OHdG), while improving antioxidant defense indicators, including glutathione peroxidase and total antioxidant capacity [10].

However, the available evidence does not clearly show that creatine independently improves antioxidant status in older adults. The observed benefits may result largely from resistance training itself, while creatine may enhance these effects indirectly by improving training capacity, muscle strength, and energetic efficiency. Therefore, creatine should be interpreted not as a primary antioxidant compound, but as a supplement that may support antioxidant protection as part of broader adaptations to exercise and improved muscle metabolism.

3. Creatine Supplementation and Musculoskeletal Health in Older Adults

Age-related decline in the musculoskeletal system represents a major health concern and a key contributor to loss of independence in older adults. It is characterized by reductions in muscle

mass, strength, and physical performance, which collectively increase the risk of falls, disability, and hospitalization. In this context, nutritional interventions have gained considerable attention as accessible strategies to support muscle health.

3.1 Effects of Creatine Supplementation on Skeletal Muscle in Older Adults

Creatine supplementation has been extensively investigated as an intervention to counteract age-related declines in skeletal muscle mass, strength, and function. These declines contribute to the development of sarcopenia, defined by the European Working Group on Sarcopenia in Older People as a progressive and generalized skeletal muscle disorder associated with increased risk of adverse outcomes such as physical disability, falls, hospitalization, and mortality [11,12]. In this context, creatine is of particular interest because its primary physiological role in the phosphocreatine system is directly related to rapid ATP resynthesis, which is essential for muscle contraction and recovery during high-intensivity or repeated muscular efforts.

Overall, the strongest evidence for the benefits of creatine in older adults comes from studies combining supplementation with resistance training. It is important to acknowledge that creatine alone appears to have limited effects on muscle outcomes, whereas creatine combined with training consistently produces greater adaptations than training alone. Meta-analyses consistently report significantly greater increases in lean body mass (LBM) in creatine-supplemented groups compared to placebo. For instance, Devries et al. reported a mean increase of approximately +1.44 kg in lean mass with creatine combined with resistance training compared to training alone [13]. Similarly, Chilibeck et al. observed an increase of approximately +1.37 kg in LBM, confirming the consistency of this effect across studies [14]. Although these absolute changes may appear modest, an increase of more than 1 kg in lean mass is clinically meaningful in older adults, particularly in the context of age-related muscle loss, which progresses gradually over time.

In terms of muscle strength, creatine supplementation produces meaningful improvements beyond placebo. Chilibeck et al. reported increases in upper-body strength of approximately +6.9 kg in bench press strength and lower-body strength of +9.8 kg in leg press strength in creatine-supplemented groups [14]. These gains suggest that creatine may enhance both upper- and lower-body adaptations to resistance training. The magnitude of improvement in lower-

body strength is particularly relevant for older adults, as lower-limb strength is closely associated with mobility, balance, fall risk, and the ability to perform activities of daily living. Other meta-analyses demonstrate approximately 8–14% greater improvements in one-repetition maximum (1RM) strength in creatine-supplemented groups to further support the conclusion that creatine has an ergogenic effect in this population [14,15]. There were reported improvements in functional capacity, including the chair stand test, alongside greater strength gains compared with resistance training alone [13]. This is important because the chair stand test reflects the ability to repeatedly generate force from the lower limbs, a movement pattern directly relevant to daily tasks such as standing up from a chair, climbing stairs, and maintaining independence. More recent meta-analytic data by Sharifian et al. confirm that creatine supplementation enhances lower-body performance and mobility outcomes in older adults undergoing resistance training [16]. Taken together, these data indicate that the benefits of creatine may extend beyond laboratory-based strength measures and may contribute to functionally meaningful adaptations relevant for maintaining physical performance in aging populations.

Importantly, the effectiveness of creatine is strongly dependent on concurrent resistance training. Studies consistently show minimal effects when creatine is used without exercise, whereas combined interventions produce robust improvements, indicating that creatine primarily acts as an exercise potentiator [16].

Despite strong evidence for performance benefits, inter-individual variability in response to creatine supplementation has been consistently reported. Factors such as baseline muscle creatine levels, dietary intake, and training status influence the magnitude of response. Individuals with lower initial creatine stores tend to exhibit greater increases, whereas others show attenuated adaptations and are classified as “low responders” [18].

In summary, creatine supplementation in older adults is associated with greater increases in lean body mass, improvements in muscle strength and functional performance, and modest reductions in body fat, when combined with resistance training. Collectively, these findings support creatine as an effective adjunct strategy for mitigating sarcopenia and improving physical function in aging populations.

3.2. Creatine Supplementation and Bone Health

Age-related bone loss results from an imbalance between bone formation and resorption, leading to decreased bone mineral density (BMD) and an increased risk of fractures.

While the positive effects of creatine on muscle function are well established, its potential role in bone health remains unclear. Current evidence suggests that creatine supplementation does not produce a significantly greater effect on BMD compared to placebo, even when combined with resistance training [19,20]. Meta-analytic data indicate no significant improvements in whole-body, hip, femoral neck, or lumbar spine BMD in older adults [19].

However, creatine may still support bone health indirectly rather than by directly increasing BMD. One of the primary pathways involves the muscle-bone axis: improvements in muscle mass and strength may enhance mechanical loading on bone, which is a key stimulus for osteogenesis [19]. At the cellular level, creatine may indirectly influence bone metabolism through its role in cellular bioenergetics. The creatine kinase system is present in bone cells and contributes to intracellular energy buffering, supporting ATP availability during periods of increased metabolic demand. Experimental evidence suggests that creatine kinase activity may be involved in osteoblast function and differentiation, although its exact role in human bone metabolism remains incompletely understood. Preclinical studies indicate that creatine may modulate osteoblast activity and mineralization processes, while potential effects on osteoclast activity have also been proposed; however, these findings are primarily derived from experimental models and have not been consistently confirmed in human studies [19].

Recent systematic reviews and meta-analyses indicate that although creatine supplementation improves muscle mass and functional performance in older adults, its effects on BMD are minimal or non-significant. Long-term randomized trials in postmenopausal women also show no meaningful improvements in BMD despite increases in lean mass [21].

4. Creatine Supplementation and Cardiometabolic Health in Older Adults

Aging is associated with several adverse changes in cardiometabolic health, including a gradual decline in skeletal muscle mass, reduced muscle quality, increased adiposity, and a higher prevalence of insulin resistance [11,22] These changes are clinically important because skeletal muscle is one of the main tissues responsible for insulin-mediated glucose uptake [22]. Loss of

muscle mass and reduced physical activity may therefore contribute to impaired glucose homeostasis, decreased metabolic flexibility, and a higher risk of type 2 diabetes [11,22] At the same time, older adults often experience an increase in visceral adiposity, which is associated with chronic low-grade inflammation, impaired insulin signaling, and increased cardiovascular risk [22].

In this context, creatine supplementation may have potential relevance mainly through its interaction with skeletal muscle metabolism. Creatine increases intramuscular creatine and phosphocreatine stores, which may improve energy availability during muscle contraction and support adaptations to exercise [2,3]. This mechanism may be particularly important in older adults, as interventions that improve muscle function may also indirectly support glucose metabolism and cardiometabolic health. However, the metabolic effects of creatine appear to be most meaningful when supplementation is combined with physical training, especially resistance exercise [23,24]

Evidence regarding the effect of creatine on glucose metabolism remains mixed [24, 25] In a randomized, double-blind, placebo-controlled trial involving patients with type 2 diabetes, creatine supplementation combined with exercise reduced HbA1c and was associated with increased GLUT-4 translocation, suggesting a possible improvement in skeletal muscle glucose uptake [23]. However, studies in non-diabetic populations have not always confirmed a clear effect on glucose tolerance or insulin sensitivity. Newman et al. reported that creatine supplementation increased muscle creatine content but did not significantly improve glucose tolerance or insulin sensitivity in healthy men [26]. A systematic review also concluded that creatine may have some favorable effects on glycemic control, but these effects appear more consistent when supplementation is combined with exercise rather than used alone [24]. More recent meta-analytic evidence indicates that the overall effects on fasting blood glucose and insulin resistance remain non-significant, supporting a cautious interpretation of creatine's role in glycemic control [25].

In older adults, the available evidence is still limited. A randomized, double-blind, placebo-controlled pilot study showed that creatine supplementation combined with resistance training did not provide additional benefits on glucose, insulin, inflammatory markers, or insulin resistance compared with resistance training alone [27]. This suggests that resistance training

itself remains the key intervention for improving metabolic health in this population, while the additional role of creatine may depend on baseline health status, training protocol, dose, duration of supplementation, and the presence of metabolic disorders [27].

Creatine may also be relevant to cardiometabolic health through its effects on body composition, although it should not be considered a direct fat-reducing supplement. In older adults, increased adiposity often coexists with reduced muscle mass, contributing to sarcopenic obesity, insulin resistance, and higher cardiovascular risk [11,22,27]. The potential benefit of creatine in this context is likely indirect, mainly through improved training capacity, greater strength, and preservation or increase of lean mass [3,28]. A meta-analysis by Forbes et al. reported a modest but significant reduction of approximately −0.55% in body fat percentage in adults aged ≥50 years receiving creatine supplementation combined with resistance training [28]. Although the absolute reduction in adiposity was small, the concurrent increase in lean mass and slight reduction in fat mass may contribute to an overall improvement in body composition. Such changes may be metabolically relevant, as greater muscle mass and lower adiposity are associated with improved insulin sensitivity, better glucose disposal, and reduced cardiometabolic risk [22,28].

The relationship between creatine supplementation and cardiovascular health should therefore be interpreted cautiously. Creatine may indirectly support cardiovascular health by improving muscle function, physical performance, body composition, and participation in exercise, all of which are important for reducing cardiometabolic risk [3,27,28]. However, current evidence does not support creatine as an independent intervention for the prevention or treatment of cardiovascular diseases [24,25,27]. Overall, creatine may be considered a supportive supplement within a broader lifestyle strategy that includes resistance training, adequate nutrition, body weight control, and medical management of cardiometabolic risk factors.

5. Creatine Supplementation and Brain Function

Age-related cognitive decline is characterized by impairments in memory, executive function, and processing speed, and is closely associated with alterations in brain energy metabolism, mitochondrial dysfunction, and increased oxidative stress [29].

5.1. Creatine and Cognitive Functions

Age-related cognitive decline is partly driven by impaired brain energy metabolism and mitochondrial dysfunction. Creatine, through the phosphocreatine system, supports ATP regeneration and may enhance neuronal energy availability, providing a mechanistic basis for its potential cognitive effects. In aging populations, this mechanism may be particularly relevant because older adults often exhibit reduced brain and muscle creatine stores, decreased metabolic efficiency, and lower dietary creatine intake [30,31].

Current evidence suggests that creatine supplementation may lead to modest improvements in certain cognitive domains, although findings remain heterogeneous. McMorris et al. demonstrated that short-term high-dose creatine supplementation (20 g/day for 7 days) in older adults improved several memory-related domains such as forward number recall, forward and backward spatial recall, and long-term memory; however, no significant improvements were observed in more complex executive tasks such as backward number recall or random number generation [32]. However, in another study, creatine supplementation, either alone or combined with resistance training, did not improve cognitive function or emotional outcomes in older women [33]. That is one of the examples of studies using broad cognitive screening tools such as the MMSE that generally do not demonstrate meaningful improvements in overall cognitive status.

Recent systematic reviews and meta-analyses indicate that the overall cognitive effects of creatine are small and domain-specific [30]. The most consistent improvements are observed particularly in short-term memory, working memory, and information processing speed whereas findings for global cognition or executive functions are non-significant [30,31].

Importantly, the effects appear to be population-dependent. Greater cognitive benefits are more frequently reported in older adults and in individuals with lower baseline creatine availability (e.g.,vegetarians), suggesting that supplementation may be more effective under conditions of reduced energy availability [30,31].

Despite these observations, the overall evidence base remains limited. Many studies are characterized by small sample sizes, short intervention durations, and methodological heterogeneity. Creatine supplementation may produce improvements in selected cognitive

functions in older adults. However, current evidence does not support broad or robust cognitive-enhancing effects. The observed effects are the reason why further large-scale, well-controlled trials are required to clarify the magnitude and clinical relevance of these findings.

5.2. Neuroprotection and Neurodegenerative Diseases

Creatine supplementation has been investigated for its potential neuroprotective effects, particularly in the context of neurodegenerative diseases such as Alzheimer's disease (AD) and Parkinson's disease (PD). These disorders are characterized by progressive neuronal loss, mitochondrial dysfunction, oxidative stress, and impaired cellular energy homeostasis, providing a strong rationale for targeting brain energetics as a therapeutic strategy [34,35].

Alzheimer's disease is the most common neurodegenerative disease. Its pathophysiology involves a complex interplay of amyloid-β accumulation, tau pathology and neuroinflammation as well as impaired brain energy metabolism, mitochondrial dysfunction, and oxidative stress, all of which contribute to neuronal degeneration. Evidence suggests that the creatine kinase/phosphocreatine system may be disrupted in AD, indicating a reduced capacity for ATP buffering in neurons. This supports a metabolic rationale for creatine supplementation [36].

Preclinical studies show that creatine supplementation can improve mitochondrial function, enhance cellular energy availability and reduce oxidative stress. In experimental models of Alzheimer's disease, creatine has been associated with improved cognitive performance and markers of mitochondrial efficiency. However, effects on classical pathological features such as amyloid-β accumulation remain inconsistent and not conclusively demonstrated, and overall findings are limited to animal and cellular models [37].

Despite mechanistic and preclinical findings, there is currently no convincing clinical evidence that creatine supplementation provides cognitive benefit or modifies disease progression in patients with Alzheimer's disease. Human studies are scarce and largely limited to showing increased brain creatine levels without consistent improvements in cognition or clinical outcomes [36,38]. Overall, current evidence supports a promising but still experimental role of creatine in the context of Alzheimer's disease, requiring further clinical validation.

Parkinson's disease is strongly associated with mitochondrial dysfunction, particularly in dopaminergic neurons. Early mechanistic and preclinical studies suggested that creatine

supplementation might slow disease progression. However, large randomized controlled trials have not confirmed these effects. A multicenter trial found no significant improvements in disease progression, motor function, or activities of daily living, leading to discontinuation of creatine as a therapeutic candidate in PD [39].

Overall, while mechanistic and preclinical evidence supports a potential neuroprotective role of creatine, current clinical data do not confirm its efficacy in neurodegenerative diseases. Nevertheless, its favorable safety profile and strong biological rationale support further investigation, particularly as an adjunct to other therapeutic strategies or in early-stage disease.

6. Safety of Creatine Supplementation in Older Adults

The use of creatine supplementation in older adults has gained increasing attention due to its potential benefits for musculoskeletal and cognitive health. However, safety concerns remain relevant, particularly in the context of comorbidities and polypharmacy, which are common in this population.

6.1. Renal Function

The most frequently discussed safety concern relates to kidney function. Creatine is non-enzymatically converted to creatinine, which is commonly used as a biomarker of renal function. As a result, creatine supplementation may lead to elevated serum creatinine levels, which can be misinterpreted as impaired kidney function. Current evidence suggests that this increase reflects higher creatine turnover rather than renal dysfunction. Recent meta-analyses and systematic reviews have shown that creatine supplementation does not adversely affect kidney function in healthy individuals [40]. However, data regarding individuals with diagnosed chronic kidney disease remain limited, as this population is often excluded from randomized controlled trials.

Moreover, some evidence suggests that creatine metabolism itself may be altered in kidney disease. It has been hypothesized that reduced renal function may affect certain steps of creatine biosynthesis, highlighting the complexity of creatine homeostasis in pathological conditions. However, clinical data in this area remain insufficient and require further investigation and cautious interpretation [41].

What is important to notice is that given the high prevalence of undiagnosed chronic kidney disease in older adults, elevations in serum creatinine during creatine supplementation should not be automatically dismissed as benign. Instead, they should prompt further diagnostic evaluation to exclude underlying renal pathology.

Taken together, current evidence supports the renal safety of creatine supplementation in healthy populations. However, given the limited data in individuals with impaired kidney function, caution is warranted, and further well-designed studies are needed.

6.2. Potential Side Effects

Creatine monohydrate is the most commonly used and extensively studied form of creatine supplementation and is generally considered safe and well tolerated when consumed at recommended dosages. Nevertheless, several side effects and safety considerations have been discussed in the literature. The geriatric population is of particular concern due to multimorbidity, polypharmacy, and limited long-term intervention data. Current evidence does not identify absolute contraindications in healthy older individuals; however, several clinical precautions are worth noticing.

One of the most commonly discussed effects of creatine supplementation is an increase in body mass and total body water. Early studies reported transient elevations in total body water during short-term loading phases, which contributed to the widespread belief that creatine causes excessive water retention. Current evidence, however, suggests that these fluid shifts occur primarily within the intracellular compartment and reflect physiological cellular hydration rather than pathological fluid accumulation. Long-term supplementation studies generally do not demonstrate clinically significant increases in extracellular water or peripheral edema [42,43]. Increased intracellular water may additionally support muscle protein synthesis and skeletal muscle adaptation. However, caution is warranted in older adults with advanced cardiovascular disease, severe heart failure, or clinically significant fluid-balance disorders as in such cases, even physiological shifts in fluid distribution may have greater clinical relevance. Although this is not usually clinically problematic in healthy individuals, data in frail or medically complex geriatric cohorts remain limited, and supplementation should therefore be introduced only after individualized risk–benefit assessment. It should be noted, however, that fluid-related outcomes are rarely primary endpoints in clinical studies, and direct evidence remains limited.

Although occasional anecdotal reports have linked creatine supplementation with gastrointestinal discomfort, including bloating, nausea, or diarrhea, controlled clinical studies have generally failed to demonstrate a significantly increased incidence of gastrointestinal adverse effects compared with placebo. That is the reason why these symptoms are rather attributed to concomitant substance use, poor-quality formulations, or misattribution than adverse effects of creatine itself [44].

In summary, the current body of evidence indicates that creatine supplementation is safe and well tolerated in healthy older adults, with adverse effects generally limited to modest changes in body mass. However, its use should be individualized in medically complex patients, particularly those with significant cardiovascular disease or extensive polypharmacy. The primary limitation remains the lack of long-term randomized controlled trials in heterogeneous geriatric populations, highlighting the need for further research to confirm long-term safety and optimize clinical guidelines for this growing demographic.

7. Conclusions

Creatine supplementation represents a biologically plausible nutritional strategy for supporting healthy aging, primarily through its role in cellular energy metabolism and phosphocreatine-mediated ATP resynthesis. The strongest and most consistent evidence in older adults concerns musculoskeletal outcomes. When combined with resistance training, creatine supplementation appears to enhance gains in lean body mass, muscle strength, and selected measures of physical performance, suggesting its potential value as an adjunct intervention for counteracting age-related muscle decline and supporting functional independence.

In contrast, the effects of creatine on bone health appear limited. Current evidence does not indicate meaningful improvements in bone mineral density, even when supplementation is combined with resistance training. Any potential benefits for skeletal health are therefore more likely to be indirect, mediated through improvements in muscle mass, strength, and mechanical loading rather than through direct effects on bone tissue.

The role of creatine in cardiometabolic health remains less clearly defined. Although creatine may contribute to favorable changes in body composition and may indirectly support glucose metabolism by improving training capacity and skeletal muscle function, current evidence does

not support its use as an independent intervention for glycemic control or cardiovascular disease prevention. Its cardiometabolic relevance should therefore be interpreted within the broader context of resistance training, adequate nutrition, and lifestyle-based risk reduction.

Emerging evidence suggests that creatine may provide modest benefits for selected cognitive domains, particularly memory and information processing speed. However, findings remain heterogeneous, and current data do not support broad or clinically robust cognitive-enhancing effects. Similarly, while mechanistic and preclinical studies provide a rationale for potential neuroprotective effects, clinical evidence in neurodegenerative diseases remains insufficient to confirm therapeutic efficacy.

Overall, creatine supplementation appears to be safe and well tolerated in healthy older adults when used appropriately. Available evidence does not indicate adverse effects on renal function in individuals without pre-existing kidney disease, and commonly discussed side effects such as fluid retention or gastrointestinal symptoms appear to be limited and generally mild. Nevertheless, caution is warranted in older adults with renal impairment, advanced cardiovascular disease, significant fluid-balance disorders, or complex comorbidities, and supplementation should be considered on an individual basis.

In conclusion, creatine supplementation may be regarded as a safe and effective adjunct to resistance training for supporting muscle health and functional capacity in aging populations. Its broader applications, particularly in bone health, cardiometabolic outcomes, cognitive function, and neuroprotection, remain promising but require further well-designed, long-term studies in diverse and clinically representative older populations.

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