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The Effects of Beta-alanine Supplementation on the Aging Population

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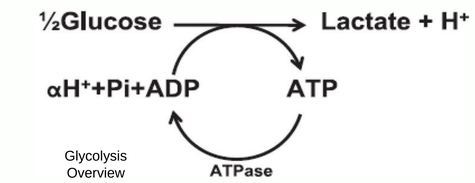
Background

As some may have already noticed, age is often associated with a normal decrease in exercise performance. As we age physical changes throughout the body are slowly occurring. Muscle is being replaced with fat leading to notable decreases in exercise performance, duration, and resistance to fatigue. Significant regression in muscle as well as its replacement with fat has been shown to peak at 50 years of age and is commonly known as sarcopenia [8]. Directly coinciding with an age related natural regression of skeletal muscle, intramuscular carnosine concentrations begin to deplete because skeletal muscle, specifically type IIb fibers, are carnosine's most abundant storage source. As a result of depleting intracellular storage sites, carnosine levels have been seen to drop 63% by age 70 [4,9].

Carnosine has many intracellular functions, however its mainly known for its natural defense against acidosis, a condition resulting in exercise fatigue due to the accumulation of waste products of anaerobic metabolism, specifically acidic hydrogen atoms from the dissociation of lactic acid.



Glycolysis Overview

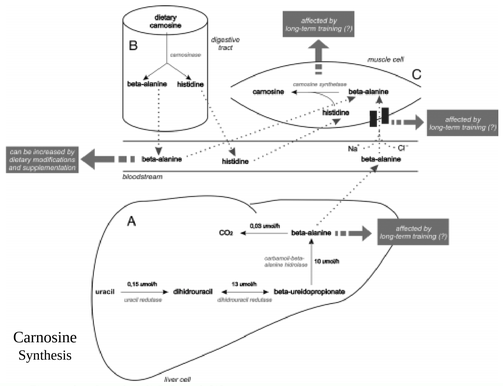
Interestingly, carnosine has also been found in notable concentrations within the human brain's cerebral areas and olfactory bulb. Though limited, studies show promising results that increased carnosine concentrations within the body can improve cognitive function during stress [10].

Objective

Aim 1: Increase serum levels of carnosine through beta-alanine supplementation.
Aim 2: Increase submaximal exercise endurance time through an increase in serum carnosine levels.
Aim 3: Increase cognitive function performance during submaximal exercise through an increase in serum carnosine levels.

Mechanism of Action

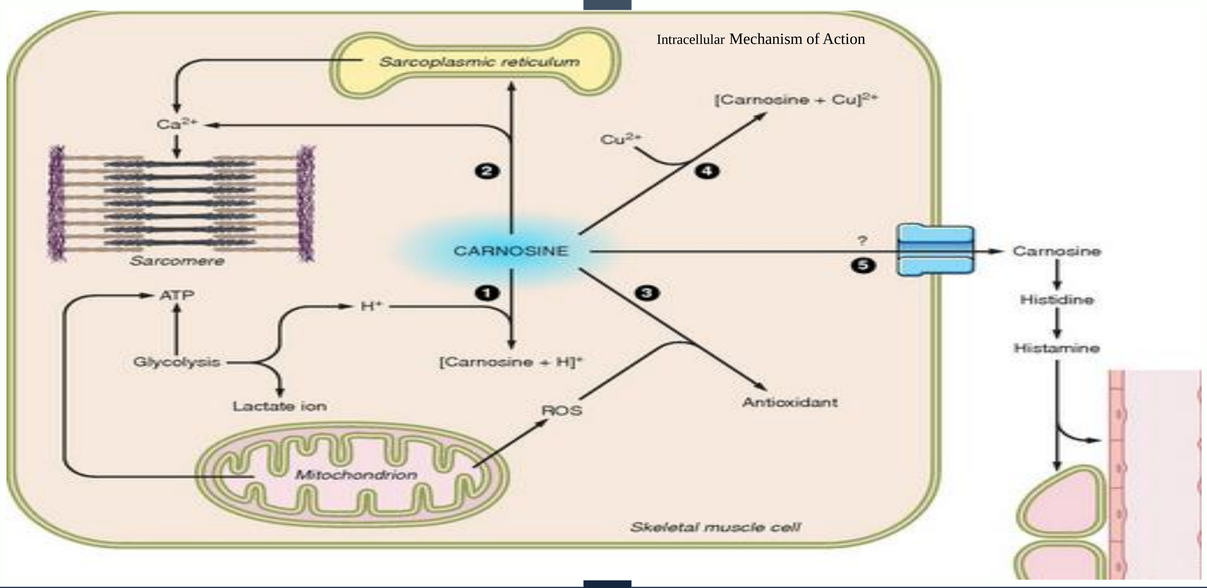
Carnosine, in its active stored form, is a dipeptide synthesized from beta-alanine and L-histidine by carnosine synthetase. To improve intracellular concentrations, beta-alanine will be administered. Beta-alanine is a non-essential amino acid broken down from uracil within the liver. As a result of naturally low beta-alanine concentrations, the activity of carnosine synthetase is limited [1]. Supplementation of beta-alanine has shown to improve carnosine concentrations by up to 40% in 4 weeks and up to 85% within 12 weeks [1,4]. Beta-alanine can be ingested from high protein foods in the form of carnosine, however due to an abundance of highly effective carnosinase within the plasma, carnosine will be broken down into its precursors before efficient absorption by the skeletal muscle can take place [5].



Carnosine Synthesis

Figure taken from Artioli G.G. et al. [1]

Carnosine acts as an acid buffer to help maintain homeostatic pH levels within the body and has been seen to buffer up to 40% of the H^+ produced during exercise [7]. Also associated with carnosine's exercise enhancing abilities, is carnosine's ability to increase the sensitivity of the sarcomere in both type I and II muscle fibers to Ca^{2+} released by the sarcoplasmic reticulum in response to stimuli leading to more efficient muscle contractions [7]. Carnosine also contains neuro-protective capabilities such as containing antioxidant properties, and an ability to act as a free radical scavenger. These properties act to protect the body, including the brain, from free radicals and oxidative conditions during stress. Previous studies suggest these neuro-protective properties may be the mechanism behind improved cognitive function [2,6].

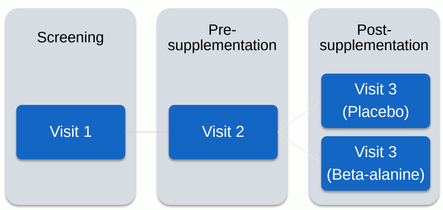


Intracellular Mechanism of Action

Cycle Ergometer Test

Methods

16 healthy adults over the age of 50 years will be randomized to two groups for supplementation using a double blinded parallel arm experimental design. They will ingest either 2.4g of beta-alanine or a Placebo daily for 28 days. Cognitive and physical assessments will be performed prior to and after supplementation, which include the Stroop test and physical work capacity (PWC) by cycle ergometer.



During screening (visit 1), subjects will undergo body composition measurements, Stroop tests, and a ventilation threshold hold test for baseline values that will be used in subsequent visits. Subjects will perform all Stroop Tests and a physical work capacity test (PWC) during the pre-supplementation visit (visit 2), thus eliminating the potential of a learning effect. After the pre-supplementation visit, subjects will receive the beta-alanine or the placebo and follow the designed supplementation plan for 28 days. Upon completion of supplementation subjects will return for their post-supplementation visit (visit 3) in which procedures from visit 2 will be repeated for comparison.

Blood samples prior to and after as well as gas collection during exercise will be taken and analyzed to ensure carnosine has improved exercise by buffering acidic byproducts. Stroop tests will be scored on accuracy and speed. Stroop test and PWC results will be analyzed by observing trends within subject performance.

Anticipated Results

Upon completion of their 28 day supplementation schedule, we expect to see positive correlations between subject's PWC results and Stroop tests scores from increased intracellular carnosine concentrations. With more carnosine, the body will be more effective at buffering fatigue inducing byproducts of metabolism allowing longer, more intense exercise. The increased carnosine may also exhibit increased neuro-protective, antioxidant, and free radical capabilities leading to improved Stroop tests scores and therefore cognitive function.

Discussion

Results from this study could be beneficial to the aging population. Improving exercise capacity and cognitive function through nutritional supplementation could be an effective, yet safe way to improve quality of life. Increasing the ability to resist fatigue, increasing exercise durations and intensities, will decrease the likely hood of discontinuing newly started exercise programs, leading to healthier individuals. Improving cognitive function may help individuals to excel in reaction time and mental effort of tasks, leading to improved work and home quality of life.

Molecular Structure of Carnosine

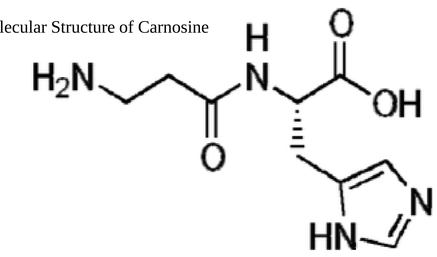


Figure taken from Culberston JY, et al. [3]

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The study is being performed in the Horvath Nutrition and Human Performance Lab.

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