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Long term habitual exercise is associated with lower resting level of serum BDNF☆

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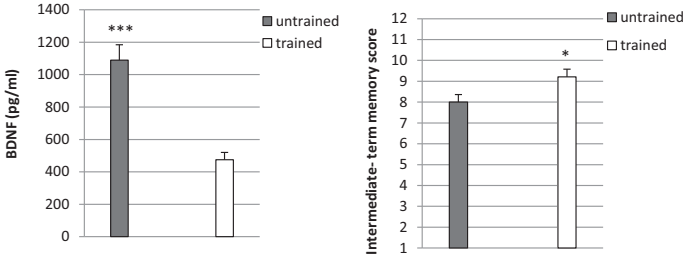
HIGHLIGHTS

- Association of basal level of BDNF with long lasting habitual exercise was studied.
- Serum BDNF level was lower in trained subjects than sedentary men.
- Aerobic and anaerobic exercise increased serum BDNF level.
- Memory performance was better in trained than sedentary.
- BDNF inversely correlated with Vo_2max.

GRAPHICAL ABSTRACT

Baseline BDNF in trained professional athletes was significantly lower than untrained subjects. However intermediate-term memory score was better.



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ABSTRACT

This experiment has been designed to evaluate the basal serum BDNF level and memory performance, and also the change in BDNF in response to acute aerobic and anaerobic training in athletes and sedentary groups. Nineteen middle aged elite athletes (45–65 years) who used to be competing at domestic championship for more than 10 years and 20 sedentary subjects participated in this study. Blood samples and cognitive function were assessed at rest and also after performing a single bout of acute aerobic and anaerobic exercise. Basal serum BDNF significantly was lower in the athletes group compared to the control one (475.18 ± 45.32, 1089.30 ± 94.92, $P = 0.001$). Serum BDNF was inversely correlated with Vo2 max ($r = -0.5$, $P = 0.013$), but positively with BMI ($r = 0.2$, $p = 0.4$). Pictures recall memory was better in the athlete group (9.25 ± 1.61) compared with the control ones (8 ± 1.15, $p = 0.04$). Basal platelets did not show any significant differences between athletes and controls ($p > 0.05$). Both acute aerobic and anaerobic activity elevated serum BDNF and platelets in athletes and sedentary groups compared with rest ($P < 0.001$). This study suggests that long-term habitual exercise is associated with lower peripheral BDNF and better intermediate memory. However acute form of intensive activity either aerobic or anaerobic are capable to elevate serum BDNF level in both sedentary and athletes.

1. Introduction

Increasing longevity multiplies the number of individuals with cognitive impairment. Considering the devastating effects of cognition deficit on the quality of life, maintaining brain health is an important public health goal. Exercise intervention could be one of the best non pharmacologic preventive tools from cognitive deficit.

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Previous studies suggest that physical activity improve memory and attention [6,7,29], delays the decline in cognitive functions [15,17] and diminishes the risk of dementia [17]. Physical exercise has also been shown to increase neurotrophins secretion [21], and more notably, brain derived neurotrophic factor (BDNF) [1,12,20].

Brain derived neurotrophic factor, is a member of the neurothrophins family which promote neuronal survival and synaptic plasticity [1]. It has been known that BDNF is mostly produced by the central nervous system (CNS) and also a range of peripheral tissues [9]. Since BDNF crosses the blood brain barrier [23], the peripheral levels of BDNF may represent a biomarker of mental health. For example its expression is reduced in several neurodegenerative diseases and depression [16]. On the other hand, it has been assumed that the beneficial effects of physical activity on brain function could be mediated by BDNF, however the existing literatures reflect wide controversies. For example, increase in BDNF level and memory performance after physical activity have been reported in some studies [4,10,27]. However an inverse relationship between physical activity and serum BDNF level has been reported too [8,14]. In addition to the inconsistency in the existing literatures, almost no study to our knowledge has specifically focused on the impact of long term training on cognitive health, and serum BDNF level in well-trained athletes. This experiment has been designed to evaluate the basal BDNF level and memory performance, also responsiveness of BDNF regulation system to acute aerobic and anaerobic training in athletes and sedentary groups.

2. Materials and methods

This study was designed in two parts: In Experiment 1 the basal serum BDNF level, platelates and memory performance were evaluated. Experiment 2 compared the changes in these parameters to a single bout of aerobic and anaerobic exercise.

2.1. Experiment 1

Twenty five elite athletes (age 45–65 years) who used to be compete at domestic soccer championship for more than 10 years and continued their regular training (3 times/week), after retirement, and 22 sedentary subjects without any regular physical activities were informed about the study. Then they were controlled for age and educations level, and those who signed the consent document participated in the study. Exclusion criteria based on the clinical and physical examinations were cardiovascular, neurological, musculoskeletal disturbances, smoking, and alcohol drinking. The study was approved by the local ethics committee of Guilan University of Medical Sciences and performed according to the principles of the Declaration of Helsinki. Six athletes and two sedentary subjects left the study because of dyslipidemia, hypertension and mistake in performing the Rast test.

Cognitive function: Since working memory and attention are more affected than others with aging [24], we used picture recall memory tests for assessing the intermediate term memory. Subjects were shown 12 emotionally neutral pictures, and then 30 min after the last picture, they asked to recall the pictures. Score was the total number of remembered pictures. Subject was defined to have impaired intermediate memory if he was in the lowest quartile of the corresponding cognitive domain.

Blood sampling: Fasting blood samples were divided into two distinct falcon tubes: one pre-cooled tube for BDNF analysis (BD Vacutainer® SST II Advance), and the other for CBC. Blood was left to clot at room temperature and was centrifuged (12 min, 3000 rpm), and the resulting serum was decanted and stored at −80 °C until analysis. Serum BDNF was assayed in duplicate according to the manufacturer's instructions (R&D BDNF ELISA kit, USA). The BDNF ELISA kit has a detection range from 7.8 to 500 pg/ml. The intra-assay and inter-assay variations were ±4.66% and ±9%, respectively.

Cardiorespiratory fitness was assessed as Vo2 max by a respiratory gas analysis in symptom-limited maximal exercise stress test on the Astrand-rhyning treadmill ergometry.

2.2. Experiment 2

Nineteen athletes and 20 controls were randomly divided into two groups: aerobic exercise (Shuttle Run test, $n = 10$ athletes, $n = 10$ control) and anaerobic exercise (Rast test, $n = 9$ athletes, $n = 10$ control).

Shuttle Run involved continuous running between two lines 20 m apart in time to recorded beeps. For this reason subjects stand behind one of the lines and begin running with slow speed (8.5 km/h), but was increased by 0.5 km/h each minute. The subject continued running between the two lines, turning when signaled by the recorded beeps. After one minute, a sound indicated an increase in speed, and the beeps became closer together. This continued each minute. If the line was not reached in time for each beep, the subject must run to the line turn and try to catch up with the pace within two more beeps. The test was stopped if the subject failed to reach the line for two consecutive ends.

For Rast test, the subjects undertook six 35 m sprints after 10 min warm up with 10 s recovery between each sprint with maximum speed and power till exhaustion.

Blood sampling was done before and after exercise. Also intermediate-term memory function was evaluated according to the experiment 1.

Statistical analysis: Normality of data was checked using Kolmogorov–Smirnov Goodness of Fit test. The data were analyzed by correlated T-test and independent T-test and $P < 0.05$ was considered statistically significant. Pearson correlation was used to assess correlations between parameters.

Table 1
Subjects characteristics and description of variables at baseline. Values are presented as mean ± SD.

Variable	GROUP					
	Athletes		Control		Sig level	
	Aerobic	Anaerobic	Aerobic	Anaerobic	Aerobic	Anaerobic
Age (years)	51.40 ± 3.40	51.33 ± 4.18	53.70 ± 6.11	52.60 ± 5.14	$P = 0.34$	$P = 0.61$
Weight (kg)	80 ± 7.8	73.83 ± 8.58	81.41 ± 10.13	77.21 ± 7.17	$P = 0.7$	$P = 0.35$
Height (cm)	177.60 ± 8.26	171.22 ± 6.07	173.47 ± 5.31	175.47 ± 4.15	$P = 0.2$	$P = 0.15$
BMI (kg/m^2)	24.65 ± 1.15	24/60 ± 1.50	27.04 ± 2.88	27.55 ± 3.05	$P = 0.03^*$	$P = 0.02^*$
Education level (years)	12.80 ± 1.3	12.88 ± 2.02	12.60 ± 1.64	12.02 ± 1.17	$P = 0.73$	$P = 0.31$
Vo2 max	45 ± 5.8	43 ± 4.4	32 ± 4.5	33 ± 4.8	$P = 0.01^*$	$P = 0.02^*$

* Significant difference between athletes and control groups.