

Brain derived neurotrophic factor of adolescents not improved after 8 weeks resistance training

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Received: 30 May 2017/ Accepted: 23 July 2017

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Abstract

Introduction: Although the benefits of physical activity on cardiovascular health are well known, recent evidence demonstrated that exercise may promote brain health by increases brain derived neurotrophic factor (BDNF); however it is still unclear. The purpose of this study was to examine the effects of 8 weeks resistance training on serum BDNF levels in adolescents.

Material and Methods: Twenty four adolescents (age, 16 to 18 years) were randomly assigned to one of the training group (n=12) or control group (n=12). The training group was performed resistance training 3 days a week for 8 weeks in 2-3 sets with 12-15 maximal repetitions at 60-75% of 1-RM in each station. Biochemical parameters were measured before and 48h after the last session of training.

Results: The results indicated that body fat percent decreased after 8 weeks resistance training ($P < 0.05$);

however, serum BDNF had no significant changes after the intervention.

Conclusions: Serum BDNF level was not affected by 8 weeks resistance training in the adolescents.

Key words: Resistance training, BDNF, Adolescents, Brain health

1. Introduction

The benefits that physical activity confers on cardiovascular health are well known, while recent evidence has also demonstrated the ability of exercise to promote brain health. The evidence that physically active older people, particularly those that have been active throughout their lifespan, are at decreased risk of developing Alzheimer's disease and other forms of dementia relative to their sedentary counterparts (1) strongly suggests that exercise may be a powerful protective strategy against age-related neurodegenerative decline. In addition to its neuroprotective actions, exercise enhances cognitive function in elderly people and slows the progression of dementia-related cognitive symptoms (2). Thus, exercise may reduce the risk of developing dementia or ameliorate cognitive impairment already present in those suffering from neurodegenerative decline.

Moreover, exercise may also enhance cognitive function in young, healthy, adults. High impact running has been shown to improve vocabulary learning (3), while cycling has been shown to improve performance in a map recognition task (4) and in the Stroop word-colour task (5). However, Grego et al. (2005) also showed that prolonged exercise leading to fatigue compromises cognitive function (4). It has been suggested that intense exercise may facilitate aspects of cognitive function in a manner dependent on an individual's cardiovascular fitness (6).

Evidence available from animal studies provides some insight into the mechanisms by which exercise may enhance cognition. In rodent models, exercise has consistently been shown to enhance learning and persistently upregulate expression of brain-derived neurotrophic factor

(BDNF) in the hippocampus (7,8). BDNF is a neuronal growth factor that plays a regulatory role in neuronal differentiation, synaptic plasticity, and apoptosis (9). BDNF is also associated with energy homeostasis (10). Serum BDNF concentration has repeatedly been reported to increase following acute and chronic aerobic exercise (5, 11-13); while the effect of resistance training on BDNF-especially on the adolescence- are not well known. For example, Marston et al. (2017) showed that BDNF concentration increases after the instance resistance exercise (14); while Antonio-Santos et al. (2016) reported that BDNF had not significant changes after 8 weeks resistance training in the young adult rats (15). Here, the aim of present study was to investigate the effect of 8 weeks resistance training on serum BDNF levels in adolescents.

2. Materials and methods

Subjects

Twenty four adolescents (16.9 ± 1.0 years; mean \pm SD) participated in this study. All the subjects were asked to complete a personal health and medical history questionnaire and they were given both verbal and written instructions outlining the experimental procedure, and written informed consent was obtained. The subjects were randomly assigned to one of the training group (n=12) or control group (n=12).

Study design

Following familiarization, subjects were asked to report to the laboratory for an additional test session designed to determine one-repetition maximum (1-RM) for 8 exercises involving the upper and lower body. Maximal strength was determined using a concentric, 1-RM (Kraemer et al. 1999), as previously described (Ahmadizad and El-Sayed 2003). The warm-up consisted of riding a stationary bicycle for 5 min, two sets of progressive resistance exercises similar to the actual exercises utilized in the main experiment, and 2-3 min of rest accompanied by some light stretching exercises. After the warm-up, subjects performed the 1-RM test, and the heaviest weight that could be lifted once using the correct technique was considered as 1-RM for all the exercises and used to calculate the percentage of resistance.

Exercise training

Two familiarization sessions were designed to habituate subjects with the testing procedures and laboratory environment. The main aim of these sessions was to familiarize subjects with different resistance exercises using weight-training machines and also to familiarize them with performing the 1-RM test. During the familiarization sessions, it was ensured that all the subjects used the correct techniques for all exercises prior to taking part in the main test sessions. Subjects executed eight resistance exercises selected to stress the major muscle groups in the following order: chest press, leg extension, shoulder press, calf sitting, latissimus pull down, leg press, biceps curl, and hamstring curl. RT consisted of 50-60 min of station weight training per day, 3 days a week, for 8 weeks. This training was performed in 8 stations and included 2-3 sets with 12-15 maximal repetitions at 60-75% of 1-RM in each station. Each station and set was separated by 2-3 min and 1-2 min rest respectively. General and specific warm-up were performed prior to each training session, as explained for the 1-RM determination, and each training session was followed by cool-down.

Blood sampling

Fasted, resting morning blood samples (2 ml) were taken at the same time before and after 8 weeks intervention. All the subjects fasted at least for 12 hours and a fasting blood sample was obtained by venipuncture. Serum obtained was frozen at -22°C for subsequent analysis. The serum BDNF level was measured in duplicate using an enzyme-linked immunosorbent assay (ELISA) kits (Casabio Biotech Co. LTD.; China). The sensitivity of kit was 0.08 ng/ml.

Statistical analysis

Results were expressed as the mean \pm SD and distributions of all variables were assessed for normality. Independent sample t-test and Paired t-test were used to compute mean (\pm SD) changes in the variables in control and training group pre- and after the intervention and between the groups. The level of significance in all statistical analyses was set at $P \leq 0.05$. Data analyses were performed using SPSS software for windows (version 19, SPSS, Inc., Chicago, IL).

Results

Anthropometric and body composition characteristics of the subjects at baseline and after training are presented in Table 1. Before the intervention, there were no significant differences in any of variables among the two groups. Body fat percent decreased ($P < 0.05$) after 8

weeks resistance training compared to the control group, while no significant changes in the body mass and BMI were found after the training.

Table 1. Anthropometric and body composition characteristics (mean \pm SD) of the subjects before and after training

	Control (mean \pm SD)		Training (mean \pm SD)	
	Pretraining	Posttraining	Pretraining	Posttraining
Age (y)	17.0 \pm 0.9	-----	16.7 \pm 1.0	-----
Height (cm)	171.5 \pm 5.7	-----	169.3 \pm 4.3	-----
Body mass (Kg)	74.7 \pm 5.3	74.8 \pm 5.2	73.5 \pm 4.7	72.3 \pm 5.0
BMI (Kg/m ²)	25.4 \pm 2.6	25.4 \pm 2.7	25.6 \pm 2.1	25.2 \pm 2.2
Body fat (%)	21.0 \pm 3.0	20.9 \pm 3.0	21.1 \pm 2.6	20.1 \pm 2.5*

*:P<0.05 for between-group differences.

†:P<0.05, pretraining *vs.* posttraining values.

The results on BDNF before and after the intervention are presented in Figure 1. Independent sample t-test and Paired t-test indicated that BDNF did not change in the exercise training compared with the control group.

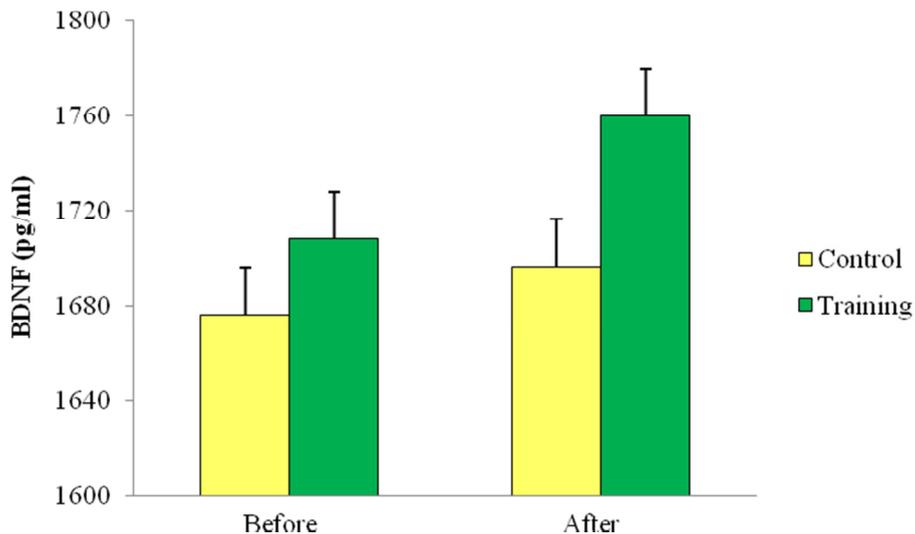


Figure 1. Changes of BDNF of the subjects before and after training

3. Discussion

BDNF is a member of the neurotrophin family expressed in many areas of the adult mammalian brain. The effects of exercise training on serum BDNF is still unclear. The purpose of this study was to examine the effects of 8 weeks resistance training on serum BDNF levels in adolescents. The results indicated that body fat percent decreased ($P < 0.05$) after 8 weeks resistance training compared to the control group, while no significant changes in the body mass and BMI were found after the training. For BDNF our results demonstrate that resistance training does not induce significant alterations in serum BDNF concentrations in adolescents. Zare Mehrjardi (2017) reported that serum BDNF had no significant changes after 8 weeks aerobic training in female athletes (16). Antonio-Santos et al. (2016) also reported that BDNF had not significant changes after 8 weeks resistance training in the young adult rats (15). However, some previous reports showed elevated blood BDNF after moderate (aerobic) and intense exercise (17,18). These discrepant results may be attributed to some mechanisms. At the first, Lee et al. (2016) showed that the BDNF decreased following body-weight reduction in subjects with obesity and metabolic syndrome. The BDNF level was associated with the reduced percentage of body weight, independent from the baseline BDNF level (19). Our results showed that body weight did not significant change after 8 weeks resistance exercise, however body fat percent decrease after the training thus it seems that the lack of effect of exercise training on BDNF in the present study might be due to the absence of reductions in body weight or the other mechanism may attribute in BDNF increase after resistance training.

Secondary, the degree of physical effort during the exercise protocol may be important for altering blood BDNF levels. In humans, the BDNF response to exercise differs depending on the type and intensity of exercise. At the end, the differences in subject populations may be attributed in these discrepant results.

At the end, resistance training can alter the manner by which trained muscles are recruited by the central nervous system such that a greater degree of muscle activation is generated by the same amount of cortical

input (20). In the present study, there were no changes in the serum level of BDNF after 8 weeks resistance training. It can be suggested that there is an adaptive mechanism induced by resistance training that minimize cortical input necessary to elicit a given level of force. In addition, this adaptation can also produce an increase in the coordinated movements by reducing the level of central drive and the functional interference provided by the motor cortex and spinal cord (20,21).

4. Conclusion

BDNF is a member of the neurotrophin family, and it is largely expressed in the developing and adult mammalian brain and peripheral tissues, such as the muscle and adipose tissue. BDNF plays a regulatory role in neuronal differentiation, synaptic plasticity, and apoptosis and it is also associated with energy homeostasis. Our results showed that serum BDNF levels were not affected by 8 weeks resistance training in adolescents.

5. Acknowledgment

The work was supported by grants from the Fars Science & Research branch, Islamic Azad University. The authors gratefully acknowledge the all subjects whom cooperated in this investigation.

Conflict of interests: No conflict of interests amongst authors.

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