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2 The Impact of Physical Exercise on Brain-Derived Neurotrophic Factor (BDNF) Level in Elderly Population

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Abstract

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BACKGROUND: Memory function disorder is a major health problem in geriatric patients. Physical exercise has the potency to decrease the incidence of many degenerative and chronic health problem, related to cognitive deterioration (dementia).

AIM: This research aimed to observe the effect of physical exercise in various doses and duration on memory function by analysing the role of Brain-Derived Neurotrophic Factor (BDNF) as a regulatory protein affected by exercise.

METHODS: This was an analytical observational study with a cohort design. Thirty participants were included in each group, classified as exercise and non-exercise group. The exercise was in the form of jogging for at least fifteen minutes every day. The observation was done for sixty days. Cognitive function assessment was done by using the Mini-Mental State Examination (MMSE) questionnaire. Meanwhile, the BDNF level was assessed by ELISA. Statistical analysis was done using Independent T-test.

RESULTS: Exercise group showed better MMSE score (28.56 ± 1.76), and a higher concentration of BDNF (235.34 ± 12.56 pg/mL), both were statistically significant.

CONCLUSION: Physical exercise was able to maintain geriatric cognitive function performance by BDNF protein regulation.

Introduction

Increase in life expectancy is related to higher geriatrics population in Indonesia. In Indonesia, life expectancy is 70.8 years by 2015 and is predicted to reach 72.2 years by 2030. In 2013, Indonesian geriatric's population was about 8.9% of all population in Indonesia; this proportion will increase to 21.4% by 2050 and becoming 41% by 2100 [1]. This phenomenon is good progress, which reflects the more conducive level of public health. However, this advance could lead to a fatal event and has the potency to develop a new problem if inadequately managed against increasing geriatric's population. Increase in geriatric's population can worsen health

burden due to population susceptibility against many disorder, such as infection, degenerative disease and memory-related disorder [2].

Memory function disorder is a major health problem in geriatric patients. This serious problem could lead to decreased geriatric function in remembering elementary subjects, like their name, family or even their place of living [3]. The decrease in cognitive function is related to geriatric personal care disturbance, especially for activity daily living such as bathing or eating. It is a very serious problem that will reduce the geriatric quality of life, even for the family and society. In concordance to that, an approach to search the modality in increasing quality of life is needed by preventing memory function deterioration.

Physical exercise is the right answer in increasing geriatric quality of life. ⁶physical exercise has the potency to decrease the incidence of many degenerative and chronic health problem, such as cancer, diabetes and ⁶coronary heart disease. Recent studies showed that physical activity is responsible for lowering dementia incidence in geriatric population [4], [5], [6], [7], [8]. On the other side, many animal trials showed the potency of physical exercise in preventing memory loss. However, the cellular and molecular mechanism of physical exercise in hindering memory loss is still being studied, particularly about the doses and duration of physical exercise.

Therefore, this study aimed to observe the effect of physical exercise in various doses and duration on memory function by analysing the role of Brain-Derived Neurotrophic Factor (BDNF) as a regulatory protein affected by exercise.

Methods

Study design and objects

This study was an analytical observational study with cohort design in the geriatric population at Kambang Iwak Palembang elderly community. Thirty participants were included in each group, classified as exercise and non-exercise group. The exercise group was the study subjects which fulfilled criteria: age more than or equal to sixty years, no history of cardiovascular disease, metabolic syndrome or neurological disorder, enduring physical exercise in the form of jogging for at least fifteen minutes a day. On the other hand, the non-exercise group had the same criteria as an exercise group with no physical exercise ¹⁷. The observation was done for sixty days. The study was approved by the Research Ethics Committee of Faculty of Medicine Universitas Sriwijaya (No.193/kptfkunsri-rsmh/2018).

Cognitive function assessment

⁹Cognitive function assessment was done by using the Mini-Mental State Examination (MMSE) questionnaire. MMSE questionnaire consisted of 11 items from five domains: 10 points related to time and place orientation, 6 points related to memory, 5 points related to numerical calculation, 7 points related to language and two points related to comprehensive/judgement ability. True answer got one point, and the wrong answer got zero points. The assessment was done by interviews to study subjects.

BDNF level assessment

Three mL of blood from each study subjects were taken from the brachial vein and inserted into

EDTA tube and centrifuged at 3000 rpm for ten minutes. Before the blood was taken, study subjects must undergo starvation phase for ten hours. Afterwards, supernatant from the serum was inserted into the tube and stored at -80°C temperature. BDNF serum measurement was done by following the manual procedure of Human Enzyme-Linked Immunosorbent Assay (ELISA) kit BDNF (Elabscience®).

Statistical analysis

Descriptive analysis (mean±SD) was done by SPSS 24.0 program ¹⁸ variates analysis to MMSE and BDNF was done by using Independent T-test. Level of significance was set at p = 0,05.

Results

Baseline characteristics

Table 1 showed no significant differences between exercise and non-exercise group. Study subjects had no statistically different age and BMI, which showed that age and BMI in both groups were identical. Blood glucose and cholesterol level data showed that both groups had no history of diabetes mellitus or hypercholesterolemia. Systolic and diastolic blood pressure on both groups reflected that participants did not have hypertension.

Table 1: Baseline Characteristics

Variable	Exercise-Group	Non-Exercise-Group	p-Value
Age (yrs)	65.13 ± 7.32	65.25 ± 8.31	0.21*
Height (m)	1.59 ± 0.03	1.59 ± 0.21	0.15*
Weight (kg)	69.97 ± 8.54	69.17 ± 7.97	0.34*
BMI (kg/m ²)	27.67 ± 3.12	27.42 ± 4.32	0.54*
Blood Glucose (mg/dL)	105.23 ± 7.67	106.83 ± 10.67	0.11*
Cholesterol (mg/dL)	176.13 ± 8.97	177.03 ± 11.12	0.09*
Systolic Blood Pressure (mmHg)	135.34 ± 6.23	136.01 ± 8.52	0.23*
Diastolic Blood Pressure (mmHg)	78.98 ± 7.31	78.01 ± 8.11	0.35*

*Independent T Test, p > 0.05.

Cognitive function

There were significant differences between exercise and non-exercise group related to MMSE scoring. MMSE is an application to assess cognitive function. Higher MMSE score shows better cognitive function. The exercise group had higher MMSE score compared to the non-exercise group and was statistically significant (Table 2).

Table 2: MMSE Scoring

Variable	Exercise-Group	Non-Exercise-Group	p-Value
MMSE (Mean ± SD)	28.56 ± 1.76	25.06 ± 1.32	0.02*

*Independent T test, p < 0.05.

BDNF concentration

BDNF concentration in the exercise group was higher than the non-exercise group and was

statistically significant (Tabel 3). Higher BDNF level reflects better maintenance of individual cognitive function.

Table 3: BDNF Concentration

Variable	Exercise-Group	Non-Exercise-Group	p-Value
BDNF (Mean (pg/mL) \pm SD)	235.34 \pm 12.56	112.01 \pm 10.12	0.01*

*Independent T-test, p<0.05.

Discussions

This study showed relevant result between cognitive function, which was assessed by MMSE and BDNF level. MMSE score in the exercise group was higher than the non-exercise group. This result showed that the exercise group was able to maintain cognitive function. This study revealed that BDNF level was higher in the exercise group compared with the non-exercise group. Molecular exploration demonstrated that BDNF possesses a role as a regulatory protein in preserving cognitive function. Elevation of BDNF level was thought to maintain cognitive function in a good state. Physical exercise, jogging for 15 minutes a day, was able to conserve cognitive function in the geriatric population by BDNF regulation. Our study strengthens physical exercise role, in the form of jogging in retaining cognitive function by BDNF regulation. This study revealed an answer about the role of physical exercise to individual memory quality, especially in the geriatric population. Brain-Derived Neurotrophic Factor (BDNF) is a neurophil family protein member that is responsible for neuronal growth, differentiation and survivability. An elevated level of BDNF that caused by physical activity is thought to increase neurogenesis dan synaptogenesis and preventing the neuronal loss, which is contributing to cognitive function and decreasing psychiatric disorder. The study showed that peripheral BDNF concentration can reflect central nervous system health, with lower BDNF concentration in patients with psychiatric dan metabolic disorder [9], [10], [11], [12]. There are possibilities that many different aspects play the role of physical exercise effect and central nervous system health. Suggested mechanism is an increase in cerebral blood flow, changes in neuroendocrine response, changes in endocannabinoid and neurotransmitter release, which lead into BDNF release and initiate structural changes in central nervous system, in order to preserve synaptogenesis, neurogenesis and maintaining cognitive function [13], [14], [15].

In conclusion, physical exercise in the form of jogging for at least fifteen minutes every day was able to maintain geriatric cognitive function performance by BDNF protein regulation.

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