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ENERGETIC AND METABOLIC RESPONSES AFTER ACUTE SESSIONS OF CONTINUOUS ENDURANCE TRAINING AND HIGH-INTENSITY INTERVAL TRAINING

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Abstract

The aim of this study was to analyze metabolic responses, energy expenditure per systems (EE, %) and total energy expenditure (TEE, kcal) after an acute session of continuous endurance training (ET) and high-intensity interval training (HIIT). Eleven healthy young men (21±3 years; BMI: 21±3 kg.m-2), performed three experimental sessions in random order: ET (40 min at 70% heart rate reserve - HRR), HIIT (40 min, 5 sets of 4 min at 90% HRR/3min at 50% HRR); and control session (CO, 40 min sitting at rest). Venous blood samples were collected Pre and Post each experimental session to analyse metabolic responses through metabolomics (H1 NMR spectroscopy); and blood from the distal surface of the finger Pre and Post 1, 3, 5 e 7 min of each session to analyse energy systems and energy expenditure (EE) through the GEDAE-LaB software. Comparisons between and within-subject were performed using Mixed Linear Models. Discriminant metabolites between-within session were identified using Partial Least Squares Discriminant Analysis models and variable importance in the projection (VIP score >1), followed by pathway over-representation and pathway topology analyses by the Metaboanalyst 4.0 software. The significance level was set up at $P < 0.05$ or false discovery rate of 0.1. ET and HIIT presented similarly higher TEE compared to CO ($P<0.01$), however, ET presented higher relative contribution of aerobic metabolism compared to HIIT ($P<0.01$), while HIIT presented higher relative contribution of anaerobic lactic metabolism than ET ($P<0.01$). Selected metabolites from VIP score (>1) were: alanine, methylsuccinate, guanidoacetate, lactate, 3-hydroxybutyrate, pyruvate, methanol, succinate, propylene glycol, hypoxanthine, O-acetylcarnitine, glycerol. These findings demonstrate the role of manipulating exercise intensity and alter the relative contribution of metabolism to produce energy to increase the overall metabolic response after matched energy expenditure and work exercise.

Key words: *Metabolomics, HIIT, Continuous Endurance Training.*

Introduction

Continuous ET has been reported as a strategy for health maintenance. Recent studies have suggested HIIT (repeated high intense bouts vs periods of recovery at low intensity) as an alternative method to produce cardiorespiratory fitness gains comparable or superior to ET exposure. Our aim was to analyze metabolic responses, energy expenditure per systems and total energy expenditure after acute sessions of ET and HIIT.

Results and Discussion

ET and HIIT presented similarly higher TEE compared to CO ($P<0.01$), however, ET presented higher relative contribution of aerobic metabolism compared to HIIT ($P<0.01$), while HIIT presented higher relative contribution of anaerobic lactic metabolism than ET ($P<0.01$). The targeted screens yielded 46 serum metabolites. The discriminant metabolites responses between each session were: alanine, methylsuccinate, guanidoacetate, lactate, 3-hydroxybutyrate, pyruvate, methanol, succinate, propylene glycol, hypoxanthine, O-acetylcarnitine, glycerol. From this set of metabolites O-acetylcarnitine, propylene glycol, succinate, pyruvate, 3-hydroxybutyrate and lactate increased post session for both ET and HIIT ($P<0.01$ for all, except to pyruvate in ET – $P<0.05$), while hypoxanthine and alanine increased only in HIIT ($P<0.01$), guanidoacetate and alanine decreased in ET and CO, respectively ($P<0.05$ for both). Additionally, O-acetilcarnitine, hypoxanthine, succinate, propylene glycol, pyruvate, 3-hydroxybutyrate, alanine and lactate presented higher serum levels post session for both ET and HIIT compared to CO ($P<0.01$ for all, except to hypoxanthine in ET – $P<0.05$). However, serum levels post session for HIIT were higher compared to ET for O-acetylcarnitine, hypoxanthine, succinate, pyruvate and lactate ($P<0.01$). The significant pathways related to this panel of metabolites were the metabolisms (Fig. 1): 1.alanine, aspartate and glutamate; 2.pyruvate; 3.butanoate; 4.taurine and hypotaurine; 5.citrate cycle; phenylalanine; 6.glycolysis or gluconeogenesis; 7.glycerolipid; 8.glycine serine and threonine; 9.cysteine and methionine; 10.synthesis/degradation ketone bodies.

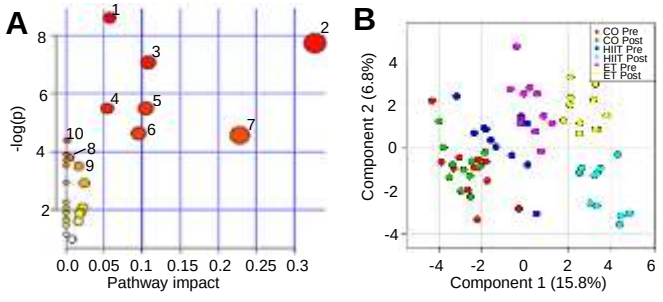

Figure 1. A: Metabolic pathways associated with ET and HIIT responses. **B:** Score plot of the PLS-DA. Cross validation: $R^2 = 0.8$; $Q^2 = 0.6$. Permutation test (1000 permutations): $P < 0.001$.

Conclusions

These findings demonstrate the role of manipulating exercise intensity and alter the relative contribution of metabolism to produce energy (e.g.: increase anaerobic lactic metabolism during HIIT and aerobic metabolism in ET) to increase the overall metabolic response after matched energy expenditure and work exercise.

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