ATLANTIS PRESS

Advances in Health Sciences Research, volume 11

3rd International Conference on Sport Science, Health, and Physical Education (ICSSHPE 2018)

The Effect of Futsal toward Neuroplasticity

(Experiment study on Junior High School)

Jajat Darajat Kusumah Negara*
School of Physical Education
Sport Education Department
Universitas Pendidikan Indonesia
Bandung, Indonesia
*jajatdarajatkn@upi.edu

Sri Widia Jusman
Department of Biochemistry and Molecular Biology
Faculty of Medicine
Indonesia University
Jakarta, Indonesia
sriwidiaaj@gmail.com

Ermita Ibrahim Ilyas
Department of Physiology
Faculty of Medicine
Indonesia University
Jakarta, Indonesia

Rini Sekartini
Department of Pediatric
Faculty of Medicine
Indonesia University
Jakarta, Indonesia

***Abstract*—Nowadays, Futsal is a sport that is very famous of sport for children, teenagers to old age. The characteristics of futsal are very dynamic with high mobility and tend to be anaerobic metabolism. Futsal can affect fitness; improve cognitive function and brain neuroplasticity. There are several parameters that can see brain neuroplasticity including BDNF (brain derived neurotropic factor) and IGF-1 (insulin like growth factor one). BDNF functions as a neuron in the CNS (central nervous system) and PNS (peripheral nervous system) to help maintain and regenerate neurons and work specifically for the survival of neurons and stimulate neuronal growth. BDNF can be influenced by the frequency and intensity of the exercise. IGF-1 is an important role in the growth of children as well as for people to act as an anabolic effect. The method used in this study is an experimental method with pre and posttest design. The Subjects used was 40 students of Junior High School. The instrument for measuring BDNF and IGF-1 used the RnD system production kit, with the ELISA (Enzyme Linked Immunosorbent Assay) technique and carried out in the Laboratory of FKUI. Sampling of ± 10cc of blood samples was carried out before and after the treatment of structured and programmed futsal sports and was divided randomly into 3 groups, namely exercises frequency 1x per week, 3x per week, and 5x per week. The BDNF levels, in the F1 group, there was no significant increase or 8.76%. In F3 group, there was no significant increase or 26.52%. In F5 group, there was no significant increase or 12.74%. The IGF-1, in the F1 group, there was significant increase or 80.85% with p-value 0.000**. In the F3 group, there was no significant increase or 35.79%. In the F5 group, there was significant increase or 52.35 with p-value 0.046.**

Keywords—futsal; BDNF; IGF-1; exercise frequency

I. INTRODUCTION

At this time the futsal sport is a game of choice and is in great demand by various groups of children, adolescents and parents. This sport has many advantages, namely increasing and maintaining fitness, coordination, memory, attention, self-confidence, social skills, commitment, discipline, teamwork and others.[1] This futsal sport has fast and dynamic movement characteristics and the player must be able to control all movements effectively and efficiently. Futsal sports have several benefits, which include improving student cognition. Because in this futsal movement there is a movement that requires precision in kicking, decisions quickly and precisely so that it is able to execute the ball perfectly, besides that it must be able to arrange the other player to anticipate quickly, both in attack and in defense. These movements can stimulate students' cognitive functions. Attention and memory are domains to improve cognitive function. Attention is the ability to react or pay attention to a stimulus by being able to ignore other stimuli that are not needed. Attention is the result of the relationship between the brain stem, limbic and cortical activity so that it is able to focus on irrelevant stimuli. Concentration is the ability to maintain attention in a longer period [2]. As was done in Lestari's research et al., It was explained that there was a significant relationship between futsal and concentration skills. The study was conducted on 70 volunteers divided into two groups. In the first group, 35 people actively participated in futsal. There were 100% who had good concentration, while in the group who were not active in futsal, 35 people had 71.4% or 25 people who had good concentration and 28.6% or 10 people have poor concentration skills [3]. Other benefits of futsal, in addition to improving physical performance, can also improve decision making ability, perceptually and visual processes, anticipation, emotional development [1,4–11]. As expressed by Ratey that exercise or physical activity has a significant relationship with increased attention and can reduce stress and anxiety [12].

The recommended exercise for children is aerobic exercise, not heavy and which is preferred to stimulate growth and development, improve children's cognitive function. As in a study conducted by Pereira et al. That regular aerobic exercise has advantages in the neuromuscular system (strength, power

and stretching), can improve balance, movement coordination. Exercise is carried out for 40 minutes, 4x per week for a period of 12 weeks. It was found to increase cerebral blood flow to the hippocampus as a sign of neurogenesis [13]. In other studies was conducted by Erickson et al. With an exercise program conducted 3 times a week, 40 minutes with an intensity of 60-75% HRM showed an increase in volume (2%) of BDNF plasma [14].

Exercise carried out routinely with moderate intensity is better at increasing plasma BDNF when compared to exercise with heavy intensity and the control group [15]. BDNF is a neurotropic type of protein that functions to regenerate neurons, transmission, modulation, syntax plasticity, memory capacity that can be found in the brain and peripheral blood, retina, kidneys and saliva [15,16]. Exercise can also activate molecular and cellular cascades that support cerebral vascularization and induce the expression of genes associated with plasticity, neurotransmitters such as BDNF encoding that occurs in the hippocampus [17]. In a study conducted by Jeon involving subjects of 20 junior high school students, doing aerobic exercise for 8 weeks obtained a significant increase in BDNF and IGF-1 while cortisol did not experience a significant increase [18]. IGF is a protein molecule that is influenced by continuous physical activity, so it can affect physical health and fitness, muscle and bone growth, including the production of BDNF. IGF-1 is an anabolic hormone secreted by the liver known as endocrine organs through stimulation of growth hormone [19-25]. IGF-1 can stimulate the growth and development of almost all cells in the body, namely muscle cells, cartilage, bones, liver, kidneys, nerves, skin and others. Of the 115 studies on the effect of exercise on IGF-1 it was found that 50% of the studies found no difference in IGF-1 after exercise, 37% found an increase in IGF-1 while the remaining 13% found a decrease in IGF-1. IGF-1 can help stimulate the formation of BDNF [26-27].

II. METHOD

The method of this study is an experimental study that applies futsal activities to the range of age 13-15 years as many as 36 subjects divided into 3 groups of different exercise frequencies and become 12 subjects each group, namely 1 time per week, 3 times per week and 5 times week, which can affect BDNF levels and IGF-1 levels. This experimental study has met the ethical clearances from the Ethic Commission of the Medicine Faculty, Indonesia University.

When the research was carried out several stages. The initial stage is futsal learning for one week. The experimental stage is futsal learning for 8 weeks. All research subjects must fill out informed consent and fulfill inclusion and exclusion criteria. Before the futsal exercise was carried out, all subjects took ± 10 cc of peripheral blood and put it into an EDTA tube for later separation into serum and then stored at -800C. The futsal exercise was carried out for 8 weeks and immediately took a blood sampling. For measurements of BDNF (ng/mL) and IGF-1 (ng/mL) levels performed by the ELISA (Enzyme Link Immunosorbent Assay) method with the Pre and Post data groups.

The data were analyzed using SPSS with the t-independent test and the one-way ANOVA test at p-value 0.05 then interpreted and concluded.

III. RESULTS AND DISCUSSION

Data on the results of futsal treatment from 3 different exercise frequency groups were obtained after 8 weeks. The following is table 1, data on the results of t-independent test analysis:

A. In the BDNF

Although it did not show a significant increase in the three different frequency groups, the frequency exercise group three times a week showed the highest increase of 26.52% compared to the other groups.

B. In the IGF-1

The frequency of exercise once a week showed a significant increase with a value of p-0,000** or 80.85%, then in the exercise group three times per week showed a significant increase with a value of p-0.046* or equal to 52.35%. However, in the group three times per week it did not show a significant increase in IGF-1 levels and increased only 35.79%.

TABLE I. MEAN DIFFERENCE OF PRE-POST WITH PAIRED T-TEST BDNF AT P- .05

Variable	Data Groups		n	$\bar{x} \pm sd$	Percent Increase	t	P
BDNF	F1	Pre	9	52704,63 ± 22799,52	8,76	-.469	.645
		Post	9	57318,76 ± 18739,65			
	F3	Pre	13	46504,95 ± 23093,06	26,52	-1.615	.119
		Post	13	58839,45 ± 15009,99			
	F5	Pre	12	53480,93 ± 17900,28	12,74	-.860	.399
		Post	12	51559,73 ± 29779,60			

TABLE II. MEAN DIFFERENCE OF PRE-POST WITH PAIRED T-TEST IGF-1 AT P- .05

Variable	Data Groups		n	$\bar{x} \pm sd$	Percent Increase	t	P
IGF-1	F1	Pre	9	96,61 ± 36,77	80,85	-4,354	.000**
		Post	9	174,72 ± 39,31			
	F3	Pre	13	126,32 ± 79,56	35,79	-1,451	.160
		Post	13	171,53 ± 79,34			
	F5	Pre	12	114,48 ± 77,77	52,35	-2,112	.046*
		Post	12	174,40 ± 60,09			

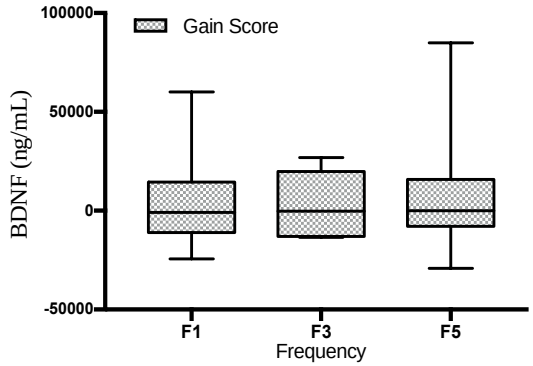

Fig. 1. Anova one way at p- .963 of BDNF. And post hoc test with Tukey LSD, F1vsF3 at p-1.000; F1vsF5 at p- .976; F3vsF5 at p- .965.

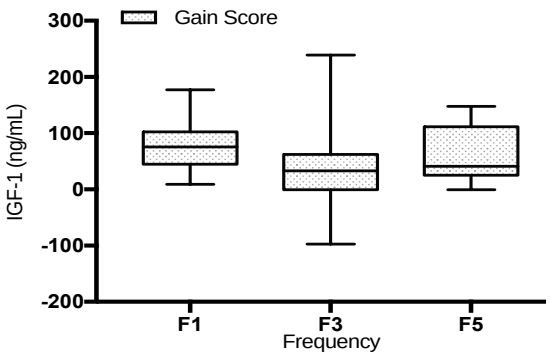

Fig. 2. Anova one-way at p- .506 of IGF-1. And post hoc test with Tukey LSD, F1vsF3 at p- .474; F1vsF5 at p- .799; F3vsF5 at p- .836.

IV. Discussion

See table 1, in the BDNF variable all exercise frequency groups did not show a significant increase, but when viewed the percentage increase in BDNF levels in the frequency group three times a week showed the highest increase among the other groups at 26.52%, this is same with research conducted by Erickson et al., with an exercise program carried out 3 times a week, for 40 minutes with an intensity of 60-75% HRM showed an increase in the volume of 2% plasma BDNF [14]. See figure 1, the results of the study show that there is no significant difference between the three groups of exercise frequency with p-0.963. When viewed from the quantity of exercise carried out in this study, the frequency of three times a week was the most optimal exercise in increasing BDNF levels, as in a study involving 20 junior high school students conducted by Jeon, there was a significant increase in BDNF levels by doing aerobic exercise with low intensity for 8 weeks [20]. Exercise carried out routinely with moderate intensity is better at increasing plasma BDNF when compared to exercise with heavy intensity and control group [15] BDNF is a neurotropic type of protein which functions to regenerate neurons, transmission, modulation, syndicate plasticity, memory capacity that can be found in the brain and peripheral blood, retina, kidneys and saliva [16-18]. Exercise can also activate molecular and cellular cascades that support cerebral vascularization and induce the expression of genes associated with plasticity, neurotransmitters such as BDNF encoding that occurs in the hippocampus [19]. Brain-derived neurotropic factor or BDNF is a protein that can be found in the brain, peripheral blood and throughout the nervous system, a type of neurotropic [28-30]. BDNF protein is a derivative of Nerve Growth Factor (NGF) that is encoded by the BDNF gene with a 1BND and 1B8M gene code [31]. BDNF functions as a neuron in CNS and PNS to help maintain and regenerate neurons and work specifically on the survival of neurons and stimulate growth and differentiation of neurons. BDNF also plays a role in maintaining the structure and endurance of neurons and is important in the process of memory consolidation [32-35]. The results of a study in Finland found that plasma BDNF in women can also be used as a biomarker for physiological responses to nervous system function, especially the ability of Long-term Memory, but in men, the results of the study showed no link between physiological responses to nerve function in the form of Long-term Memory BDNF plasma [28-30].

In contrast to the IGF-1 variable (see table 2), from the three futsal training frequency groups, the one-time weekly group was the group that experienced a significant increase, which increased by 80.85% with p- ,000**. Next in the group the frequency of exercise 5 times a week increased by 52.35% with p- .046*. There is a contradiction with the previous study, that of 115 studies on the effect of exercise on IGF-1, 50% of the studies found no difference in IGF-1 after exercise, 37% found an increase in IGF-1 while the remaining 13% found a decrease in IGF-1 [26-27]. The study involved 235 subjects, 58.2% of whom were women for 12 weeks [35]. Then in Wood et al, study explained that IGF-1 has an important role for brain development that has been shown to have IGF-1 gene mutations in microcephaly and sensor neural [35]. IGF-1 circulation occurs in the granule cells in the adult hippocampus that are treated with training, an increase in IGF-1 can interact with exercise intensity and duration of exercise [36].

V. Conclusion

The frequency of futsal exercises 3 times a week implies better and more harmless than futsal 1 times and 5 times for physical fitness, neuroplasticity, physical stress and oxidative stress in adolescents.

References

[1] Benefit of playing futsal. http://www.washingtonyouthsoccer.org

[2] Kim, G. Ha, “Higher physical activity is associated with increased attentional network connectivity in the healthy elderly,” Frontiers in Aging Neuroscience, 2016, 8(198) pp1-10.

[3] G. Y. Lestari, R. I. Widayanti, “Hubungan antara olahraga futsal dengan konsentrasi. Prosiding Pendidikan Dokter,” Repository UNISBA, 2015.

[4] N. Husseini, Bulletin: Personal health and wellbeing, Quarterly Magazine of Consolidated Contractors Company, Issue 116, 2015.

[5] K. Martin, “Brain boost: Sport and physical activity enhance children’s learning,” Government of Western Australia, Departement of Sport and Education Article, 2010.

[6] Shonkoff, “Understanding the effect of maltreatment on brain development,” Children’s Bereau: Child Welfare Information Gateway, 2015.

[7] N. Bostrom, A. Sandberg, “Cognitive enhancement: methods, ethics, regulatory challenges,” Sci Eng Ethics, 2009, 15:311-41.

[8] A. Sandberg, N. Bostrom, "Converging cognitive enhancements," NY Acad Sci, 2006, 1093:201-27.

[9] K. I. Erickson, A. G. Gildengers, M. A. Butters, "Physical activity and brain plasticity in late adulthood," Dialogues in Clinical Neuroscience, 2013, 15(1) pp99-108.

[10] A. S. Aguar, R. A. Pinho, "Effect of physical exercise over the redox brain state," Rev Bras Med Esporte, 2007, 13(5)pp322-7.

[11] Enhancing and practicing executive function skills with children from infancy to adolescence, Developing Child, Harvard University, 2014.

[12] Ratey, "Exercise seen as priming pump for students academic strides," Case grows Stronger for Physical Activity's link to Improved Brain Function, Exer_edu-research, 2008, 27(23)pp14-15.

[13] A. C. Pereira, D. E. Huddleston, A. M. Brickman, A. A. Sosunov, R. Hen, G. M. McK-hann, "An in vivo correlate of exercise-induced neurogenesis in the adult dentate gyrus," Proc Natl Acad Sci USA, 2007, 104:5638-43.

[14] K. I Erickson, M. V. Voss, R. S. Prakash, C. Basak, A. Szabo, L. Chaddock, "Exercise training increases size of hippocampus and improves memory," Proc Natl Acad Sci USA, 2011, 108:3017-22.

[15] L. Lubis, A. Purba, Setiawan, N. Sutadipur, "Respons fisiologis long-term memory terhadap perubahan molekuler bdnf di hipokampus dan plama darah pada berbagai intensitas aktivitas fisik tikus wistar," Indonesian Journal of Applied Sciences, 2014.

[16] H. Praag, "Exercise and brain: something to chew on," Rev Trends in Neurosciences, 2009, 32(5):284-90.

[17] K. Helen, "Exercise induces age-dependent neuroplastic changes in brain regions responsible for learning memory and emotional behavior," [Undergraduate Thesis], University of Colorado, Boulder, 2015.

[18] G. Kempermann, "Why and how physical acivity promotes experience-induced brain plasticity," Foc Rev Frontiers in Neuroscience, 2010, 4(189)pp1-9.

[19] C. W. Cotman, N. C. Berchtold, "Exercise: a Behavioral intervention to enhance brain health and plasticity," Trends in Neurosciences, 2002 l(25)pp8.

[20] Y. K. Jeon, C. H. Ha, "Expression of Brain-Derived Neurotrophic Factor, IGF-1 and cortisol elicited by regular aerobic exercise in adolescents," J. Phys, Ther. Sci, 2015, 27 pp737-41.

[21] L. R. Brilla, V. Conte, "Effect of a novel zinc-magnesium formulation on hormones an strength," Journal of Exercise Physiology, 2000, 3(4) pp26-36.

[22] M. Maggio, "IGF-1, The cross road of the nutritional, inflammatory and hormonal pathways to frailty," Nutrients Journal, 2013, 5:4184-205.

[23] W. J. Kraemer, "Growth homrmone, exercise, and athletic performance: a continued evolution of complexity," Nutrition and Ergogenic Aids Journal, Vol 9(4):241-52.

[24] R. M. Brummen, B. A. Bengtsson, "The effect of growth hormone on body composition," Asia Pasific Journal Clinical Nutrition, 1995, 4 pp151-5.

[25] C. D. Schneider, R. Oliveira, "Oxygen free radicals and exercise: mechanisms of synthesis and adaptation to the physical training," Review Article: Brasileira Medicina Esporte, 2004, 10(4)pp314-18.

[26] Brain derived neurotropic factor, insulin-like growth factor and growth hormone, http://wikipedia.com

[27] M. R. Orenstein, C. M. Friedenreich, "Review of physical activity and the IGF family," Journal of Physical Activity and Health, 2004, 1;291-320.

[28] P. Komulainen P, "BDNF is a novel marker of cognitive functionin ageing women: The DR's EXTRA Study," Neurobilogy of Learning and Memory, 2008, 90(4)pp596-603.

[29] M. E. Greenberg, B. Xu, B. Lu, B. L. Hempstead, "New insights in the biology of bdnf synthesis and release: implications in cns function," The Journal of Neuroscience, 2009, 29(41):12764–67.

[30] Quantikine, "Human BDNF Immunoassay. For the quantitative determination of human brain-derived neurotrophic factor (BDNF) concentrations in cell culture supernates, serum, and plasma," R&D Systems Inc, 2009.

[31] D. K. Binder, H. E. Scharfman, "Brain-derived neurotrophic factor," Growth Factors, 2004, 22(3)pp123–31.

[32] P. Bekinschtein, M. Cammarota, C. Katche, L. Slipczuk, J. Rossato, A. Goldin, "BDNF is essential to promote persistence of long-term memory storage," PNAS, 2008, 105(7):2711–16.

[33] S. Vaynman, Z. Ying, F. Gomez-Pinilla, "Hippocampal BDNF mediates the efficacy of exercise on synaptic plasticity and cognition," European Journal of Neuroscience, 2004, 20:2580–90.

[34] Amarson, "Insulin-like growth factor-1 and resistance exercise in community dwelling old adult," J Nutr Health Aging, 2015, 19(8):856-60.

[35] K. Woods, C. Camacho-Hübner, M. Savage, A. Clark, "Intrauterine growth retardation and postnatal growth failure associated with deletion of the insulin-like growth factor i gene," N Engl J Med, 1996, 335(18):1363-7.

[36] J. Svensson , B. SöDerpalm, K. SjöGren, J. Engel, C. Ohlsson, "liver-derived igf-i regulates exploratory activity in old mice," Am J Physiol Endocrinol Metab, 2005, 289(3):E466-E73.