Turkish Journal of Sport and Exercise
http://dergipark.gov.tr/tsed
Year: 2019 - Volume: 21 - Issue: 2 - Pages: 349-354
DOI: 10.15314/tsed.540690

ISSN: 2147-5652

The Effect of Beta-Hydroxy-Beta-Methylbutyrate Supplementation on Performance Adaptations Following Resistance Training in Young Males

Hani Haj SALIMI[1], Farhad RAHMINI-NIA[2]

[1]*Department of Sport Sciences, Rasht Branch, Islamic Azad University, Rasht, Iran*
[2]*Department of Exercise Physiology, Faculty of Sport Sciences, University of Guilan, Rasht, Iran*
**Corresponding author: Hani Haj Salimi, E-mail: Hanihajsalimi@gmail.com*

Abstract:

The aim of this study was to examine the effects of 8 weeks beta-hydroxy-beta-methylbutyrate (HMB) supplementation with resistance training on some components of physical fitness and body composition in young males. Twenty healthy young men volunteered to participate for the study and divided into two groups and performed 8-week resistance training while supplementing with either HMB or placebo (3 g per day). The subjects were evaluated for 1 repetition maximum (1RM) bench press and leg press, vertical jump (VJ), anaerobic power (RAST) prior to and after training intervention. In addition, body composition variables such as percent body fat, and BMI were assessed per and post training period. Both the groups showed significant increases in 1RM bench press and leg press, VJ, and anaerobic power (RAST), and also the HMB supplementation group showed greater gains compared with the placebo. In addition, percent body fat decreased significantly in HMB and placebo groups. BMI enhancements were greater for the HMB supplementation group indicated gains in body weight.

The results indicated that resistance training improved physical performance and HMB supplementation induced greater gains and therefore it could be recommend to coaches and athletes who use this supplementation to greater gains in physical fitness variables.

Keywords: body composition, leucine, , performance, strength training.

INTRODUCTION

β-hydroxy-β-methylbutyrate (HMB) has a long history of use as a nutritional supplement for enhancing recovery, and for increasing strength, power, aerobic performance and lean body mass with exercise (1-3). HMB improves muscle protein balance by decreasing muscle protein breakdown and by increasing muscle protein synthesis [3], resulting in reduced muscle damage and faster and improved recovery (4).

Studies assessing the effects of HMB in physically active individuals have mainly focused on verifying changes in the state of nutrition, assessing protein synthesis and proteolysis rates, and monitoring hormone levels and selected indices illustrating, for example, the degree of muscle damage and determination of changes in physical capacity (5,6). Since 1996, studies have been published that claim that HMB uptake may promote advantageous changes in body composition and strength, and reduced levels of muscle damage markers during resistance training (7,8). Further, in a meta-analysis by Nissen and Sharp (9), it was found that HMB supplementation for resistance exercise resulted in increased strength and fat-free mass by (net value) 1.4 and 0.28 % per week, respectively, in both trained and untrained individuals.

Although some findings suggest that HMB supplementation during training may enhances adaptations of trained and untrained individuals, others report no significant effects of HMB supplementation (8,10). Thus, the available scientific literature on HMB supplementation in humans is still preliminary in nature and should be considered with reservation (11,12).Also, the data about the influence of HMB supplementation, particularly with resistance training, in younger males are still scarce in the literature regarding the effect of HMB supplementation on these variables.

Therefore, the aim of the present study was to assess the effect of HMB supplementation on body composition, muscular strength and, performance adaptations after 8 weeks resistance training in younger males. We hypothesized that HMB supplementation will lead to greater adaptive responses than placebo groups in performance and body composition.

MATERIALS & METHODS

The subjects were 20 healthy men who were familiar with resistance exercise and training volunteered to participate in this study. Subjects were randomly assigned to one of two training groups: HMB plus resistance training group (HMB; *N* = 10, age = 17.5 ± 0.7 y, height = 172.2 ± 3.1 cm, and body mass = 75.4 ± 1.1 kg) and (b) placebo plus resistance training group (PL; *N* = 10, age = 17.1 ± 0.6 y, height = 175.2 ± 4.3 cm, and body mass = 76.3 ± 2.2 kg). The subjects did not have medical or orthopedic problems that compromised their participation in this study. Each parent subject was informed of the risks and benefits of the study and subsequently signed an informed consent form in accordance with the guidelines of the university's Institutional Review Board.

This study was designed to examine the effects of resistance training plus HMB or PL supplementation on body composition and performance adaptations. Subjects in both groups were instructed on proper technique of training one week prior to initiation of study. The subjects subsequently underwent 8 weeks of training and were tested a week pre-and a week post-training for the variable

The participant underwent 4 days of testing, namely 2 pre- (48 h apart between testing sessions) and 2 post-test day (48 h apart between testing sessions), respectively. A week before the initiation of training, each subject was familiarized with the training programs, and the demographic data were gathered and anthropometric measurements taken. The subjects were tested at the exact same time of day (2 to 4 P.M, post-test day) and same day of the week as the pre-test day to minimize the effect of circadian variations in the test results. All subjects had to continue with the normal daily life activity and dietary intake.

Anthropometric measurements were done in light clothes before and after the training period. Height and weight were measured by an automatic height–weight scale, to the nearest 0.1 cm and 0.1 kg, respectively. BMI was calculated by dividing weight (kg) by the square of the height (m^2). To estimate the amount of subcutaneous fat in the body, skinfold thickness was measured (Lafayette Caliper, model 01128, USA) at three sites (Chest, Abdomen and Quadriceps) in the right of body. Each measurement was performed in triplicate and the average was taken for analysis. All the measurements were made with the subject in standing position and body fat percent were estimated in accordance with Jackson and Pollack [13]. LBM was determined by subtracting the fat mass from weight.

The RAST test was used to measure subjects' anaerobic performance ability, maximum power. Subjects run 35-m intervals, six times, with 10 s of rest between each interval. Power was calculated as previously suggested (14).

In the vertical jump test (VJT), subjects performed three trials with 30-sec of rest in between each jump. The following procedure was used for each subject during data collection. Subjects stood directly under the Vertec, fully extending an arm to touch the highest vane possible while remaining flat-footed to establish standing reach height, which was recorded. Subjects were instructed to perform the highest jump vane possible. The difference between standing reach height and each vertical jump height was calculated and the highest jump was used in the data analysis (15).

A bilateral leg press test was selected to provide data on maximal strength through the full range of motion of the muscles involved. Maximal strength of the lower extremity muscles was assessed using concentric 1RM leg press action. Bilateral leg press tests were completed using standard leg press equipment, with the subjects assuming a sitting position and the weight sliding obliquely at 45°. On command, the subjects performed a concentric leg extension (as fast as possible) starting from the flexed position to reach the full extension against the resistance determined by the weight. Warm-up consisted of a set of 10 repetitions at loads of 40-60% of the perceived maximum [16].

For the bench press, each participant lowered the bar until contact with the chest was achieved and subsequently lifted the bar back to the fully extended elbow position. Any trials failing to meet the standardized technique criteria were discarded. A warm-up consisting of 5-10 repetitions with approximately 40-60% of perceived maximum was performed. The rest period between the actions was always 2 minutes. Subjects were allowed to perform maximum 8 repetitions during bench press and leg press, and were used equation of Brzycki [17]: estimated 1RM= weight (kg)/1.0278 – (repetitions x 0.0278) for determining of 1RM.

The resistance training programs included three days weekly (on Saturday, Monday and Wednesday) for 8 weeks. Each training session lasted 85-min, including 10-min warm-up (e.g., jogging, stretching and ballistic exercises), 70-min training, and 5-min cool-down (e.g., jogging and stretching exercises). The resistance training program stressed all major muscle groups and included the following exercises (or variations of) in each session: leg press, knee extension, knee flexion, lat pull-down, bench press, shoulder press, cable biceps curl and triceps push down 3 sets of 12 to 8 repetitions with 70 to 80 % of 1RM . Exercise volume and intensity progressed during the training program according to previous recommendations [12]. Two and three minutes of rest intervals were assigned between sets and exercises, respectively.

The HMB supplementation consisted of 1 gram of β-hydroxy-β-methylbutyrate in the calcium salt form (Optimal Nutrition, USA) in each daily meal. Likewise, the subjects in PL group ingested 1 gram of polydextrose. In training days, only one gram of HMB or PL was consumed prior to the exercise session and other servings was consumed with breakfast and supper [18].

All data are presented as mean ± SD. The distribution of each variable was examined using the Shapiro-Wilk test. A two-way analysis of variance with repeated measures (2 [group] x 2 [time]) was used to determine significant differences between groups. A criterion α level of $P \leq 0.05$ was used to determine statistical significance. All statistical analyses were performed through the use of a statistical software package (SPSS®, Version 16.0, SPSS., Chicago, IL).

RESULTS

The results of this study are presented in Table 1. There were significant improvements in the percent body fat, RAST test, VJT, 1RM bench press and 1RM leg press after 8 weeks resistance training for both the HMB and PL groups ($P < 0.05$). In addition, the HMB group indicated greater changes than PL group in RAST test, VJT, BMI, 1RM leg press and bench press after training intervention ($P < 0.05$).

Table 1. Changes in anthropometric and performance variables in response to 8 weeks training intervention (mean ± SD).

	HMB (n = 10)	PL (n = 10)	Significance
Body fat (%)			
Pre	14.9±4.5	14.5±5.7	G=0.981
Post	12.1±3.6*	12.2±5.0*	T=0.039
			G×T=0.07
BMI (kg/m²)			
Pre	25.4±1.7	26.1±3.3	G=0.55
Post	27.7±2.5*, **	26.4±3.2	T=0.04
			G×T=0.05
RAST (w)			
Pre	562±32.5	568.1±25.5	G=0.08
Post	580.1±31.3*, **	577 ±23.3*	T=0.001
			G×T=0.045
VJT (cm)			
Pre	38.0±3.5	37.1±2.2	G=0.12
Post	46.1±3.1*, **	41±2.2*	T=0.02
			G×T=0.03
1RM leg press (kg)			
Pre	175.2±42.1	177.1±45.8	G=0.23
Post	201±35.7*, **	191.8±37.2*	T=0.02
			G×T=0.02
1RM bench press (kg)			
Pre	54.3±14.1	54.2±10.5	G=0.16
Post	66.3±13.6*, **	61.2±12.7*	T=0.01
			G×T=0.042

*: denotes significant differences between baseline and post-training values ($p \leq 0.05$); **: denotes significant differences between the HMB and PL supplementation groups at post-training ($p \leq 0.05$). G = group, T = time

DISCUSSION

The present study investigated the effect of 8 weeks HMB supplementation on body composition, muscular strength and power performance after resistance training. The results have shown that HMB supplementation induced significant change in body composition variables, power performance and strength gains after 8 weeks resistance training and the changes in strength, power and BMI were greater for HMB group compared to PL group. These results are in contrast with previous studies which found positive effects of HMB supplementation for performance adaptations [2-9].

In body composition variables such as BMI and body fat, both the groups showed improvements in these variables and also the changes in BMI was greater for the HMB group.

Recent dada suggests that HMB supplementation improves fatty acid oxidation, adenosine monophosphate kinase (AMPK), Sirt1, and Sirt3 activity in muscle cells. Sirt proteins modify the acetylation level of histones and proteins [19]. AMPK is also a sensor of energy balance, but does so through changes in AMP/ATP ratios [20]. Collectively, these proteins act to improve mitochondrial biogenesis, fat oxidation, energy metabolism, and the reactive oxygen defense system [20]. Consequently, this recent evidence has shown that HMB supplementation increases mitochondria biogenesis and fat oxidation [14], and it could be main mechanism to decrease body fat and increase BMI following HMB supplementation. These findings agreed with Kraemer et al. [21], who also found that participants lost more body fat following 12 weeks of HMB supplementation relative to a placebo- matched control.

Power is one of the most critical attributes underlying success in sport [6,7]. This variable is intimately related and allows athletes to be successful in their respective sport [7]. In this study, both the groups showed meaningful gains in VJ and RAST test after 8 weeks training, while the HMB group indicated more changes than PL group in power performance. In line with the present study, Kraemer et al. [21], suggest that changes in power following HMB supplementation are optimized within the training program [11]. Moreover, it is conceivable that the magnitude of power adaptations resulting from HMB supplementation may be reflective of the measurement technique. For example, past research utilizing compound, sport-specific movements such as VJ have found more changes in power following HMB supplementation [21,22]. In contrast, researchers have found small treatment effects when using non-specific movements [9]. The greater adaptations in power performance may be due to neuromuscular adaptations and changes in muscle mass hypertrophy following HMB supplementation; however, it only could be speculations and more studies are necessary.

Regarding to strength performance, the results of our study indicated that HMB supplementation induced greater changes in 1RM leg press and bench press which is in line with previous findings that HMB supplementation resulted in a significant greater strength gain after training [3,4]. Recently, Portal et al.[23] showed that HMB supplementation led to an increase in knee flexion isokinetic force in elite adolescent volleyball players. In the study conducted by Kraemer et al. [21] bench press and squat 1RM were increased in HMB and control groups after 12 weeks of resistance training. However, the increases in 1RM were significantly greater in the HMB group when compared to the control group. However, other studies did not find positive effects of HMB to strength gains [4-8]. Changes in strength are largely due to neurological adaptations early in practice (i.e., changes in motor unit recruitment, asynchronous to synchronous contractions, etc.), while increases in lean muscle mass, which increases the capacity of the body to produce force, accounts for a greater percentage of strength gain later. Currently, the ability of HMB to increase indices of strength has been attributed to the changes observed in lean mass. However, to our knowledge, no research has examined possible neurological adaptations facilitated by HMB supplementation. It seems that HMB supplementation may have beneficial effects on neurological adaptations of strength gain [24].

In summary, the results of this eight-week study demonstrated the efficacy of HMB supplementation on strength and power performance. The use of these supplements appears to provide greater changes compared with placebo supplementation. It could be concluded that eight weeks of HMB supplementations induced meaningful increases in power and strength performance with reduction of body fat and increases in BMI.

REFERENCES

1. Hoffman JR, Cooper J, Wendell M, et al. Effects of β-hydroxy-β-methylbutyrate on power performance and indices of muscle damage and stress during high-intensity training. J Strength Cond Res, 2004: 18, 747-752.
2. Arazi H, Rohani H, Ghiasi A. Resistance training & beta-hydroxy-beta-methylbutirate supplementation on hormones. Brezi J Sport Med, 2015; 21 (5); 386-389.
3. Wilson JM, Lowery RP, Joy JM, et al. The effects of 12 weeks of beta-hydroxy-beta-methylbutyrate free acid supplementation on muscle mass, strength and power in resistance-trained indeviduals: a randomized, double-blind, placebo-controlled study. Eur J Appl Physiol, 2014; 114: 1217-1227.
4. Kraemer WJ, Hatfield DL, Volek JS, et al. Effects of amino acids supplement on physiological adaptations to resisiatnce training. Med Sci Sport Exerc, 2009; 41(5): 1111-1121.
5. Wilson GJ, Wilson JM, Manninen AH. Effects of β-hydroxy-β-methylbutyrate (HMB) on exercise performance and body composition across varying levels of age, sex and training experience: A review. Nut Met, 2008: 5, 1-17.
6. Nissen, S., et al., β-Hydroxy-β-methylbutyrate (HMB) supplementation in humans is safe and may decrease cardiovascular risk factors. The Journal of nutrition, 2000. 130(8): p. 1937-1945.
7. Slater, G., et al., Beta-hydroxy-beta-methylbutyrate (HMB) supplementation does not affect changes in strength or body composition during resistance training in trained men. International journal of sport nutrition and exercise metabolism, 2001. 11(3): p. 384-396.
8. Durkalec-Michalski K, Jeszka IJ, Podgórski T. The Effect of a 12-Week Beta-hydroxy-beta-methylbutyrate (HMB) Supplementation on Highly-Trained Combat Sports Athletes: A Randomised, Double-Blind, Placebo-Controlled Crossover Study. Nutrients, 2017, 9, 753; doi:10.3390/nu9070753
9. Panton, L.B., et al., Nutritional supplementation of the leucine metabolite β-hydroxy-β-methylbutyrate (HMB) during resistance training. Nutrition, 2000. 16(9): p. 734-739.
10. Durkalec-Michalski, K.; Jeszka, J. The efficacy of a _-hydroxy-_-methylbutyrate supplementation on physical capacity, body composition and biochemical markers in elite rowers: A randomised, double-blind, placebo-controlled crossover study. J. Int. Soc. Sports Nutr. 2015, 12, 31.
11. Albert, F.J., et al., Usefulness of β-hydroxy-β-methylbutyrate (HMB) supplementation in different sports: an update and practical implications. Nut Haspital 2015.12(2):233-248
12. Alway, S.E., et al., β-Hydroxy-β-methylbutyrate (HMB) enhances the proliferation of satellite cells in fast muscles of aged rats during recovery from disuse atrophy. Experimental gerontology, 2013. 48(9): p. 973-984.

13. Caperuto, É.C., et al., β-Hydoxy-β-methylbutyrate supplementation affects Walker 256 tumor-bearing rats in a time-dependent manner. Clinical Nutrition, 2007. 26(1): p. 117-122.
14. Portal, S., et al., Effect of HMB supplementation on body composition, fitness, hormonal profile and muscle damage indices. Journal of Pediatric Endocrinology and Metabolism, 2010. 23(7): p. 641-650.
15. Thomson, J.S., P.E. Watson, and D.S. Rowlands, Effects of nine weeks of β-Hydroxy-β-Methylbutyrate supplementation on strength and body composition in resistance trained men. The Journal of Strength & Conditioning Research, 2009. 23(3): p. 827-835.
16. Slater, G.J. and D. Jenkins, β-hydroxy-β-methylbutyrate (HMB) supplementation and the promotion of muscle growth and strength. Sports Medicine, 2000. 30(2): p. 105-116.
17. Smith, H.J., P. Mukerji, and M.J. Tisdale, Attenuation of proteasome-induced proteolysis in skeletal muscle by β-hydroxy-β-methylbutyrate in cancer-induced muscle loss. Cancer research, 2005. 65(1): p. 277-283.
18. Townsend JR, Hoffman JR, Gonzalez AM, et al. Effects of β-hydroxy-β-methylbutyrate (HMB)-free acid ingestion and resistance exercise on the acute endocrine response. Int J End, 2015: ID 856708
19. O'Connor, D. and M. Crowe, Effects of [beta]-hydroxy-[beta]-methylbutyrate and creatine monohydrate supplementation on the aerobic and anaerobic capacity of highly trained athletes. Journal of sports medicine and physical fitness, 2003. 43(1): p. 64.
20. Nissen, S.L. and R.L. Sharp, Effect of dietary supplements on lean mass and strength gains with resistance exercise: a meta-analysis. Journal of Applied Physiology, 2003. 94(2): p. 651-659.
21. Brzycki M. Strength testing-predicting a one-rep max from reps to-fatigue. Journal of Physical Education Recreation and Dance. 1993; 68:88-90.
22. Jackson AS, Pollock ML. Practical assessment of body composition. Physician and Sports Medicine. 1985; 13:82-90.
23. Hardie DG. Minireview: the AMP-activated protein kinase cascade: the key sensor of cellular energy status. Endocrinology 2003, 144:5179–5183
24. Stancliffe RA, Zemel MB. Role of β-hydroxy-β-methylbutyrate (HMB) in leucine stimulation of muscle mitochondrial biogenesis. FASEB J 2012; 26:251–256