MULTI-INGREDIENT PRE-WORKOUT SUPPLEMENT AFFECTS ENERGY METABOLISM FOLLOWING HIGH-INTENSITY FUNCITONAL TRAINING AMRAPS

James W. Henley, Kristyn McGeehan, Christopher Staples, Jacob Fanno, Ashley Hines, Wysmark Chaves, Jacob Grazer, Tiffany A. Esmat, John J. McLester , and Gerald T. Mangine. Department of Exercise Science and Sport Management, Kennesaw State University, Kennesaw, GA

INTRODUCTION

The 'as many repetitions as possible' (AMRAP) circuit format is common in high-intensity functional training (HIFT) (2). Optimizing repetitions completed is dependent on how well one manages fatigue and avoids deviating from their fastest sustainable pace (2, 12). This ability is enhanced by training experience and adaptations (6), and potentially, nutritional supplementation. Several ingredients commonly found within multi-ingredient pre-workout supplements are known to impact energy availability (1, 4, 5, 7, 9,11), and might aid HIFT performance. However, only one study has examined the effect of this type of supplement on HIFT performance (8).

Outlaw and colleagues (2014) observed that 6 weeks of regular consumption of a formulation containing extracts of pomegranate, tart cherry, green and black tea improved performance in the second of two consecutive HIFT-style workouts. However, the study did not examine acute workout performance, nor did it test for any changes in any physiological measures related to energy utilization and fatigue. The reasons for why performance improved remain unclear.

PURPOSE

To examine the acute effects of a multi-ingredient pre-workout supplement and exercise duration on metabolism and perceived exertion following a HIFT-style workout.

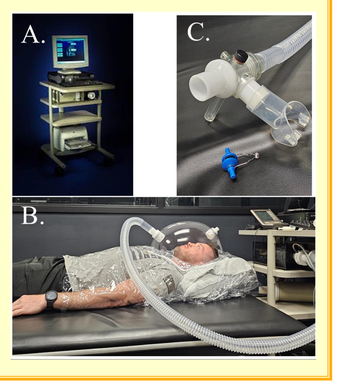
METHODS

Men (n=12) and women (n=10) with at least 2 years of HIFT experience (29.3±7.1 years, 171±7 cm, 80.5±15.6 kg) volunteered to complete four weekly visits in randomized, cross-over fashion at a time consistent with their normal workout schedule.

Upon arrival, participants were then affixed with a Polar® heart rate monitor before laying quietly for a pre-exercise metabolic assessment (Figure 1). This was followed by collection of a blood sample to quantify blood lactate concentrations and the consumption of either a multi-ingredient pre-workout supplement (S; Table 1) or a non-caloric placebo (P).

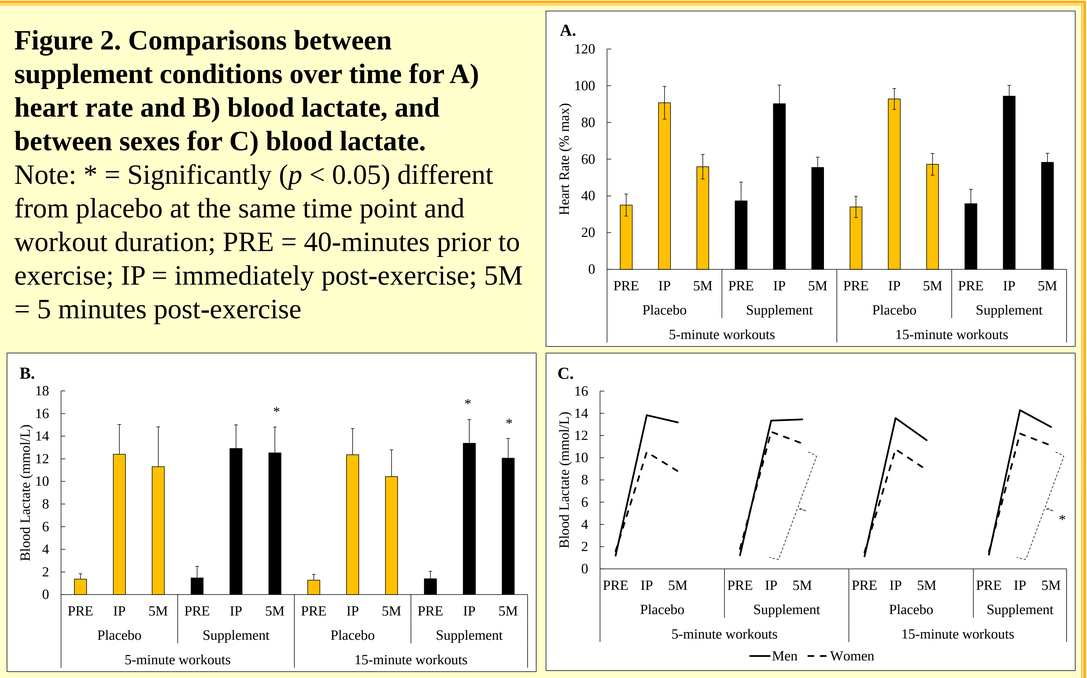
Following 40 minutes of rest, participants completed either a 5- or 15-minute circuit of rowing (men: 9kcal; women: 7kcal), six barbell thrusters (men: 43.1 kg; women: 29.5 kg), and three box jumps (men: 0.6 m; women: 0.5 m) for 'as many reps as possible' (AMRAP). All pre-exercise assessments were repeated post-exercise.

Figure 1. Metabolic Testing
Indirect colorimetry was performed with a **A)** Parvo Medics True One 2400 metabolic testing cart **B)** prior to exercise underneath a canopy and **C)** immediately post-exercise with a mouthpiece. Both occasions lasted 10 minutes with the final 5 minutes of each period being used to estimate oxygen consumption (VO2), metabolic equivalents of task (METs), and respiratory quotient (RQ).



RESULTS

Figure 2. Comparisons between supplement conditions over time for A) heart rate and B) blood lactate, and between sexes for C) blood lactate.
Note: * = Significantly ($p < 0.05$) different from placebo at the same time point and workout duration; PRE = 40-minutes prior to exercise; IP = immediately post-exercise; 5M = 5 minutes post-exercise



Separate 3-way (Condition [S or P] x Time [PRE or POST; PRE, 5M] x Sex [Men or Women]) analyses of variance with repeated measures were performed on each variable.

- No supplement-condition differences in any measure collected prior to exercise, nor with repetitions completed during the AMRAP workouts.
- Figure 2 illustrates comparisons made with percentage of maximal heart rate and blood lactate concentrations. A main effect for time ($p < 0.001$) was noted for heart rate where percentage of maximal heart rate remained elevated at IP and 5M for all conditions. Meanwhile, significant condition x time ($p = 0.049$) and condition x sex ($p = 0.021$) interactions were noted for blood lactate concentrations. Greater concentrations were noted during S at IP (15-minute workouts) and at 5M (both workouts), with overall differences primarily being seen in women.
- Table 3 presents comparisons made with metabolic data. Although significant condition x time interactions ($p < 0.05$) were noted in each variable, condition differences between the same workout durations were only seen with VO_2 and METs. Higher post-exercise values were seen with S following both workout durations.

Table 2. Metabolic comparisons between workout conditions.

	5-minute Workouts				15-minute Workouts			
	Placebo		Supplement		Placebo		Supplement	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
Oxygen consumption (ml/kg/min)								
Men	4.01 ± 0.63	7.59 ± 1.42	4.03 ± 0.57	8.74 ± 0.96	4.00 ± 0.42	7.76 ± 1.04	4.00 ± 0.56	8.26 ± 0.79
Women	3.89 ± 0.43	6.89 ± 0.96	3.97 ± 0.53	7.24 ± 1.64	4.00 ± 0.45	6.24 ± 1.28	4.04 ± 0.50	6.83 ± 1.75
Total	3.96 ± 0.54	7.27 ± 1.25	4.00 ± 0.54	**8.06 ± 1.49***	4.00 ± 0.42	7.07 ± 1.37	4.02 ± 0.52	**7.61 ± 1.47***
Metabolic Equivalents of Task (a.u.)								
Men	1.15 ± 0.18	2.17 ± 0.40	1.15 ± 0.16	2.50 ± 0.27	1.14 ± 0.12	2.22 ± 0.30	1.14 ± 0.16	2.36 ± 0.23
Women	1.11 ± 0.12	1.97 ± 0.27	1.13 ± 0.15	2.07 ± 0.47	1.14 ± 0.13	1.78 ± 0.37	1.15 ± 0.14	1.95 ± 0.50
Total	1.13 ± 0.15	2.08 ± 0.36	1.14 ± 0.16	**2.30 ± 0.43***	1.14 ± 0.12	2.02 ± 0.39	1.15 ± 0.15	**2.17 ± 0.42***
Respiratory Quotient								
Men	0.91 ± 0.09	1.23 ± 0.15	0.89 ± 0.07	1.21 ± 0.16	0.88 ± 0.07	1.09 ± 0.16	0.90 ± 0.06	1.1 ± 0.12
Women	0.85 ± 0.05	1.06 ± 0.21	0.82 ± 0.09	1.06 ± 0.18	0.85 ± 0.09	0.97 ± 0.16	0.85 ± 0.05	0.95 ± 0.17
Total	0.89 ± 0.08	1.15 ± 0.20	0.86 ± 0.09	1.14 ± 0.18	0.87 ± 0.08	1.04 ± 0.17	0.88 ± 0.06	1.03 ± 0.16

* = Significantly ($p < 0.05$) different from placebo at same time point and workout duration.

Table 1. Supplement ingredient list

Serving Size: 1 scoop (30 g)		
Ingredients	Amount per serving	% DV
Calories	5	
Total Carbohydrate	1 g	<1%*
Niacin (as Nicotinic Acid)	15 mg	94%
Vitamin B6 (as Pyridoxine HCl)	1 mg	59%
Vitamin B12 (as Methylcobalamin)	100 mcg	4167%
Iron	1 mg	6%
Magnesium (from Red Spinach Leaf Extract and Dimagnesium Malate)	9 mg	2%
Sodium (as Pink Himalayan Sea Salt)	40 mg	2%
Potassium (from Red Spinach Leaf Extract and Potassium Chloride)	248 mg	5%
L-Citrulline	8 g	**
Creatine Monohydrate	5 g	**
Taurine	3 g	**
Beta-Alanine (as CarnoSyn®)	2.5 g	**
Betaine Anhydrous	2.5 g	**
L-Tyrosine	2 g	**
Red Spinach Leaf Extract (as Oxystorm®)	1 g	**
Beet Root Extract	1 g	**
Alpha-GPC (Alpha-Glycerol Phosphoryl Choline 50%)	300 mg	**
Caffeine Blend Caffeine Anhydrous (250 mg) zimXR® Delayed Release Caffeine (50 mg)	300 mg	**
L-Theanine	150 mg	**
ElevATP® (Ancient Peat and Apple Fruit Extract)	150 mg	**
Pink Himalayan Sea Salt	100 mg	**
Rhodiola rosea (root) Extract	100 mg	**
Co-Enzyme Q10	25 mg	**
AstraGin® [Astargalus membranaceus (root) Extract & Panax notoginseng (root) Extract]	25 mg	**
BioPerine® (Black Pepper Fruit Extract)	5 mg	**

*Percent Daily Values (DV) are based on a 2,000-calorie diet
** Daily value not established
OTHER INGREDIENTS: Citric acid, Natural Flavor, Calcium Silicate, Malic Acid, Silicon Dioxide, Sucralose, Spirulina Powder

CONCLUSIONS and PRACTICAL APPLICATIONS

The multi-ingredient pre-workout supplement led to greater post-exercise oxygen consumption and higher blood lactate concentrations compared to placebo. Although this did not impact repetitions completed, these data suggest an enhanced ability to sustain greater relative effort. It is possible that the lack of scoring differences were simply a function of workout design limiting the potential benefit of the supplement. Since HIFT workouts will differ in duration, athletes might consider the present supplement to better sustain effort during longer duration HIFT-style workouts and/or possibly those that require less transitions.

REFERENCES

1. Caetano ML et al. (2023). The effects of acute caffeine supplementation on performance in trained CrossFit® athletes: A randomized, double-blind, placebo-controlled, and crossover trial. *Science & Sports*. 38 (7): 701-707
2. CrossFit. (2023) Open Workouts, in: CrossFit Games. Accessed online at: https://games.crossfit.com/workouts/open/2024/3.
3. Curtis J et al. (2022). The Effects of a Pre-workout Supplement on Measures of Alertness, Mood, and Lower-Extremity Power. *Cureus*, 14 (5).
4. Kreider RB et al. (2017) International Society of Sports Nutrition position stand: safety and efficacy of creatine supplementation in exercise, sport, and medicine. *Journal of the International Society of Sports Nutrition*, 14 (1): 18.
5. Goldstein ER et al. (2010). International society of sports nutrition position stand: caffeine and performance. *Journal of the International Society of Sports Nutrition*, 7 (1): 5.
6. Mangine GT and Seay TR (2022). Quantifying CrossFit®: Potential solutions for monitoring multimodal workloads and identifying training targets. *Frontiers in Sports and Active Living*, 4(949429).
7. Nicoll JX et al. (2023). The effects of a caffeine containing pre-workout supplement on β2-adrenergic and MAPK signaling during resistance exercise. *European Journal of Applied Physiology*, 123(3), 585-599.
8. Outlaw, J. J., Wilborn, C. D., Smith-Ryan, A. E., Hayward, S. E., Urbina, S. L., Taylor, L. W., & Foster, C. A. (2014). Effects of a pre-and post-workout protein-carbohydrate supplement in trained crossfit individuals. *Springerplus*, 3(1), 1-7.
9. Trexler ET et al. (2015) International society of sports nutrition position stand: Beta-Alanine. Journal of the International Society of Sports Nutrition, 12 (1): 30.
10. Cameron M et al. (2018). The acute effects of a multi-ingredient pre-workout supplement on resting energy expenditure and exercise performance in recreationally active females. *Journal of the International Society of Sports Nutrition*, 15(1).
11. Figueiredo C et al. (2020). Multi-ingredient pre-workout supplementation changes energy system contribution and improves performance during high-intensity intermittent exercise in physically active individuals: A double-blind and placebo controlled study. *Journal of the International Society of Sports Nutrition*, 17(1).
12. de-Oliveira LA at al. (2021). Analysis of pacing strategies in AMRAP, EMOM, and FOR TIME training models during "Cross" modalities. *Sports (Basel)*, 9(11), 144.
13. Guest NS et al. (2021). International society of sports nutrition position stand: Caffeine and exercise performance. *Journal of the International Society of Sports Nutrition*, *18*(1), 1.

ACKNOWLEGEMENTS

THIS STUDY WAS FUNDED BY SHIFTED, LLC (EUGENE, OR).