Journal of Physical Activity and Hormones
Vol 1, No. 4, Ser. 4 (December 2017), 013-022

Effect of 8 weeks selected Spark Motor Program on brain derived neurotrophic factor in intellectually disabled educable boys

Hamid Arvin[1*] and Latifeh Tavakol[2]

Received: 3 October 2017 / Accepted: 19 November 2017

(1) PhD candidate in Motor behavior and motor development, Department of Motor behavior, Shiraz branch, Islamic Azad University, Shiraz, Iran
(2) BS in Exercise physiology, Department of Exercise physiology, Shiraz branch, Islamic Azad University, Shiraz, Iran
(*) PhD candidate in Motor behavior and motor development.
E.mail: hamidarvin36@yahoo.com

Abstract

Introduction: Intellectually disabled is a generalized neurodevelopmental disorder characterized by significantly impaired intellectual and adaptive functioning. Brain-derived neurotrophic factor (BDNF) has emerged as a key neurotrophin regulating synaptic plasticity, neuronal differentiation and survival. The effect of exercise training on BDNF in intellectually disabled educable children is not well known. Thus the present study was conducted to examine the effect of 8 weeks selected Spark Motor Program on BDNF in intellectually disabled educable boys.

Material & Methods: Twenty intellectually disabled educable boys participated in this study as the subject. The subjects were divided into experimental group (n=10) or control group (n=10) randomly. The experimental group was performed selected Spark Motor Program 3 days a week for 8 weeks.

Results: The results showed that BDNF had not significant change after 8 weeks selected Spark Motor Program.

Conclusions: In summary, Spark Motor Program that selected in this study had not significant effect on BDNF in intellectually disabled educable boys.

Key words: Intellectually disabled, BDNF, Spark training

1. Introduction

Intellectual disability is a disability characterized by significant limitations in both intellectual functioning and in adaptive behavior, which covers many everyday social and practical skills. This disability originates before the age of 18 (1,2). Intellectual disability begins during childhood and involves deficits in mental abilities, social skills, and core activities of daily living when compared to same-aged peers (3). Intellectual disability affects about 2–3% of the general population. Seventy-five to ninety percent of the affected people have mild intellectual disability (2).

It is well established on the fact that regular exercise can help in treating various brain disorders such as autism (4,5), depression (6), insomnia (7), Parkinson disease (8), and Alzheimer's disease (9). However in case of the patients with intellectual disabilities, they lack determination to participate in any physical exercise mainly due to decreased motor nerves activity, behavioral disorder, lack of concentration and poor communication skills. Additionally, since establishing voluntarily participations and self-motivations are difficult for the intellectual disabled patients, the effectiveness of the rehabilitation treatment is also very limited (10). Therefore there is a need for appropriate measure to be taken for the purpose of providing interest and motivation to the intellectually disabled patients.

Neurotrophins play a pivotal role in the functioning of the nervous system including development, survival, function and plasticity. Brain-Derived Neurotrophic Factor (BDNF) is the most abundant and widely distributed neurotrophin in the mammalian Central Nervous System (CNS). Since the purification of BDNF protein, definitive evidence has emerged for its key role in mammalian brain development, physiology and pathology (11). There is a growing evidence for the role of BDNF in the survival, differentiation and plasticity of neurons throughout the brain and spinal cord. BDNF is thought to participate by inhibiting apoptosis (12) and stimulating sprouting and neuronal reorganization (13). The cellular actions of BDNF are believed to be mediated through tyrosine kinase receptor B (TrkB) and by p75NTR (p75neurotrophin receptor), a member of the TNF (tumor necrosis factor) receptor superfamily (14). Previous studies indicated that exercise training increases levels of neurotrophic factors in the brains of humans (15), but effect of exercise training on BDNF in intellectually disabled educable children is not well known. Thus the present study was conducted to examine the effect of 8 weeks selected Spark Motor Program on BDNF in intellectually disabled educable boys.

2. Materials and Methods

Subjects

The participants of this experiment are 20 intellectually disabled patients, aged between 10~14 with second to third degree of mental disability ratings which included autistic patients. The parents or guardian of the subjects were given both verbal and written instructions outlining the experimental procedure, and written informed consent was obtained. The study was approved by the Islamic Azad University, Shiraz branch Ethics Committee. The subjects were divided into experimental group (n=10) or control group (n=10) randomly.

Measurements

Anthropometric measurements

Height and weight were measured, and body mass index (BMI) was calculated by dividing weight (kg) by height (m^2).

Biochemical analyses

Fasted, resting morning blood samples (5 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 ^{oC} for subsequent analysis. The serum BDNF level was measured in duplicate using an enzyme-linked immunosorbent assay (ELISA) kits (Eastbiopharm Co. LTD.; China). The sensitivity of kit was 0.01 ng/ml.

Spark Motor Program

Selected exercise program was originated from Spark Motor Program that involves exercising and playing. Two kind of Spark Physical Education plan are exist: Elementary PE (1.K-2 PE 2. 3-6 PE) and Secondary PE (1. Middle School PE 2. High School PE). Gross motor skills like crawling, balancing and running are expanded during early childhood and are considered as a necessary item of motor development. The major muscle groups are mostly responsible for gross motor movements. Fine motor skills are those attributed to the coordination of minor groups of muscles for example involved in playing piano. Test of Gross Motor Development-edition 2 called TGMD-2 is a norm-reference measurement of gross motor development (16).

The exercise program includes 45 minutes for each session that is divided into 4 parts. The first 15 minutes is allocated to warm up and then playing for 10 minutes that involves motor skill movements, next 10 minutes for manipulation movement skills and finally 10 minutes for cool down. The experimental group did the selected spark motor program 3 times in the week and for 8 weeks (17). During this period the control group did their routine activity. In the end of the 24th session, the posttest was conducted.

Statistical analysis

Results were expressed as the mean $\pm$ SD and distributions of all variables were assessed for normality. Data were analyzed using Mann-Whitney U test. The level of significance in all statistical analyses was set at $P<0.05$. Data analysis was performed using SPSS software for windows (version 17, SPSS, Inc., Chicago, IL).

Results

Anthropometric parameters of the subjects are presented in Table 1. No significant differences were observed on the anthropometric parameters of the subjects at baseline.

Table 1. Anthropometric parameters (mean ± SD) of the subjects

	Experimental group (mean±SD)	Control group (mean±SD)
Height (cm)	143.0 ± 10.3	141.5 ± 8.8
Body weight (Kg)	38.3 ± 9.4	37.7 ± 8.3
BMI (Kg/m^2)	18.3 ± 2.7	18.5 ± 2.1

The data on BDNF concentration of the experimental and control group is presented on figure 1. The results indicated that although BDNF concentration increases in the experimental group, but it was not significant statistically (z = -1.4, P = 0.1).

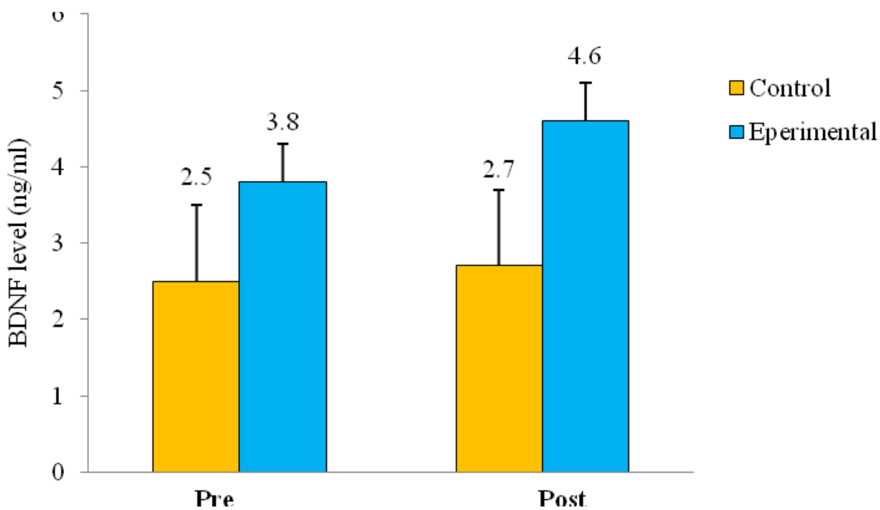

Figure 1. BDNF concentration of the subjects

3. Discussion

BDNF is a member of the neurotrophin family of survival-promoting molecules, plays a vital role in the growth, development, maintenance, and function of several neuronal systems (18). Lee et al. (2014) indicated that BDNF levels are lower in the intellectually disabled educable cases than the normal cases (10). Previous studies indicated that exercise training increases levels of neurotrophic factors in the brains of humans (15), but effect of exercise training on BDNF in intellectually disabled educable children is not well known. In this experiment, the effect of Spark Motor Program measures on the changes of BDNF values were analyzed and discussed accordingly in the intellectually disabled educable boys.

Our results showed that although BDNF concentration increases after 8 weeks selected Spark Motor Program, but it was not significant statistically. Lee et al. (2014) reported that BDNF levels increase by 52.6% after 12 weeks aquatic training program in the intellectually disabled patients (10). According to the Seifert et al. (2010), it has been suggested that the BDNF concentration was increased in the brain after 3 month of exercising (19), and the Ferris et al. (2007) and Hillman et al. (2008) studies have reported that the brain function was increased including cognitive function resulted by the BDNF increase through exercising (20,21). These discrepancy results might due to subjects' population, mode, type and duration of exercise training.

Low BDNF mRNA and protein levels in the brain are reported in several patient groups (22,23), and serum BDNF levels are reduced in patients with autism, Alzheimer's disease and major depression (4-6,9). Conversely, when patients are treated with antidepressants both hippocampal BDNF mRNA expression and serum BDNF levels increase (24,25). Seifert et al. (2010) demonstrated that BDNF mRNA expression was increased in the hippocampus in rats following exercise training (19), and the endurance training-induced increase in BDNF release from the brain at rest suggests that exercise may be neuroprotective and important for maintaining neuronal health and survival in humans suffering from neurological and psychiatric diseases and diseases related to obesity and physical inactivity (19). Since cortisol inhibits hippocampal BDNF production (26) and resting BDNF level has inverse relationship to the leptin concentration (27), thus exercise- induced changes on BDNF levels are related to blood cortisol and leptin levels. We couldn't measure cortisol and leptin levels in the current study and additional studies are needed to evaluate these mechanisms. On the other hand, Seifert et al. (2010) noted that the site of blood sampling is affected on the BDNF concentration (19).

In the present study, blood samples were obtained from the antecubital vein however in the Seifert et al. study blood samples were obtained from the internal jugular vein with the catheter advanced to the bulb of the vein. Seifert et al. (2010) noted that because BDNF crosses the blood-brain barrier in both directions (28) and the influence of platelets to the measured values is considered minimal, the increase in internal jugular venous BDNF concentration following endurance training, most likely, reflects increased release from the brain (19).

4. Conclusion

In conclusion, Spark Motor Program that selected in this study had not significant effect on BDNF in intellectually disabled educable boys. It is suggested that in the future studies, to obtain cortisol and leptin levels and take blood samples from the internal jugular vein for to ensure the accuracy of the evaluation of BDNF concentration.

5. Acknowledgment

The authors gratefully acknowledge the all subjects whom cooperated in this investigation.

Conflict of interests: No conflict of interests amongst authors.

References

1. Faal Moghanlo H, Hosseini F, Mikaili Manee F. Effect of Spark Motor Program on the development of gross motor skills in intellectually disabled educable boys. J Birjand Univers Med Sci 2013; 20: 262-270.

2. Daily DK, Ardinger HH, Holmes GE. Identification and evaluation of mental retardation. Am Fam Physician 2000; 61: 1059-1067.

3. Kaneshiro NK. Intellectual disability. MedlinePlus, U.S. National Library of Medicine, 2016. Available at: https://medlineplus.gov/ency/article/001523.htm.

4. Ghanizadeh A. Physical exercise and intermittent administration of lactulose may improve autism symptoms through hydrogen production. Med Gas Res 2012; 2: 19.

5. Anderson-Hanley C, Tureck K, Schneiderman RL. Autism and exergaming: effects on repetitive behaviors and cognition. Psychol Res Behav Manag 2011; 4: 129-137.

6. Mokhtari-Zaer A, Hosseini M, Boskabady MH. The effects of exercise on depressive- and anxiety-like behaviors as well as lung and hippocampus oxidative stress in ovalbumin-sensitized juvenile rats. Respir Physiol Neurobiol 2017; 248: 55-62.

7. Rubio-Arias JÁ, Marín-Cascales E, Ramos-Campo DJ, Hernandez AV, Pérez-López FR. Effect of exercise on sleep quality and insomnia in middle-aged women: A systematic review and meta-analysis of randomized controlled trials. Maturitas 2017; 100: 49-56.

8. Mak MK, Wong-Yu IS, Shen X, Chung CL. Long-term effects of exercise and physical therapy in people with Parkinson disease. Nat Rev Neurol 2017; 13: 689-703.

9. Machado S, Filho ASS, Wilbert M, Barbieri G, Almeida V, Gurgel A, et al. Physical exercise as stabilizer for Alzheimer'S disease cognitive decline: Current status. Clin Pract Epidemiol Ment Health 2017; 13: 181-184.

10. Lee IH, Seo EJ, Lim IS. Effects of aquatic exercise and CES treatment on the changes of cognitive function, BDNF, IGF-1, and VEGF of persons with intellectual disabilities. J Exerc Nutrition Biochem 2014; 18: 19-24.

11. Balaratnasingam S, Janca A. Brain Derived Neurotrophic Factor: a novel neurotrophin involved in psychiatric and neurological disorders. Pharmacol Ther 2012; 134: 116-124.

12. Riccio A, Ahn S, Davenport CM. Blendy JA, Ginty DD. Mediation by a CREB family transcription factor of NGF-dependent survival of sympathetic neurons. Science 1999: 286.

13. McAllister AK, Katz LC, Lo DC. Neurotrophins and synaptic plasticity. Annu Rev Neurosci 1999; 22: 295-318.

14. Chao MV. Neurotrophins and their receptors: a convergence point for many signalling pathways. Nat Rev Neurosci 2003; 4: 299-309.

15. Hashimoto K, Iwata Y, Nakamura K, Tsujii M, Tsuchiya KJ, Sekine Y, et al. Reduced serum levels of brain-derived neurotrophic factor in adult male patients with autism. Prog Neuropsychopharmacol Biol Psychiatry 2006; 30: 1529-1531.

16. Ulrich DA. Test of gross motor development-2. Austin, T.X.: Prod-Ed Press; 2000.

17. Rezvankhah Golsefidi N, Emami Hashemi SA. Effect of Selected Spark Motor Program on anxiety of children with asperger. Physic Treat 2015; 5: 83-88.

18. Halepoto DM, Bashir S, A L-Ayadhi L. Possible role of brain-derived neurotrophic factor (BDNF) in autism spectrum disorder: current status. J Coll Physicians Surg Pak 2014; 24: 274-278.

19. Seifert T, Brassard P, Wissenberg M, Rasmussen P, Nordby P, Stalknecht B, et al. Endurance training enhances BDNF release from the human brain. Am J Physiol Regul Integr Comp Physiol. 2010; 298: 327-377.

20. Ferris LT, Williams JS, Shen, CL. The effect of acute exercise on serum brain-derived neurotrophic factor levels and cognitive function. Med Sci Sports Exerc 2007; 39: 728-734.

21. Hillman CH, Erickson KI, Kramer AF. Be smart, exercise your heart: exercise effect on brain and cognition. Nature Rev Neurosci 2008; 9: 58-65.

22. Ferrer I, Goutan E, Marin C, Rey MJ, Ribalta T. Brain-derived neurotrophic factor in Huntington disease. Brain Res 2000; 866: 257-261.

23. Mogi M, Togari A, Kondo T, Mizuno Y, Komure O, Kuno S, et al. Brain-derived growth factor and nerve growth factor concentrations are decreased in the substantia nigra in Parkinson's disease. Neurosci Lett 1999; 270: 45-48.

24. Chen B, Dowlatshahi D, MacQueen GM, Wang JF, Young LT. Increased hippocampal BDNF immunoreactivity in subjects treated with antidepressant medication. Biol Psychiatry 2001; 50: 260-265.

25. Shimizu E, Hashimoto K, Okamura N, Koike K, Komatsu N, Kumakiri C, et al. Alterations of serum levels of brain-derived neurotrophic factor (BDNF) in depressed patients with or without antidepressants. Biol Psychiatry 2003; 54: 70-75.

26. Luger A, Deuster PA, Kyle SB, Gallucci WT, Montgomery LC, Gold PW, et al. Acute hypothalamic-pituitary-adrenal responses to the stress of treadmill exercise. Physiologic adaptations to physical training. N Engl J Med 1987; 316: 1309-1315.

27. Chaldakov GN, Fiore M, Stankulov IS, Hristova M, Antonelli A, Manni L, et al. NGF, BDNF, leptin, and mast cells in human coronary atherosclerosis and metabolic syndrome. Arch Physiol Biochem 2001; 109: 357-360.

28. Pan W, Banks WA, Fasold MB, Bluth J, Kastin AJ. Transport of brain-derived neurotrophic factor across the blood-brain barrier. Neuropharmacology 1998; 37: 1553-1561.