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The effects of 10-week leucine supplementation on muscle growth, body composition, metabolism, inflammation and wellbeing of adolescents and young adults with cerebral palsy

Cerebral palsy (CP) is caused by damage to the developing brain and descending pathways, leading to altered patterns of growth and development. Those with CP may encounter early symptoms of paresis and spasticity, leading to progressive secondary musculoskeletal complications, including increased muscle atrophy and abnormal growth of contractile and non-contractile tissue. This causes significant weakness of the muscle and compromises daily motor function leading to substantial declines in activities of daily living and independence. As such, interventions aimed at increasing muscle mass or preventing muscle atrophy for those with CP must be established.

Recent research has shown that reduced protein synthesis could be overcome in immobilised patients by providing additional leucine supplementation into the diet. The administration of leucine-rich amino acids has also been shown to reduce the appearance of inflammatory markers and muscle soreness (a common complaint of people with CP) following exercise. Finally, branched chain amino acids such as leucine participate in many major biochemical processes in the brain. Leucine administration has been shown to improve cognition and mood among fatigued athletes.

Therefore, in children and young adults with CP, a leucine-rich diet may:

- promote protein synthesis, thus increasing muscle mass and strength and/or reducing muscle atrophy
- reduce muscle soreness and inflammation
- improve cognition, mood and sleep behaviour

Methods

Adolescents and adults with CP were randomised into an intervention or control group. The intervention group (n = 11; 18.6 ± 1.7 years; 68.3 ± 20.2 kg) received 192 mg/kg body mass per day of leucine supplementation, in addition to their normal diet for 10 weeks. The control group (n = 11; 18.3 ± 2.8; 48.8 ± 11.9 kg) continued with their normal diet. At 0 and 10 weeks, measures of muscle volume, muscle strength, resting metabolic rate, body composition and blood measures were taken. Measures of cognition and wellbeing were taken daily with a wellbeing questionnaire, which assessed fatigue, sleep quality, general muscle soreness, stress levels and mood on a five-point scale. Overall wellbeing was determined by summing these five scores. Participants were also asked to keep a daily food diary throughout and there were no differences in the average daily total energy intake and macronutrient contributions of participants' typical diets between groups (as determined from 3-day food diaries completed by 19 participants: n = 8 leucine; n = 11 control).

Results

Muscle strength, muscle volume, and C-reactive protein (CRP)

There was an increase in muscle strength (Fig. 1) and muscle volume (Fig. 2) and a reduction in CRP (Fig. 3) in the leucine compared to the control group at 10 weeks compared to 0 weeks.

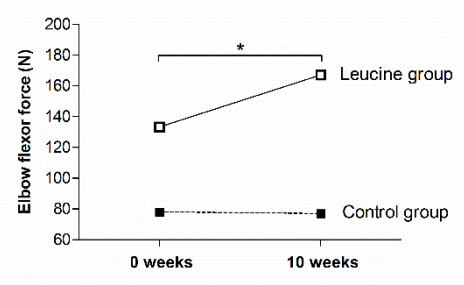

Fig 1. Mean elbow flexor strength in the leucine group (n = 11) and control group (n = 10). Note: * = sig. different between 0 and 10 weeks

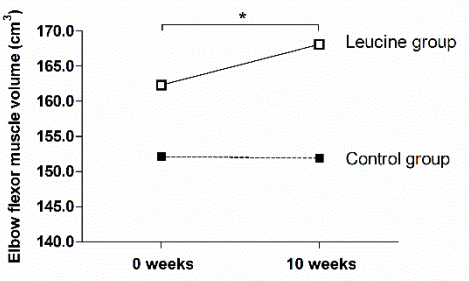

Fig 2. Mean elbow flexor muscle volume in the leucine group (*n* = 10) and control group (*n* = 10). Note: * = sig. different between 0 and 10 weeks

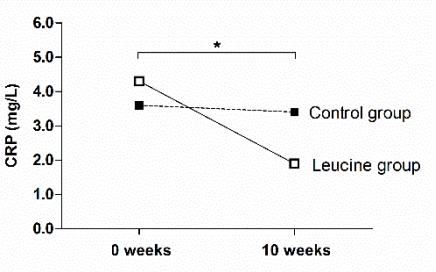

Fig 3. Mean CRP levels in the leucine group (*n* = 9) and control group (*n* = 8). Note: * = sig. different between 0 and 10 weeks.

Substrate oxidation, resting energy expenditure, and body composition

No changes were observed in fat oxidation, carbohydrate oxidation or resting energy expenditure in either group. There were no changes in body fat, lean mass, or the sum of skinfolds between groups after 10 weeks.

Wellbeing

Perceptions of muscle soreness and stress were significantly reduced, and mood and general wellbeing were significantly higher in the leucine group (Fig. 4) after 10 weeks compared to the control group. There were no changes in ratings of fatigue or sleep quality in either group.

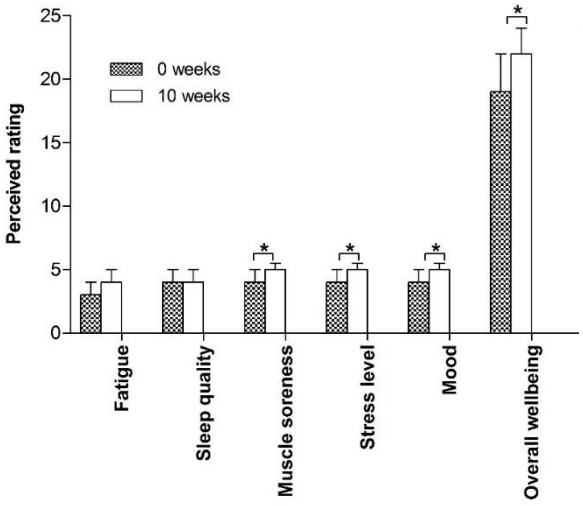

Fig 4. Fatigue, sleep quality, muscle soreness, stress level, mood and overall wellbeing in the leucine group (*n* = 11).

Conclusion

Ten weeks of daily leucine ingestion (192 mg/kg, ~9-15 g) provided a variety of benefits to young adults and adolescents with moderate to severe CP. The changes in muscle strength and muscle volume might provide important functional changes and could be partly explained by the reduced systemic inflammation. The improved wellbeing of the leucine-fed CP group also highlights its alternative roles and capacity to improve the quality of daily living.