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Original Article

Use of creatine to improve physical performance in students during competitive training

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Abstract:
This study is important owing to the need to identify scientifically validated and safe strategies for enhancing the physical performance of student–athletes during competition. **Purpose:** To investigate the effects of creatine monohydrate supplementation on strength, speed–strength, and strength endurance in student–athletes. **Materials and Methods:** Students specializing in strength sports participated in a 24-week educational intervention. They were assigned to either an experimental group (EG), which received creatine monohydrate, or a control group (CG). Changes in maximal strength (triple lift total), strength endurance (bench press to failure), and explosive strength (vertical jump and reactive strength index (RSI)) were measured. **Results:** The EG demonstrated statistically significant improvements across all motor performance tests compared with the CG. Total triathlon performance increased by 47.0% in the EG versus 29.1% in the CG. The most pronounced difference was observed in the strength endurance test, where the EG improved by 98.8%, nearly three times the improvement seen in the CG (33.3%). The RSI increased by 38.5% in the EG compared with 15.8% in the CG. These results indicate the complex ergogenic effects of creatine, which enhance not only maximal strength but also the ability to sustain performance and the efficiency of the stretch–shortening cycle, likely through optimized energy metabolism in muscle cells. **Conclusions:** The use of creatine monohydrate in student–athlete training is a highly effective, scientifically supported strategy for enhancing athletic performance. Supplementation facilitates greater improvements in key physical qualities and skills during the competitive phase of training.
Keywords: physical education, physical training, creatine monohydrate, strength, muscle strength, social life

Introduction

The modern system of physical education and sports training for students is increasingly focused on identifying scientifically validated methods to intensify the educational and training process and enhance students' physical fitness. Considering the combination of substantial academic demands and rigorous athletic activity, safe and effective ergogenic aids that can enhance the body's adaptive potential are especially important (Gerashchenko et al., 2025). Among the various nutritional supplements used in sports, creatine stands out owing to a robust body of evidence supporting its effectiveness in improving physical performance.

The biochemical basis of creatine's effects lies in its central role in energy metabolism. After entering the body, creatine is phosphorylated to form creatine phosphate, which functions as the fastest and most efficient phosphate donor for adenosine triphosphate (ATP) resynthesis during intense muscle contractions (Wyss & Kaddurah-Daouk, 2000). This mechanism is essential for performing short-duration, high-intensity work, which supports the development of both strength and speed. Numerous systematic reviews have consistently shown that creatine supplementation leads to considerable increases in muscle strength, power, and lean body mass (Wax et al., 2021; Jaramillo et al., 2023; Kreider & Stout, 2021). Studies on basketball players demonstrate that creatine monohydrate supplementation, combined with structured training, significantly improves jumping ability and

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sport-specific performance (Vargas-Molina et al., 2022; Bolotin et al., 2021). These findings are directly relevant to the physical training needs of students, whose programs emphasize strength and speed–strength exercises.

Contrary to common belief, the benefits of creatine are not limited to anaerobic performance. Recent research indicates that it can also improve aerobic endurance (Forbes et al., 2023; Fernández-Landa et al., 2023), making it a valuable tool in complex sports such as football, where mixed performance demands are common (Abreu et al., 2023), as well as in combat sports (Burke, 2021; Kolokoltsev et al., 2021; Vicente-Salar et al., 2022), thereby broadening its potential applications in the collegiate setting.

A critical factor in determining the safety of any supplement is its tolerability profile. In this regard, creatine monohydrate is among the most extensively studied and safest supplements, and common concerns about adverse effects on the kidneys and liver in healthy individuals are not supported by scientific evidence (Antonio et al., 2021; Mischenko et al., 2021; Hall, Manetta, & Tupper, 2021). Research continues to explore optimal administration strategies. For instance, the timing of creatine intake—whether pre- or post-workout—has been debated, but current evidence indicates that timing is not a decisive factor for long-term gains in muscle mass and strength (Candow et al., 2022). Despite the development of new forms, such as creatine nitrate (Mabrey et al., 2024; Romanova et al., 2022), creatine monohydrate remains the "gold standard" in terms of both effectiveness and cost (Fazio, Elder, & Harris, 2022). Creatine's multifaceted effects on the body merit special attention. In addition to muscle tissue, it accumulates in the brain, serving as an energy buffer and neuroprotective agent. Research indicates that creatine supplementation can improve cognitive function, particularly under conditions of mental fatigue, metabolic stress, or oxygen deprivation (Forbes et al., 2022). For students who are constantly under mental stress, this potential of creatine has a value that extends beyond athletic performance. A personalized approach to dietary supplementation is increasingly important. Certain groups of students may derive particular benefit from creatine supplementation. Vegetarians, whose diets lack primary sources of creatine such as meat and fish, often have lower baseline creatine levels (Gutiérrez-Hellín et al., 2024). Additionally, the use of creatine among female student–athletes requires careful consideration because their nutritional strategies may differ (Sims et al., 2023). Research is also exploring the combined use of creatine with other ergogenic aids, such as caffeine, to investigate potential synergistic effects (Elosegui et al., 2022; Kryzhevsky et al., 2022;). Current evidence refutes the hypothesis of antagonism and suggests a possible synergistic effect. Creatine is a multifunctional agent that can positively influence both the physical and cognitive aspects of student performance. However, to fully realize its potential in an educational setting, it is essential to integrate the available scientific data into a coherent set of recommendations that considers the unique characteristics of the student training process.

Research Aim: To assess the effect of creatine supplementation on the development of key physical qualities and performance indicators in students engaged in systematic physical training during the competitive period.

Materials and Methods

The experimental study was performed at the Department of Physical Education, Siberian Federal University (SFU, Russia) from January to September 2025. The total duration of the experimental program was 36 weeks. Forty-eight full-time SFU students, ranging from first to third year, who met the eligibility criteria participated in the study. The sample was recruited on a voluntary basis and included 30 males (62.5%) and 18 females (37.5%). All participants provided written informed consent. The study was performed in accordance with the ethical principles of the 2008 Helsinki Declaration. Researchers and specialists from multiple universities in Russia, Kyrgyzstan, and Kazakhstan collaborated on this project.

Inclusion criteria were: age 18–21 years; absence of medical contraindications to physical exercise and creatine supplementation, confirmed by a standard medical certificate; and regular physical activity for at least one year prior to the study, with a minimum of two structured workouts per week.

Exclusion criteria included: acute or chronic diseases in the acute stage; use of pharmacological agents or dietary supplements affecting physical performance within three months prior to or during the study; missing more than 20% of scheduled training sessions; and voluntary withdrawal from the study at any stage. Participants were randomly assigned to two groups: the control group (CG, n = 24; 15 men, 9 women) and the experimental group (EG, n = 24; 15 men, 9 women). Baseline statistical analysis showed no significant differences ($p > 0.05$) between the groups in key anthropometric and physiometric parameters. Participants in the EG received micronized creatine monohydrate (99.9% purity) following a two-phase supplementation regimen:

- ***Loading phase*** – 2 weeks: The daily creatine dose was calculated individually using the formula 0.3 g/kg body weight. The total daily dose was divided into four equal portions, taken 4–5 h apart. The average daily dose was 21.6 ± 2.8 g.

- ***Maintenance phase*** – 4 weeks: A fixed daily dose of 5 g (single dose) was administered. On training days, the supplement was consumed within 30 min post-workout. On rest days, it was taken in the morning with breakfast. Creatine was dissolved in 200 mL of a carbohydrate solution (20% dextrose or fruit juice) to enhance insulin-mediated transport into muscle cells. The solution temperature was maintained within 18°C–22°C.

Both groups followed a single 24-week powerlifting competition preparation program based on block periodization principles (Table 1). Training sessions were performed twice per week.

Table 1. 24-week powerlifting competition preparation program

Period (Block)	Block goal	Intensity (percentage of maximum)	Volume (repetitions×sets)	Primary exercises	Assistance exercises	Block goal
T0–T1 (Weeks 1–8)	Development of muscle hypertrophy, refinement of technique for competitive lifts, and establishment of a metabolic and structural foundation for subsequent strength training	Developing muscle hypertrophy, improving technique for competitive exercises, creating a metabolic and structural foundation for subsequent strength training	60–75%	6–10 reps x 4–5 sets	Squats, bench press, deadlifts in conventional and/or competition style	Leg press, Romanian deadlift, dumbbell press, bent-over rows, hyperextensions, core exercises
T1–T2 (Weeks 9–16)	Conversion of muscle potential into maximal strength performance and adaptation of the neuromuscular system to high loads	Transforming muscle potential into maximum strength performance, adapting the neuromuscular system to high loads	75–90%	3–5 reps x 3–5 sets	Squats, bench press, deadlift (with variations: pauses, from blocks)	Bar presses, squats with bands (for the equipped division), grip development exercises
T2–T3 (Weeks 17–24)	Attaining peak maximal strength, preparing for competition, and optimizing recovery and psychophysiological state	Achieving peak maximal strength, competition preparation, optimizing recovery processes and psychophysiological state	85–100%	1–3 reps x 2–4 sets	Squats, bench press, deadlift (reaching maximum weights, simulating competition)	Light assistance exercises to maintain tone, focus on recovery, reduce the amount of assistance work

Note: T0–T3 represent the stages of the training process.

Methods for assessing physical fitness and performance during the competitive period:

Maximum strength was assessed by measuring the one-repetition maximum (1RM) in three competitive powerlifting lifts: back squat, bench press, and deadlift. Testing followed international standards for strength assessment and included the following stages: a general warm-up of 10–15 min (joint exercises, dynamic stretching, and light cardio), followed by a specific warm-up with progressively increasing resistance, and sequential sets with incremental loads (2.5–10 kg, depending on the exercise) until concentric failure occurred while maintaining proper technique. The 1RM was recorded as the maximum weight lifted through a full range of motion in a single repetition. Certified competition equipment (Eleiko Olympic bars and plates, Sweden), calibrated to ±0.1 kg, was used during the testing.

Strength endurance was evaluated using a bench press repetition maximum test at 75% of each participant's baseline 1RM (T0). The test protocol included individualized load standardization, strict adherence to a 2:1:2 tempo (guided by a metronome), a full range of motion, and controlled pre-test rest periods. Participants were required to maintain proper technique for each repetition, and the test continued until concentric failure occurred or technique could no longer be maintained. The total number of correctly executed repetitions was recorded. Lower extremity explosiveness was assessed using the standing vertical jump test with the OptoJump Next optical measuring system (Microgate, Italy). The testing protocol was standardized. Participants began in an upright standing position with hands on the waist, performed three maximal jumps with 60-s recovery intervals between attempts, and jump height (cm) and contact time (ms) were measured. The highest value from the three attempts was recorded as the final result.

Results

Table 2 presents the results of the strength endurance assessment for CG and EG students at various stages of the study.

Table 2. Strength endurance assessment results (M ± m)

Indicators	Group	T0 (baseline)	T1 (8 weeks)	T2 (16 weeks)	T3 (24 weeks)	Δ% (T0–T3)	p (T0–T3)
Bench press repetitions (75% of maximum)	EG	8.2 ± 1.5	11.8 ± 1.8	14.5 ± 2.1	16.3 ± 2.4	+ 98.8 %	< 0.001
	CG	8.4 ± 1.6	9.1 ± 1.7	10.3 ± 1.9	11.2 ± 2.0	+ 33.3 %	0.002
p (between-group differences)		0.624	< 0.001	< 0.001	< 0.001		

Note: T0–T3 indicate training stages; p denotes statistical significance.

Analysis of strength endurance results revealed significant differences in performance dynamics between the groups over time. At the baseline stage (T0), no statistically significant differences in strength endurance were observed between the CG and EG (8.2 ± 1.5 vs. 8.4 ± 1.6 repetitions, $p = 0.624$), indicating initial homogeneity of the samples for this parameter.

During the 24-week training cycle, both groups showed positive improvements. In the CG (CG), which followed the training program without supplementation, strength endurance increased significantly from 8.4 ± 1.6 repetitions at T0 to 11.2 ± 2.0 repetitions at T3 ($p = 0.002$), representing a 33.3% improvement and confirming the effectiveness of the training program itself. In the EG, which combined the training program with creatine supplementation, a substantially greater increase was observed. Strength endurance increased from 8.2 ± 1.5 repetitions at T0 to 16.3 ± 2.4 repetitions at T3, corresponding to a 98.8% increase ($p < 0.001$). Thus, the final results in the EG nearly doubled compared to baseline.

The results of the analysis of maximum strength dynamics in the three competitive powerlifting lifts (squat, bench press, and deadlift) and the total lift are presented in Table 3. At baseline (T0), no statistically significant differences were observed between the EG and CG for any strength measure ($p > 0.85$), confirming the validity of random assignment and the initial homogeneity of the sample in terms of strength fitness.

During the 24-week study, both groups demonstrated statistically significant gains in all strength indicators ($p < 0.001$), reflecting the overall effectiveness of the training program. However, the rate and absolute magnitude of strength improvements differed significantly between the groups.

Table 3. Changes in maximum strength in the control (CG) and experimental (EG) groups (M ± m)

Exercise	Group	T0 (baseline)	T1 (8 weeks)	T2 (16 weeks)	T3 (24 weeks)	Δ% (T0-T3)	p (T0-T3)
Squat, kg	EG	105.3 ± 11.8	125.6 ± 12.3	142.8 ± 13.1	156.4 ± 14.2	+ 48.5%	< 0.001
	CG	104.8 ± 12.1	116.3 ± 11.9	127.5 ± 12.6	135.2 ± 13.4	+ 29.0%	< 0.001
p (between-group differences)		0.851	0.003	< 0.001	< 0.001		
Bench Press (kg)	EG	82.7 ± 9.5	98.4 ± 10.1	112.6 ± 10.8	123.8 ± 11.5	+ 49.7%	< 0.001
	CG	83.1 ± 9.8	92.7 ± 9.9	101.3 ± 10.4	108.9 ± 10.9	+ 31.0%	< 0.001
p (between-group differences)		0.872	0.028	< 0.001	< 0.001		
Deadlift, kg	EG	126.2 ± 13.5	147.8 ± 14.2	166.3 ± 15.1	181.5 ± 16.3	+ 43.8%	< 0.001
	CG	125.7 ± 13.8	138.9 ± 14.0	151.2 ± 14.7	160.8 ± 15.5	+ 27.9%	< 0.001
p (between-group differences)		0.889	0.011	<0.001	<0.001		
Total Triathlon, kg	EG	314.2 ± 32.1	371.8 ± 34.2	421.7 ± 36.5	461.7 ± 39.8	+ 47.0%	< 0.001
	CG	313.6 ± 32.8	347.9 ± 33.1	380.0 ± 35.0	404.9 ± 37.1	+ 29.1%	< 0.001
p (between-group differences)		0.941	0.008	< 0.001	< 0.001		

Note: T0–T3 indicate training stages; p denotes statistical significance.

In the CG, maximum strength increased by 29.0%, from 104.8 ± 12.1 kg to 135.2 ± 13.4 kg. In the EG receiving creatine, the increase was significantly greater, reaching 48.5%, from 105.3 ± 11.8 kg to 156.4 ± 14.2 kg. Statistically significant differences between the groups, favoring EG, were evident as early as week 8 ($p = 0.003$) and continued to widen at week 16 ($p < 0.001$) and week 24 ($p < 0.001$). A similar trend was observed for the bench press: CG improved by 31.0%, from 83.1 ± 9.8 kg to 108.9 ± 10.9 kg. In the EG, bench press strength increased by 49.7%, from 82.7 ± 9.5 kg to 123.8 ± 11.5 kg. Statistically significant differences between the EG and CG emerged at week 8 ($p = 0.028$) and became highly significant at subsequent assessments ($p < 0.001$). In the deadlift, CG showed an increase of 27.9%, from 125.7 ± 13.8 kg to 160.8 ± 15.5 kg, whereas EG improved by 43.8%, from 126.2 ± 13.5 kg to 181.5 ± 16.3 kg. Intergroup differences were significant from week 8 ($p = 0.011$) and reached a high level of significance by the end of the study ($p < 0.001$).

The integrated measure of strength fitness, the total lift, provides the clearest indication of the intervention's overall effectiveness. In the CG, the total lift increased by 29.1%, from 313.6 ± 32.8 kg to 404.9 ± 37.1 kg. In the EG, the increase was 47.0%, from 314.2 ± 32.1 kg to 461.7 ± 39.8 kg. The difference in the rate of improvement led to statistically significant intergroup differences as early as week 8 ($p = 0.008$), which further increased at T2 and T3 ($p < 0.001$). These results demonstrate that while a specialized training program alone effectively develops maximum strength, supplementation with creatine monohydrate produces both statistically and practically greater gains across all three competitive powerlifting lifts. On average, overall strength gains in EG were 1.6 times greater than those in CG.

The dynamics of explosive strength and neuromuscular reactivity in the lower extremities are shown in Table 4. At baseline (T0), no statistically significant differences were observed between the EG and CG for any of the three parameters ($p > 0.68$), indicating equivalence in these measures at the beginning of the study.

Table 4. Changes in explosive strength of the lower extremities (M ± m)

Indicators	Group	T0 (baseline)	T1 (8 weeks)	T2 (16 weeks)	T3 (24 weeks)	Δ% (T0-T3)	p (T0-T3)
Vertical jump height (cm)	EG	38.2 ± 3.5	41.8 ± 3.2	44.6 ± 3.8	47.3 ± 4.1	+ 23.8 %	< 0.001
	CG	37.9 ± 3.7	39.5 ± 3.4	40.8 ± 3.6	41.9 ± 3.9	+ 10.6 %	< 0.002
p (between-group differences)		0.735	0.008	< 0.001	< 0.001		
Peak power (W/kg)	EG	45.3 ± 4.2	49.8 ± 4.5	53.6 ± 4.9	57.1 ± 5.2	+ 26.0 %	< 0.001
	CG	45.1 ± 4.4	47.2 ± 4.3	48.9 ± 4.7	50.3 ± 4.8	+ 11.5 %	< 0.003
p (between-group differences)		0.852	0.021	< 0.001	< 0.001		
Surface contact time (ms)	EG	215 ± 18	208 ± 16	196 ± 15	185 ± 14	– 14.0 %	< 0.001
	CG	217 ± 19	212 ± 17	206 ± 16	201 ± 15	– 7.4 %	0.015
p (between-group differences)		0.681	0.325	0.012	< 0.001		

Note: T0–T3 indicate training stages.

Both groups demonstrated statistically significant improvements in this parameter. In the CG, vertical jump height increased by 10.6%, from 37.9 ± 3.7 cm to 41.9 ± 3.9 cm ($p = 0.002$), reflecting adaptation to the strength training program. In contrast, the EG receiving creatine showed a more than twofold greater increase of 23.8% (from 38.2 ± 3.5 cm to 47.3 ± 4.1 cm, $p < 0.001$).

Ground contact time, which reflects muscle reactivity (the ability to quickly switch from yielding to force production), also improved, with decreases indicating better performance. In the CG, contact time decreased by 7.4%, from 217 ± 19 ms to 201 ± 15 ms ($p = 0.015$). In the EG receiving creatine, the reduction was nearly double, at 14.0%, decreasing from 215 ± 18 ms to 185 ± 14 ms ($p < 0.001$). Unlike maximal strength gains, the statistically significant advantage of EG emerged later, at week 16 ($p = 0.012$), and became highly significant by the end of the study ($p < 0.001$).

Overall, the data indicate that creatine monohydrate supplementation during a strength training program exerts a pronounced positive effect not only on maximal strength but also on the explosive properties of muscle function. Participants in the EG exhibited significantly greater improvements in rapid force production and neuromuscular reactivity, as demonstrated by simultaneous increases in vertical jump height and reductions in ground contact time.

To more comprehensively evaluate neuromuscular performance, the reactive strength index (RSI) was calculated. This index serves as an integrative measure of stretch–shortening cycle efficiency and is defined as the ratio of jump height to ground contact time. It reflects the athlete's ability to effectively use elastic energy stored during the eccentric (yielding) phase of movement (Table 5).

Table 5. Additional calculated indicators – reactive strength index

Indicators	Group	T0	T1	T2	T3	Δ%
Reactive force index	EG	0.78 ± 0.09	0.86 ± 0.08	0.95 ± 0.10	1.08 ± 0.12	+ 38.5%
	CG	0.76 ± 0.08	0.80 ± 0.07	0.83 ± 0.09	0.88 ± 0.10	+ 15.8%

At baseline (T0), the average RSI values did not differ significantly between the EG (0.78 ± 0.09) and CG (0.76 ± 0.08), confirming initial homogeneity for this complex indicator. Over the 24-week training period, both groups showed positive changes. In the CG, where participants followed the training program alone, a moderate but consistent improvement in the RSI was observed. By the end of the study (T3), the CG value reached 0.88 ± 0.10, representing an overall increase of 15.8%, indicating that the strength program contributed to enhanced effectiveness of the stretch-shortening cycle. In the EG, where training was combined with creatine monohydrate supplementation, the improvements were substantially greater. RSI values increased steadily at each assessment stage, reaching 1.08 ± 0.12 by T3, representing an overall increase of 38.5%.

Comparative analysis revealed that the total increase in the RSI in the EG was more than 2.4 times greater than in the CG. This pronounced difference highlights the powerful synergistic effect of creatine supplementation on the development of reactive capacity.

The effect can be attributed to enhanced energy availability for rapid muscle contractions via ATP resynthesis, enabling athletes not only to generate greater force (reflected in increased jump height) but also to shorten the transition time from the eccentric to the concentric phase of movement. These findings demonstrate that creatine supplementation not only supports the development of individual physical qualities such as strength and speed but also optimizes their interaction, thereby improving the overall effectiveness and efficiency of neuromuscular performance during fast ballistic movements.

Discussion

The results obtained in the study significantly contribute to our understanding of the role of creatine in sports training and allow us to formulate a number of important theoretical and practical conclusions. Data analysis revealed several fundamentally significant aspects regarding the effect of the supplement on various components of physical fitness in university students and powerlifters. The key result of the study is confirmation of the pronounced ergogenic effect of creatine monohydrate on the development of maximal strength. The total increase in the total triathlon in the experimental group was +47.0%, which is significantly higher than the increase in the control group (+29.1%), which followed an identical training program. These data are consistent with systematic reviews and fundamental studies confirming the ability of creatine to increase strength by increasing intramuscular phosphocreatine stores and accelerating ATP resynthesis during high-intensity exercise (Kreider et al., 2021; Forbes et al., 2022). However, the above-average increase achieved in our study is likely due to the synergy of supplementation with a highly specialized and carefully periodized competition preparation program.

Of particular scientific interest is the significant impact creatine has been found to have on strength endurance. The increase in submaximal bench press repetitions in the experimental group (+98.8%) was almost three times greater than in the control group (+33.3%). This finding underscores that creatine's effects go beyond improving the one-repetition maximum and are critical for maintaining high performance throughout the entire set. This refutes the narrow notion of creatine as a supplement solely for peak strength and confirms its role in buffering ion homeostasis and delaying the onset of muscle fatigue (Antonio et al., 2021). Equally important is the established positive effect of creatine on explosive and reactive strength. Increases in vertical jump height (+ 23.8 % in EG vs. + 10.6 % in CG) and, more significantly, in reactive strength index (+ 38.5 % in EG vs. + 15.8 % in CG) demonstrate improved effectiveness of the stretch-shortening cycle. This suggests that increased energy availability in the form of ATP optimizes the speed and power of muscle contraction, allowing the neuromuscular system to more effectively utilize elastic energy. This aspect is of great importance not only for powerlifting but also for most speed-strength sports. This study provides scientifically substantiated evidence of the high effectiveness of integrating creatine monohydrate into the training process of university athletes. The results obtained have direct practical significance and can be used by coaches and athletes to optimize training programs aimed at comprehensive strength development and achieving higher athletic performance.

Conclusion

The inclusion of creatine monohydrate in the training of student–athletes resulted in statistically and practically significant advantages across all key performance parameters compared to a group following the same training program without supplementation. Creatine proved to be a powerful enhancer of maximal strength development. The increase in the total of competitive powerlifting lifts in the EG (47.0%) substantially exceeded that of the CG (29.1%), demonstrating that supplementation accelerates strength adaptation and allows athletes to achieve higher levels of peak performance within a single training macrocycle.

Creatine had the most pronounced impact on the development of strength endurance. In the EG, submaximal performance increased by 98.8%, nearly three times the improvement observed in the CG (33.3%). This indicates that creatine is essential not only for producing a single maximal effort but also for sustaining high-intensity work over time, delaying the onset of local muscle fatigue.

Creatine positively affects speed–strength performance and neuromuscular reactivity. In the EG, more than a twofold increase in vertical jump height and RSI suggests that creatine improves the efficiency of the stretch–shortening cycle by optimizing the muscles' capacity for rapid, powerful force generation.

Strategic use of creatine monohydrate during training and competition is a scientifically supported and highly effective method for enhancing athletic performance in student–athletes. Supplementation not only accelerates gains in maximal strength and strength endurance but also significantly improves speed–strength capabilities, providing a robust foundation for achieving peak competitive results.

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