Capter 128

Creatine and physical resistance exercises: positive effects and changes in the years: an integrative review

https://doi.org/10.56238/devopinterscie-128

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ABSTRACT
A supplement widely used in resistance training is creatine, which is composed of three amino acids (arginine, glycine, and methionine). It is found primarily in skeletal muscle (95%) and plays an important role in the rapid supply of energy during muscle contraction via the ATP-CP system. Because of this, in this study, an integrative literature review was carried out, to understand the positive effects and renal changes of creatine in physical exercises. The research was carried out between September 2021 and May 2022, with searches in PubMed and Scielo databases. The following descriptors from the DeCS (descriptors in health science created by BIREME) and MESH (medical subject headings) were used: "creatine supplementation", "dose-dependent creatine", "creatine", "Creatine Supplementation and Exercise Training". Most studies have shown that creatine supplementation (CR) is important for resistance training and muscle performance and is an effective resource in increasing energy, as creatine is involved in one of the metabolic energy delivery systems, in which Adenosine bisphosphonates (ADP) are enzymatically linked to phosphocreatine (CP) to regenerate adenosine triphosphate (ATP), the main energy currency. After creatine supplementation, there is more CR in the muscles, which favors an increase in energy supply through ATP resynthesis

Keywords: creatine supplementation, creatine and physical exercise

1 INTRODUCTION

Creatine supplementation is beneficial in increasing muscle mass, and its content in muscles assists in the development, of maximum strength, strength during exercise, and less fatigue during training sessions. Athletes who benefit the most are those who perform high-intensity and short-term exercises (e.g., sprints, jumps) (VEGA, et al 2019).

There are several supplements used to promote muscle recovery by replacing energy substrates such as creatine monohydrate (CrM) or β-hydroxy β-methyl butyrate (HMB). Monohydrate creatine (CrM) improves aerobic capacity mainly by increasing the flow of "creatine-phosphocreatine" (Cr-PCr), which leads to a higher yield of myocellular ATPases, an increase in the synthesis of PCr, the accumulation of inorganic phosphorus, Ca2 +H + and ADP, greater availability of amino acids, inhibition of glycolysis and possible increased neuromuscular performance (FERNÁNDEZ-LANDA *et al*., 2020).

Exogenous creatine supplements are often consumed by athletes in amounts up to 20 g/day for a few days, followed by 1 to 10 g/day for weeks, months, and even years. Typically, consumers do not report any adverse effects. However, gastrointestinal disorders and muscle cramps have occasionally been reported in healthy individuals, but the effects are anecdotal. Liver and kidney dysfunctions have also been suggested, based on small changes in markers of organ functions and occasionally reported cases, but well-controlled studies on the adverse effects of exogenous creatine supplementation are almost nonexistent. Studies that followed liver changes during the use of medium-term creatine (4 weeks) in young athletes have not shown any evidence of dysfunction based on serum enzymes and urea production. In the short-term (5 days), medium to ln go (9 weeks) and long-term (up to 5 years) small groups of athletes were observed whose renal function was monitored by methods of clearance and rate of protein excretion in the urine, and in them, no adverse effects on renal function was found (JACQUES R. POORTMANS *et al*., 2000).

In contrast to most studies that did not report a direct association between renal dysfunction and long-term creatine supplementation, few investigations have revealed a slight but not clinically significant increase in creatinine. For example, Taner et al. (2011) reported an 18-year-old man referred to the hospital with the main complaint of nausea, vomiting, and gastric pain. As a bodybuilder, I had supplemented creatine with the dose of 20 g/d for 5 days followed by 1 g/d for the next 6 weeks. Regarding the laboratory data of the patient at admission, serum urea (39.98 mmol / L), serum creatinine (201.55 mmol / L), and uric acid values (0.37 mmol / L) were high. Other biochemical parameters and hemo gram were normal. A urine test revealed only proteinuria and protein excretion in urine in 24 hours was 284 mg. Although there were no abnormalities in the kidneys by ultrasound, renal biopsy was suggestive of acute tubular necrosis (CHARLOTTE LANHERS et al 2016).

.The day before the above, this study, had the purpose of contributing to the improvement of knowledge with efficient dosages of creatine supplementation, to promote an improvement in markers and performance of athletes practicing resistance exercise.

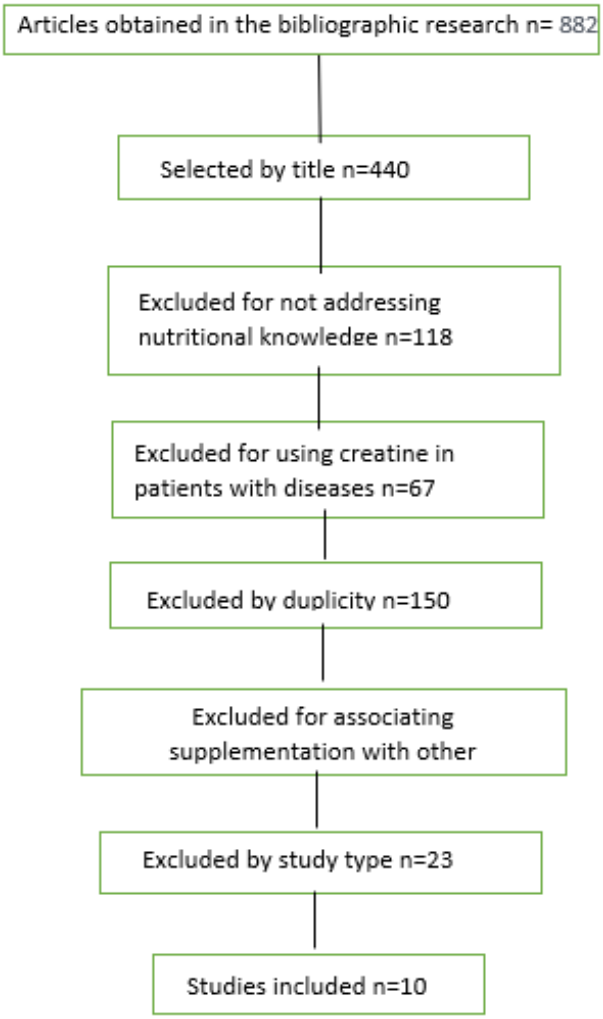
2 METHODOLOGY

This is an Integrative Literature Review. To achieve it, it took six stages: 1- Identify the theme and formulate the guide question 2 - establishment of inclusion and exclusion criteria for studies; 3- Definition the information extracted from the selected studies and Additional classification; 4- Evaluation of the

studies included in the review; 5- Interpretation of the results 6- Introduction to the review and synthesis and condition. For the first stage, the following guide question was formulated, which involves "the answers in creatine supplementation dosages in hypertrophy and possible changes in the row". Eligibility criteria were then established. The scientific survey was conducted between April and May 2022, with articles published in the last 10 years (2012 to 2021) in the PubMed databases, medical literature analysis and retrieval,scielo, *Journal of the International Society of Sports Nutrition* (*JISSN*), National Center for Biotechnology Information.

The inclusion criteria were the scientific articles available in the ígra, the studies published in national and international journals, in English, Portuguese, and Spanish; the studies had to be clinical, randomized, using individuals practicing resistance exercise, non-vegetarian, and using creatine. The following descriptors were used in the DeCS (descriptors in health science created by BIREME) and MESH (medical subject headings): "creatine supplementation", "creatine dependent dose", "creatine", "Creatine Supplementation and Exercise Training". The Boleano operator of choice was "AND" and "OR".

Figure 1. Graphical representation of the application of inclusion and exclusion criteria



Source: Author himself,2022.

3 RESULTS AND DISCUSSION

Most studies have shown that creatine (CR) supplementation is important for muscle endurance and performance training and is an effective resource in increasing energy because creatine is involved in one of the metabolic energy supply systems, in which adenosine bisphosphonates (ADP) are encresteredly bound to phosphocreatine (CP) to regenerate adenosine triphosphate (ATP), the main energy currency. After creatine supplementation, there is more CR in the muscles, which favors the increase in energy supply through atp resynthesis

The combination of keywords related to the theme was searched in the databases, in which 882 articles were found, of these 872, was excluded because they did not fit the inclusion requirements, resulting in 10 articles for analysis. Of the 10 articles analyzed in Chart 1, 9 were performed by double-blind randomized control case method and 1 by single-blind. The research locations found were: Europe (Spain), South America (Brazil and Colombia), North America (USA and Canada), and Asia (Taiwan). The types of creatine used were: creatine monohydrate and creatine magot. Regarding the characteristics of the individuals selected to carry out the studies, the majority were male, with a total of 272 men and with ages ranging from 20-76 years, while in females, a total of 19 women were found, aged 57-64 years.

Of the included articles, two (6 and 9º) did not present significant changes in the supplemented group compared to placebo, both with protocol times of 6 and 8 weeks and with different creatine supplementation strategies, 0.07g/Kg, and 5g, respectively. The other 8 articles (1, 2, 3, 4, 5, 7, 8, and 10), which, despite presenting different protocol times, being the lowest of 5 days (article 1) and the largest of 12 months (Article 4), presented positive results, in the strength to perform a repetition with the maximum load compared to individuals who received placebo.

In addition to the force markers to perform a maximum repetition, in exercises such as leg press, supine, knee extension, and squat. 2 studies (5th and 9th) reported a greater gain in muscle mass in creatine intake (post: 80.0 ± 18.3 kg)) compared to pre-training intake (pre:78.3 ± 17.3 kg). These indicate that creatine supplementation possibly has a synergistic effect with training, but supplementation may play an important role in the activity intensity and duration of training.

Table 1 - Synthesis matrix used in this integrative review.

author/site	sample characteristics			type of study/method	supplementation			findings	main conclusions
	(n)	Age (±DP)	Sex		Kind	Dose	Intervention period:		
Diego A. Bonilla. 2021	27	(26.1 ± 7.6 years	m	single-blind three-arm controlled randomized study	creatine monohydrate	0.1 g·kg−1	8 weeks	Significant improvements were observed after the CS-RT program in the participants supplemented with or without CrM in the main variables studied(e.g., percentage of total body fat, fat mass, full-body LGM, lower limbs fat mass, and lower- sulfate MLG).	Men trained in resistance following a high protein diet and a CS-RT program with orwithout CrM supplementation improved body composition and strength-related variables in the lower limbs after eight weeks
Darren G Candow-Saskatoon, SK. 2020	46	49-58 years old	m	double-blind	creatine monohydrate	0.05g/kg	12 months	Overall, creatine supplementation didn't affect bone, muscle, or strength changes. Any positive changes in thesevariables were therefore related to the resistance training program.	results showed no effectof creatine supplementation on bone mineral density
Patrick Bernat.2019	27	60-76 years old	m	randomized clinical trial	creatine monohydrate	0.1 g·kg	8 weeks	Creatine supplementation produced higher leg press gains and total lower bodystrength (leg press, knee flexion, combined knee extension)	Both groups significantly similarly increased body mass over time (CR: 1.80 kg; 95% CI [0.73, 2.86]; PLA: 0.96 kg; CI 95% [-0.22, 2.16]; p = 0.011; ES: 0.04).
Sarah johannsme	40	M: 58.0 ± 3.0 F: 57.6 ±	(21 m,19 f)	double-blind	creatine monohydrate	(0.1 g/kg/day	12 weeks	The results showed that drop-set resistance	The RC group experienced a significant increase in

yer. 2018		5.0						training increased musclemass, strength, endurance, and functionality tasks, and creatine supplementation increased the gains mass and muscle strength	weight over time (pre: 78.3 ± 17.3 kg, post: 80.0 ± 18.3 kg) without alteration for the PLA group (pre: 81.8 ± 18.9,post: 81.2 ± 18.4 kg).
Chia-Chi-Wang, Taiwan. 2018	330	20± 2	M	double-blind	creatine monohydrate	5 5g	4 4 weeks	the strength in the Cr group was significantly highercompared to the Pla group after training (178.33 ± 16.86 kg vs. 165.66 ± 14.62 kg, p < 0.05, ES = 0.80).	creatine supplementation duringthe training protocol applied in this study may result in Increase maximum muscle strength after 4weeks of training and reduce muscle damage caused by complex training.
João Pedro Nunes, BRAZIL. 2017	43	(22.7 + 3.0 years	M	double-blind	creatine monohydrate capsule form of 0.625 g	0 0.3 g/kg perday	12 weeks	the group achieved higher increases compared to PLA. However, no major effect of time has been revealed on body fat	Cr supplementation produces non-uniform hypertrophic effectsbetween body segments, with the greatest change
									observed in the upperlimbs.
Sarah Johannsmeyer,	40	M: 58.0 ± 3.0 F: 57.6 ± 5.0	(21 m,19 f)	double-blind	creatine monohydrate	(0.1 g/kg/day	12 weeks	The results showed that drop-set resistance	The RC group experienced a significant increase in

USA. 2016								training increased muscle mass and strength. Creatine supplementation increasedgains mass and muscle strength	weight over time (pre: 78.3 ± 17.3 kg, post: 80.0 ± 18.3 kg) without alteration for thePLA group (pre: 81.8 ± 18.9, post: 81.2 ± 18.4 kg).
Jose Antonio, BRAZIL.2013	19	3.1 ±2.9	m	Control case	creatine monohydrate	5g	4 weeks	The results of this study suggest that creatine monohydrate consumption improves. body composition.	In conclusion, post- workout creatine supplementation for 4weeks in recreational bodybuilders mayproduce superior gains in LgM and strength compared topre-workout supplementation
Stanislaw Sterkowicz1.2012	10	21.2±3.3 years	M	double-blind	Creatine Malyth	0.07 g. Kg	6 weeks	The aerobic power index decreases, in the case ofpeople who have not supplemented but the differences were not significant	Use of supplementation of creatine marate does notcause an increase body mass greater than in the control group
MIKEL IZQUIERD	19	age, 20.8 and 23.6 5	M	Clinical rehearsal	creatine monohydrate	220 g	5 5d	In Cr individuals,	the study demonstrated that short-term Cr

O-Madrid, SPAIN.2002		years		randomized, double-blind				1RM increased significantly from 133 11.9 to 147.7 14.1 kg (P 0.001) during the supplementation period.On the other hand, no significant changes were observed in the 1Rm of placebo subjects during theentire experimental period.	supplementation (20 g·d 1 by 5 d) led to significant improvements in the maximum strength ofthe lower body,

Table 02- of publication of selected articles

Creatine Enhances the Effects of Cluster-Set Resistance Training on Lower-Limb Body Composition and Strength in Resistance-Trained Men: A Pilot Study	Iego A. Bonilla. 2021
Effect of 12 months of creatine supplementation and whole-body resistance training on measures of bone, muscle, and strength in older evils	Darren G Candow-Saskatoon, SK. 2020
Effects of high-velocity resistance training and creatine supplementation in untrained healthy aging evils	Patrick Bernat. 2019
Effects of 4-Week Creatine Supplementation Combined with Complex Training on Muscle Damage and Sport Performance	Sarah johannsmeyer. 2018
The Effects of Creatine Supplementation on Explosive Performance and Optimal Individual Postactivation Potentiation Time	Chia-Chi-Wang, Taiwan. 2018
Creatine supplementation elicits greater muscle hypertrophy in the upper than lower limbs and trunk in resistance-trained men	João Pedro Nunes, BRAZIL. 2017
Effect of creatine supplementation and drop-set resistance training in untrained aging adults	Sarah Johannsmeyer, USA. 2016
The effects of pre versus post-workout supplementation of creatine monohydrate on body composition and strength	Jose Antonio, BRAZIL. 2013
The effects of training and creatine malate supplementation during the preparation period on physical capacity and special fitness in judo contestants	Stanislaw Sterkowicz1. 2012
Effects of creatine supplementation on muscle power, endurance, and sprint performance	MIKEL IZQUIERDO-Madrid, SPAIN. 2002

4 FINAL CONSIDERATIONS

Given the content of the exposure and the results obtained in this study, it can be concluded that creatine supplementation is an effective resource of energy increase for high-intensity exercises. Creatine works in one of the metabolic pathways for energy supply and replacement, allowing individuals to improve training performance, repetitions, and strength and delay fatigue during the final stages of exercise, thereby increasing muscle damage and mass development. In addition, water retention in muscle cells caused by supplementation can be perceived to produce a stimulus that increases protein synthesis. The dose used and the time of use is necessary to provide the synergistic effect of creatine, highlighting that doses between 3 grams and 5 grams for a minimum period of 4 to 5 weeks. Thus, some changes are already observed, which are enough to increase creatine stocks in muscle. The safety of supplements is highlighted, as there is no convincing scientific evidence of harmful effects with short or long-term use of the selected articles, the complications reported, were between a slight feeling of nausea or intestinal discomfort. Regarding the combination of Cr supplements with other substances (carbohydrates, beta-alanine/or protein) to potentiate the effect, this practice may be beneficial for increasing cr absorption in muscles, but there does not seem to be a greater impact on performance than Cr alone.

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