Acute Effects of Creatine and Branch Chain Amino Acids on Resting Energy Expenditure: Considerations for Testing

Original Research

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Abstract

Introduction: The purpose of this study to was to elucidate the potential effects of acute creatine monohydrate (CM) and branched chain amino acid (BCAA) ingestion on resting energy expenditure (REE).

Methods: Young physically active individuals (n=60) were randomly allocated to a single treatment: 1) Placebo (PL), 2) CM, or 3) BCAA. Participants completed a REE test via indirect calorimetry to establish baseline REE prior to ingesting their corresponding treatment. A post-REE was then conducted 60-mins after treatment consumption. Estimate daily caloric expenditure at rest was compared between treatments.

Results: PL consumption did not result in changes of REE from pre- (1691 ± 360) to post-ingestion (1671 ± 319; p= 0.395; d= 0.06). However, acute ingestion of BCAA (p= 0.008; d= 0.12) resulted in significantly higher REE pre- (1678 ± 401) versus post- (1761 ± 357) . A non-significant trend towards decreases in REE were noted pre- (1663 ± 421) to post- (1590 ± 346) for CM (p=0.056; d=0.17). The magnitude of the effects for all conditions were small or trivial. These findings suggest that while the popular supplements CM and BCAAs alter REE acutely, the small changes may not be practically important to consider for REE testing.

Conclusions: While the effects were small, individualized considerations for REE testing may still be necessary, but further testing using larger and more diverse sample sizes are needed.

Key Words: Supplements, Metabolism, Indirect Calorimetry

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Introduction

Resting energy expenditure (REE) measurements are commonly utilized to optimize fitness and dietary prescriptions. Accordingly, maintaining rigorous standards and procedures to maintain accuracy is of critical importance. REE is the largest contribution to total daily energy expenditure (TEE) and accounts for 60-75% of total daily calories (1). Importantly, REE is highly influenced by various factors such as age, sex, diet, and supplement intake. Engagement in regular supplement intake to enhance fitness goals is common among recreational exercisers and competitive athletes alike. While certain supplements, such as various classes of stimulants, have been well described to acutely alter REE readings, the influence of other popular supplements on REE are less understood.

Induction of muscle hypertrophy and increasing lean mass are foundational to fitness and training goals. Ingestion of dietary supplements to support this is common with emphasis on improving recovery from exercise. Of commercially available supplements, creatine monohydrate (CM) and branch chained amino acids (BCAA) are among the most

consumed in single or multi-ingredient supplements. CM use is highly prevalent among high school and collegiate athletes with between 30-40% of individuals reporting daily ingestion (2, 3). Similar prevalence (~40%) of BCAA supplementation in athletes has also been reported (4, 5). When used chronically, both BCAAs and CM have been suggested to alter body composition and REE which has led to recommendations of the abstinence of such supplements prior to REE assessment (6-9). However, there is little empirical knowledge of the acute effects of their ingestion and how that may impact REE testing.

Measurement of REE via indirect calorimetry has become increasingly prevalent leading to the development of a multitude of protocols and methodologies. Factors such as equipment for measurement, time of day, duration of testing, and pre-test instructions have been suggested to alter validity and reliability of REE tests (10-12). Most protocols have suggested a minimum of 4-6 hour fast prior to testing (13). While macronutrient consumption and availability have been suggested to alter REE, many reports suggest that acute changes are small or trivial. For example, Stauffer et al. suggested that acute intermittent fasting does not does not significantly impact REE in college-aged males (14). This is supported further by evidence suggesting that interventions lasting less than 14 days are unlikely to see meaningful changes in energy balance and REE (15). However, much less is known about the acute effects of common performance enhancing supplements on REE. Given the prevalence of supplement use in athletic populations, currently recommendations of abstaining use prior to REE testing may impose burdens on training and nutrition plans. Thus, identifying the effects of single ingredient supplements on REE may inform ways to optimize testing while minimizing disturbances of athletic nutrition. The purpose of this study was to elucidate the potential effects of acute creatine monohydrate (CM) and branched chain amino acid (BCAA) ingestion on REE. We hypothesized that the consumption of CM and BCAA would not significantly alter REE in young physically active individuals.

Methods

Sixty participants (male n=22, female n=38) aged 18-42 volunteered to participate in the three-arm, randomized, placebo-controlled design (Table 1). The study was conducted following the principles of the Helsinki Declaration, with approval from the Institutional Review Board at Nova Southeastern University (IRB# 2024-20-NSU). All participants provided written informed consent.

Table 1. Demographics

Measure	*BCAAs*	*Creatine*	*Control*
Sex	9 males, 11 females	7 Males, 13 females	6 Males, 14 females
Age	21.4 ± 1.9	22.2 ± 5.1	21.4 ± 2.0
Height (cm)	168.0 ± 9.9	167.9 ± 6.9	166.9 ± 7.6
Weight (kg)	74.2 ± 22.5	69.1 ± 14.5	69.9 ± 9.8
LBM (kg)	47.7 ± 18.9	45.5 ± 17.7	46.1 ± 15.1
Fat mass (kg)	19.2 ± 8.7	17.8 ± 6.5	19.6 ± 6.3
Body fat %	24.9 ± 8.2	26.2 ± 7.5	28.2 ± 7.8
TBW	38.0 ± 9.1	37.3 ± 8.8	36.0 ±7.3

Procedures

Participants underwent a 48-hour washout period where they were instructed to abstain from both BCAAs and Creatine. Caffeine and exercise were prohibited on testing day. There were no dietary restrictions, however, participants were told to refrain from caloric foods and liquids for 4 hours prior to testing. Hydration status was not assessed; however, participants were told to arrive in an euvolemic state to ensure that hydration levels did not influence the outcomes of the experiment. Additionally, they were questioned about supplement usage and adherence fasting protocols upon arrival. Participants were instructed to arrive adequately hydrated. Body composition and resting metabolic rate were evaluated. Body composition was assessed using a multi-frequency bioelectrical impedance device (InBody 270). Subjects stood on the platform of the device barefoot with the soles of their feet on the electrodes and then grabbed the handles with their thumb and fingers to maintain direct contact with the electrodes. They remained motionless for approximately 1 minute while keeping their elbows fully extended with their shoulder joint abducted to approximately a 30-degree angle. Participants were then seated and instructed to remain still and relaxed for 5 minutes.

Then resting metabolic rate was assessed by the Korr REEVUE, which utilizes indirect calorimetry to assess oxygen consumption and calculate energy expenditure. Participants sat in a seated position with their backs at a 90-degree angle while breathing normally through the mouthpiece. The test took approximately 10 minutes to complete. After each test, the mouthpiece was disposed of, and the device was cleaned according to hygiene and safety protocol. Subjects then consumed either 10g of either branched-chain amino acids (BCAAs), 5g of CM, or placebo (Crystal Light) dissolved in 8 ounces of water. Subjects had to remain seated in the lab, where they were prohibited from consuming any additional foods or fluids. All subjects were post-tested at 60 minutes post-consumption.

Statistical Analyses

All analysis was completed using Jamovi statistical software (Version 0.9; Sydney, Australia). Normality of data was confirmed using the Shapiro-Wilk method. A 3 ´ 2 (treatment ´ time) repeated measures ANOVA was used to determine main effects and interactions. A Bonferroni- Holm post-hoc analysis was completed to determine mean differences as warranted by significant main effects. Estimates of effects sizes for main effects are shown as eta-squared (h^2) and interpreted as: 0.01—small; 0.06—medium; ≥0.14—large (16, 17). Effect sizes for mean differences were calculated via Cohen's d (d) and interpreted as: 0.2—small; 0.5—moderate; 0.8—large (16, 17). Data are presented as mean ± standard deviation (SD). Significance was set at $p \leq 0.05$ a priori.

Results

Pre- and post-ingestion measures of REE are shown in Figure 1. There were no main effects for treatment ($p = 0.800$; $\eta^2 = 0.007$) or time ($p = 0.907$; $\eta^2 < 0.001$). However, there was a significant interaction for treatment × time ($p = 0.010$; $\eta^2 = 0.008$). Post hoc analysis of interactions revealed that ingestion of BCAAs resulted in increased REE ($p=0.019$; $d = 0.19$) while CM resulted in a non-significant trend towards decreases in REE ($p=0.056$; $d=0.17$) when comparing pre- to post. No other differences between treatment or timepoints were observed. There were no significant outliers based on the z-score method (threshold of ±3).

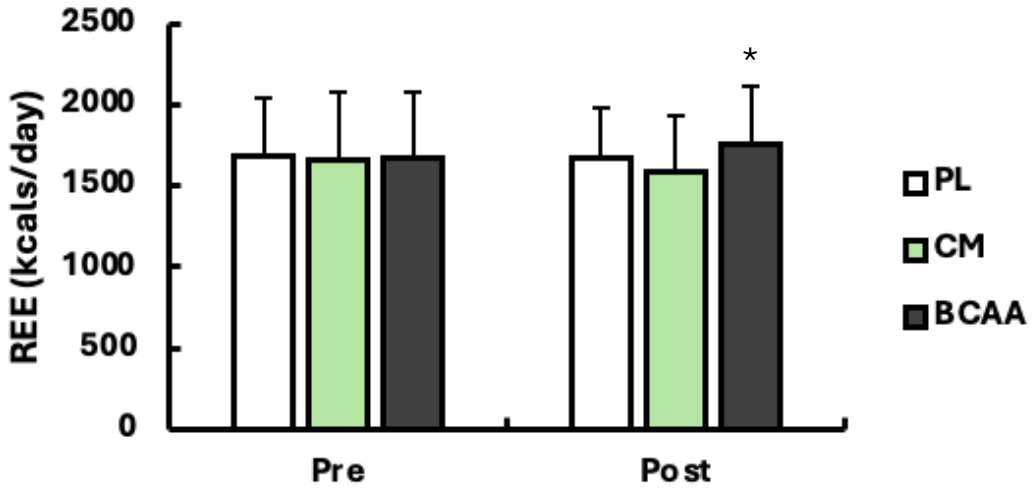

Figure 1. Changes in resting energy expenditure (REE) pre- and post- supplement ingestion. Data are presented at mean ± SD. * Indicates significantly different from Pre ($p \leq 0.05$).

Discussion

Previous evidence has suggested that long-term CM and BCAA use results in changes to metabolism and energy utilization at rest (6, 8, 18, 19). Abstinence from supplementation is often recommended prior to REE testing despite a lack of available evidence supporting this practice. Currently, it is unknown if acute supplementation of CM and BCAA influences REE. Thus, this investigation sought to identify the potential effects of acute CM and BCAA ingestion on REE. Present findings show that acute supplementation resulted non-significant decreases in REE for CM and a significant increase in REE from BCAA ingestion. However, the magnitude of change for these effects were small-trivial suggesting minimal impact of supplementation on REE. While these findings are only partially supported by evidence using long-term supplementation, the current findings from acute supplementation may hold important implications for pre-test instructions in REE testing.

The absence of a significant change in REE following CM supplementation is consistent with prior studies reporting no effect on REE during extended periods of creatine use (6). Huso et al. demonstrated that long-term CM supplementation did not increase REE, however, creatine supplementation did alter substrate utilization, favoring carbohydrates (6). This may be due to alterations of CHO transport with CM co-ingestion (20, 21). CM ingestion has been linked to alterations in glucose transport and metabolism in skeletal muscle (22). It is possible that CM ingestion altered substrate utilization in the current study which may not have been reflected in the total rate of REE. Further study will be needed to determine the effects of CM supplementation on substrate utilization to fully understand if precautions are warranted with CM and fuel utilization interpretations during REE testing. Furthermore, the timing of CM ingestion may have led to the lack of differences in REE currently. Persky et al. showed peak concentrations of a single dose of CM in plasma at 1.9 hours and 2.1 hours in skeletal muscle (23). Due to the nature of the current protocol timing, ingestion of CM 60 minutes prior to testing may have not resulted in discernable changes to REE albeit evidence on single doses of CM is sparse. Detailed time course studies that are investigating REE changes with serial measurements are warranted to further understanding if timing of ingestion of CM influences REE.

The current findings indicate a statistically significant increase in REE following BCAA ingestion; however, the magnitude of change was small to trivial. This rise in REE may be attributed to the oxidation of BCAAs, which can stimulate mitochondrial activity and elevate ATP turnover, thereby contributing to increased energy expenditure. Additionally, the process of BCAA catabolism produces acetyl-CoA and succinyl-CoA, which enter the tricarboxylic acid cycle, enhancing overall metabolic activity (9). Previous evidence on long-term BCAA supplementation does not generally support increases in REE (8, 19). Dudgeon et al. showed that chronic ingestion of BCAAs resulted in decreases in REE although this was concomitant with a caloric restriction and exercise intervention (19). Due to the differences in protocols and approaches, the mechanism for changes and discrepancies is not fully clear. However, the current increases observed in REE from acute BCAA supplementation may not be practically meaningful. In the current study, REE increased by approximately 4% and was estimated for the course of an entire day. Due to the length of testing protocol, it is not clear if the increase in REE due to BCAA lasts for a meaningful period or if it is a transient effect. Furthermore, many indirect calorimeter devices, including the one used in the present study, have small degrees of error. The current device utilized has an error rate of ±2% according to the manufacture which agrees with most equipment utilized in research settings. Thus, it is difficult to interpret the current changes in REE with acute BCAA ingestion as a practically important change worth accounting for in REE testing protocols.

While the present investigation provides new insights into the acute effects of creatine and BCAA supplementation on resting energy expenditure (REE), several limitations must be acknowledged. As noted previously, supplement ingestion may influence substrate utilization even in the absence of changes in total REE. However, because substrate utilization was not specifically measured in this study, it remains possible that alterations in substrate use occurred as a result of supplementation. Additionally, hydration status was not directly assessed between participants. Given that prior evidence indicates hydration level can affect measured energy expenditure, this represents another potential source of variability (24). Thus, hydration status cannot be ruled out as a factor that may have influenced REE or the physiological response to acute supplement ingestion. Additionally, only a single acute REE measurement was obtained. Considering that both creatine monohydrate (CM) and BCAAs reach peak plasma concentrations beyond the 60-minute post-ingestion window used in this study, future research should incorporate serial time-point measures to better capture temporal effects. Lastly, individual variability in supplement response may have impacted the findings. Future investigations should assess intra-individual trends across multiple times to account for this variability.

Conclusion

In conclusion, the acute ingestion of both CM and BCAA appears to cause few practical changes on REE. This may aid in forming pre-instructions for REE protocols for specific populations. However, further research is needed examine the transient effects of CM and BCAA and to confirm whether these findings hold true across different populations and testing conditions.

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