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The Effect of Creatine Supplementation on Body Composition and Bone Health in the Elderly

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Abstract

Introduction: Ageing is associated with body composition changes, including decreases in muscle mass and bone content and increases in fat mass. Creatine supplementation is associated with increases in lean Tissue mass in athletes, leading to increased strength and power. There has been recent interest in if creatine supplementation may have similar effects in older individuals, to offset the changes seen in body composition and increase quality of life.

Aims: This review assesses the current literature on whether creatine supplementation in the presence or absence of resistance training improves body composition and bone health in older adults.

Results: In terms of resistance training and creatine supplementation in Combination, there is evidence for increased lean body mass following long-term investigations, above that of resistance training with placebo. Studies without resistance training mostly use acute strategies of creatine supplementation and have produced conficting reports on lean body mass. Body fat percentage does not seem to be altered by either resistance training or creatine supplementation. The literature on creatine supplementation's effect on bone health is also inconclusive, with some reports showing signifcant increases in bone mineral density, whereas several others show no effect.

Conclusions: Creatine supplementation in the elderly may lead to increased lean body mass, and increased bone strength; however these results are far from conclusive. Dosing and timing supplementation protocols between studies may be responsible for the different results and future studies should concentrate on determining if acute or chronic creatine supplementation has a more benefcial effect on body composition in the elderly.

K : Ageing; Creatine; Elderly; Supplementation; Resistance training; Bone health; Body composition

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In the developed world, we are seeing a rapidly expanding elderly population. Latest statistics suggest that the number of people aged over 65 is projected to rise by over 40% in the next 17 years in the United Kingdom [1]. Hence there is a greater need now than ever to understand the biochemical and anatomical changes that occur in ageing, in order to allow them a continued quality of life.

Ageing has been associated with increases in body weight and fat mass, along with decreases in muscle, protein and bone mineral content [2]. A cross-sectional study determined that the increase in fat mass percentage seen in ageing is mostly due to reduced lean mass, except for in the abdomen where the increase is due to fat deposits [3]. is increase in fat mass seen in the elderly is especially worrying as adipose tissue is an important source of pro-in ammatory mediators [4]. is state of in ammation can lead to an increase in risk for many age-related disorders such as atherosclerosis through processes such as endothelial dysfunction [5]. Furthermore, body composition changes in age o en occur in the absence of actual weight changes, making investigating the di erences in lean body mass and fat mass of high importance [6].

Resistance training has shown positive e ects on body composition in elderly subjects [7] and if individuals are healthy enough, regular strength and cardiovascular exercises should be encouraged to maintain body health. However, a longitudinal study in healthy elderly subjects which showed decreases in lean tissues with age, reported that increased physical activity was not able to limit this loss in females at all, and only o set it slightly in males [2]. Also not all elderly subjects are able to or willing to partake in resistance exercise on a regular basis [1]. us an additional strategy may be advantageous in negating this lean body mass loss seen in age.

Over the past years, many studies have indicated the potential use of creatine supplementation in the elderly in order to increase strength and counteract sarcopenia [8]. Creatine is naturally synthesised within the body and is located in skeletal muscles as either free (40%) or in its phosphorylated form (PCr) [9]. It is an important molecule in energy transfer during skeletal muscle contraction, allowing for short bursts of high intensity exercise [9]. Creatine kinase maintains ADP and ATP concentrations at a near constant level for several seconds when the muscle contracts through transfer of a phosphoryl group from PCr to ADP (Figure 1) [10]. Creatine also acts through mitochondrial-myo bril shuttling, where PCr is moved from the mitochondria to the myo brils in periods of intense exercise [11]. PCr is subsequently dephosphorylated, allowing for ATP regeneration and sustained

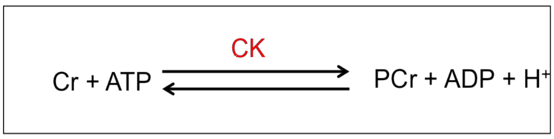

Figure 1: Creatine (Cr) and ATP are catalysed by creatine kinase (CK) to form PCr, which acts as an energy store when extra energy is not required.

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muscle contraction, before being shuttled back to the mitochondria to be phosphorylated again [11]. Creatine supplementation is suggested to increase this free pool of creatine needed for PCr resynthesis, which may enhance energy transfer [9].

In times of requirement, for example high intensity exercise, PCr is shuttled to sites of ATP consumption, where CK catalyses the reverse reaction to replenish ATP at these sites, allowing for increased muscular contraction. PCr and ATP stores are limited however and exercise can only be sustained for approximately seconds [9] exogenous creatine may increase the efficiency of this system by providing more substrate for sustained energy provision [12].

Creatine supplementation has been reported as an effective method to increase physical performance and body mass in many studies utilising it as a sporting aid, especially those involving short, anaerobic activities [13]. Recent interest has also focused on the use of creatine in human ageing, where it has been suggested to have a role in increasing muscle strength and lean body mass, with or without associated resistance training [14]. Interestingly, creatine supplementation has also been linked to an increase in bone cell development and differentiation [15], especially important in the elderly due to the high levels of osteoporosis (OP) reported with age [1]. OP is characterised by low bone mineral density (BMD) and bone tissue deterioration that

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Study'	Supplementation	Training ssions/wk	Body Mass	Fat Mass	Fat Free Mass	% Body Fat
Aguiar et al. 2013	5 g/d for 84 days	3	NS	-	Muscle Mass SD + 3.7%, P<0.01	NS
Bermon et al. [29]	5 g/d for 98 days	3	NS	NS	NS	NS
Bermon et al. [38]	LP = 7 g/day for 14 days on training days MP = 5 g/day for 98 days on training days	3	-	-	NS	NS
Brose et al. [24]	5 g/d for 98 days	3	SD + 1.2 kg (P<0.05)	NS	SD + 1.3 kg (P <0.05)	NS
Candow et al. [25]	0.1 $g.kg^{-1}$ on training days only for 70 Days (Average Cr/d = 8.6 g/d)	3	SD + 1 kg (P<0.05)	-	SD + 1.5 kg (P<0.05)	-
Candow et al. [43]	0.1 $g.kg^{-1}$ on training days only for 224 days	3	-	NS	10ass 1(i)-dn72Bk8sf otf otf	ot6ld.(as)-f[(f ot)1oti7(i

Study	Supplementation	Training sessions/wk	Bone health parameters
Chilibeck et al. [30]	LP = 0.3 g.kg^{-1} body mass for 5 days MP = 0.07 g.kg^{-1} body mass for 79 days Average: LP = 26.4 g/day MP = 6.16 g/day	3	Increased arm BMD (3.2%, p <0.01)
Chilibeck et al. [43]	0.1 g.kg^{-1} body mass for 365 days	3	Decreased femoral neck BMD loss (CR = -1.9 vs. Placebo = -3.9%, P < 0.05) Increased femoral shaft subperiosteal width (Cr = +0.25 cm vs. placebo = +0.22 cm, P <0.05)
Gualano et al. [42]	LP: 20 g/day for 5 days MP: 5 g/day for 161 days	2	NS
Lobo et al. [39]	1 g/d for 365 days	0	NS
Tarnopolsky et al. [8]	5 g/day for 168 days	2	NS

Table 3: Summary table of key studies investigating the effect of creatine supplementation on bone health parameters in elderly subjects. Cr: Creatine. LP: Loading Phase. MP: Maintenance Phase. G/d: grams per day. SD: significant difference. NS: No significant difference. -: Not measured. BMD: Bone Mineral Density. Values given are improvements made after creatine supplemented training compared with placebo

e ect through several mechanisms, for example through activation of myogenic transcription factors, such as Myo-D, myogenin and MRF-4 [45,46]. is may also lead to enhancement of satellite cell activation which progress along the myogenic lineage to produce activated myoblasts, eventually fusing to become a myo bril [47]; similar to increases in satellite cells seen during resistance training. is has particular relevance in the elderly population as satellite cell populations are known to decline with advancing age [48]. is may

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