

AEROBIC TRAINING AND THE CHANGES ON THE SERUM LEVELS OF SEROTONIN AND IN THE SYMPTOMS OF DEPRESSION IN ELDERLY WOMEN

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Abstract. This study investigated the effects of an 8-wk aerobic training program on the serum levels of serotonin and in the changes in the symptoms of depression in elderly women. The sample of this study was divided in two groups: experimental (n=28) and control (n=20), with 58.6±6.4 and 56.8±5.1 years old respectively. The serum levels of serotonin were significantly reduced ($p<0.05$) in the experimental group when compared to the control group. A significant improve ($p<0.05$) in the symptoms of depression was also observed. This study demonstrated that 8-wk with 5 d.wk⁻¹ of moderate and progressive aerobic training emphasizing walking can safely cause significant reduction in the serum levels of serotonin and improve the symptoms of depression in elderly women.

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Key words: Aerobic exercise - Serotonin - Depression - Aging

Introduction

A recent systematic review of 34 community based studies found an average prevalence for depressive syndromes of 13.5% in adults aged 55 years and over, although the reported prevalence rate as found to vary enormously between 0.4% and 35% [5]. Multiple studies of depressive symptoms using primarily the Center for Epidemiologic Studies Depression scale (CES-D) [29] have revealed higher symptom rates in older adults than those younger adults [19,23,27].

In the last decades, studies have reported an intimate relation of the serotonin (5-HT) neurotransmitter with mental health. Serotonergic deficiencies are presumably responsible for the etiology of some emotional disorders, or considered as important cofactors of the physiopathology of depression [30]. The synthesis of

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serotonin decreases with age. This decrease is related to the drop of the enzyme tryptophan hydroxylase activity in the raphe nuclei resulting in alterations of this neurotransmitter concentration [35]. In contrast, Chaouloff [8] reported that the exercise has an important factor for the synthesis and metabolism of the serotonin and could play an important role as a possible anti-depressive agent. Therefore, the aim of this study was investigate the effects of an 8-wk aerobic training program on the serum levels of serotonin and in the changes in the symptoms of depression and was examined the relative importance of Relative Body Fat (%BF), Body mass, $VO_2\text{max}$ and Symptoms of depression as determinants of Serum levels of serotonin in older Brazilian women.

Materials and Methods

Forty-eight women from the Brasilia area in Brazil, with a mean age of 57.7 years volunteered to participate in this study and provided informed consent in accordance with institutional guidelines. Subjects were randomized into experimental group (EG) or a non exercise control group (CG). Subjects in the EG conducted a 8-week aerobic (walking) training program (ATP) consisting of a one hour session, five times a week. At the beginning, each session lasted 20 to 40 minutes with an intensity of 40% to 60% of the maximum heart rate reserve (MHRR). During the ATP, walking duration and intensity were being gradually incremented, up the maximum of 60 min, keeping the training zone between 60% and 75% of the MHRR (ACSM, 2000).

Body composition: The relative body fat were determined using the Lange® skinfold calliper with a scale up to 60 mm, 10 g/mm² pressure, and 1 mm accuracy [21].

Serum serotonin: To assess the serum levels of serotonin (5-HT) in both groups, blood was collected twice: 1) before the start of the oriented physical exercise program, and 2) at the end of this period. For the blood sampling, participants were asked not to eat in the previous 12 hours and were submitted to a standard diet 24 hours within the test. They were also asked not to use any type of medication in a 24-hour-period. When arriving at the laboratory, they were requested to remain still for 30 min (seated). The blood samples were collected in the morning from 7 to 9 a.m. Each sample contained 10 ml of total blood taken in a plastic syringe containing EDTA. Then, 5 ml of the blood were put in each plastic tube containing 10 mg of EDTA and 75 mg of ascorbic acid. Immediately after the sampling, the blood was homogenized and centrifuged at 1200 rpm for 20 min. The 5-HT assays were done in no more than one week using a High-performance liquid



Chromatographic with a Fluorometric Detection (HPLC-FD). This system consists of a pump (Waters-model 515) with fluorometric detection (Waters-model 474) with an excitation wave length of 285 nm and emission wave length of 345 nm. The Column Nova-Pak C 18 (3.9 x 150 nm) was used and the mobile phase consists of a buffering solution containing 50.7 ml of ammonia hydroxide, 64.7 ml of glacial acetic acid and 0.2 g of EDTA and 1,760 ml of distilled water. The pH was adjusted to 5.1 with 6M of ammonia hydroxide and 325 ml of methanol. This technique can be found in Pesce and Kaplan [28].

Symptoms of depression: The Portuguese version of Beck Depression Inventory (BDI) was used to assess the symptoms of depression. BDI is a 21-item self-report questionnaire of depressive symptoms in a 4-point Likert format (0–3 scale) [4,20] BDI scores range from 0 to 63 (<10, no depression; 11-18, mild to moderate; 19-29, moderate to severe; and >30, severe).

Statistical analysis: All values are presented as the mean \pm SD and parametric procedures were employed for statistical analysis, including inferential statistics and using the Split-Plot (SPANOVA) analysis of variance. Levene's test was used for analysis of homogeneity, and the Post hoc Scheffe test for comparison of group results. A significance level of $p \leq 0.05$ was utilized for all groups. Standard multiple linear regression analyses were used to determine the relative contributions of Relative Body Fat (%BF), Body mass, VO_2 max, Symptoms of depression (Beck Symptoms) and age in changes of 5-HT levels.

Results

Relative Body Fat (%BF): When the SPANOVA was applied to relative body fat, no significant differences was observed between the EG and CG at pre-test ($p > 0.05$). Similarly, after the application of the experimental factor, results indicated that no significant improvement on Relative body fat in both groups.

Cardiorespiratory Fitness (VO_2 max): Table 1 shows cardiorespiratory fitness (VO_2 max). When the SPANOVA was applied to cardiorespiratory fitness, no significant differences was observed between the EG and CG at pre-test were observed ($p > 0.05$). However, after the application of the experimental factor, results indicated that only the EG had a significant improvement on VO_2 max levels.

Serum levels of serotonin (5-HT): When the SPANOVA was applied to 5-HT levels, no significant differences was observed between the EG and CG at pre-test ($p > 0.05$). However, after the training period, results indicated that only the EG had a significant decrease ($p < 0.05$) on the 5-HT levels (Table 1).



Table 1

Mean body mass, body fat percentage (% fat), cardiorespiratory fitness (VO₂max) and 5-HT levels, of control and experimental groups at pre and post-test

Variable	Control		Experimental	
	Pre	Post	Pre	Post
Body mass (kg)	62.0±9.3	62.2±9.4	63.5±9.62	64.1±11.6*
Fat mass (%)	31.8±5.5	32.6±5.4	33.1±7.6	31.8±6.9**
VO ₂ max (ml·kg ⁻¹ ·min ⁻¹)	25.8±5.8	23.8±9.0	21.8±6.5	27.6±6.7***
5-HT (ng·ml ⁻¹)	129.7±57.9	109.2±38.1	140.4±53.1	96.4±28.1***

*p<0.05; **p<0.01; ***p<0.001

Symptoms of depression: When the SPANOVA was applied to Symptoms of depression at the period that preceded the aerobic training, no significant differences in the symptoms of depression were observed between the control and the experimental group. But, after the training, only the EG presented a significant change of the depression levels (p<0.05) when compared to pre-test (Fig. 2).

Table 2 shows no significant correlations among changes of 5-HT levels and Relative Body Fat (%BF), Body mass, VO₂max, Symptoms of depression (Beck Symptoms) and age variables.

Table 2

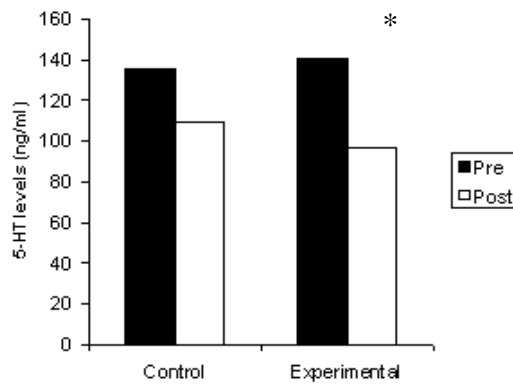
Correlations among IVS and DV for sample data

Variable	Age	Body Mass	Fat Mass	VO ₂ max	Beck symptoms	5-HT
Age	-	0.000620	0.00147	0.332*	0.0138	0.0302
Body Mass	0.000620	-		0.275*	0.0334	0.00475
Fat Mass	0.00147	0.0204	-	0.146*	0.0404	0.0204
VO ₂ max	0.332*	0.275*	0.146*	-	0.0382	0.00778
Beck	0.0138	0.00665	0.0404	0.0382	-	0.00665
5-HT	0.0302	0.00475	0.0204	0.00778	0.00665	-

IVS – Independents variables; DV - Dependent variable (5 – HT)

*p<0.001





* $p < 0.001$

Fig. 1

Mean 5-HT levels (ng/ml) in older women before and after aerobic training

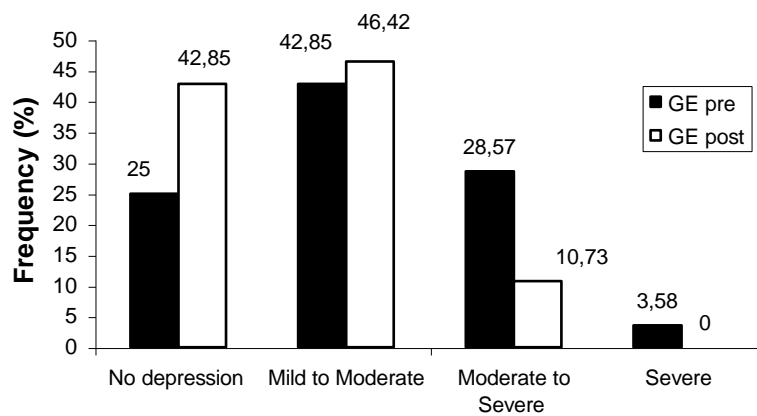


Fig. 2

Frequency of symptoms of depression in the experimental group before and after 8 weeks of aerobic training



Discussion

It is known that when people are aging humor disorders increase and women are more susceptible and fragile than men to this fact. These behavior problems might be associated with both high or low levels of 5-HT [24].

The improvement on the state of humor in this study by means of the Beck Depression Inventory (BDI) application, retakes the hypothesis previously raised by other authors that physical exercise may act as an anti-depressive agent [1,14,15,17]. The idea is that physical exercise may be recognized and used as an alternative treatment in fighting depression.

Chaouloff [6] states that acute and chronic exercises may affect the monoaminergic system. Studies are reinforcing the possibility that physical exercise alter both peripheral and central serotonergic levels. Morgan [26], after observing the benefits and consequence of these alterations after exercise, stated that the acute effects of physical exercise could be related to an anxiety reduction and the chronic effects related to a decrease of both anxiety and depression levels.

The serotonergic system do not respond uniform and linearly to protocols which use physical exercise as a stress model. Different intensities and duration, while in a physical exercise session, may or may not significantly alter the responses of these systems. Studies which used low duration and low intensity protocols did not show any significant alterations in the 5-HT peripheral concentration levels [22,33], contrasting therefore, with results observed at central levels by Kurosawa *et al.* [25]. These researchers observed that 5-HT release in the cerebral cortex raised after a 5 minutes walk (2.3 m/min). On the other hand, long term moderate exercises may increase tryptophan and 5-hydroxyindolacetic-acid in the liquor cerebrospinalis [11] and increase 5-HT synthesis and turnover, possibly by the raise of free plasma tryptophan [13]. However, the serotonergic system seems to show different responses to chronic effects of physical exercise.

Strüder *et al.* [34] when comparing the acute and chronic effects of exercise over the serotonergic system, observed by the peripheral analyses, an increase in the plasmatic 5-HT concentrations after an acute resistance test; however, after training period, it's observed a decline in the plasmatic levels of this neurotransmitter. In a study performed by Arida *et al.* [3], when the subjects were submitted to an aerobic, moderate intensity, three months training, three-times-a-week sessions, they reported that plasmatic 5-HT concentration was lower when compared to levels obtained before training, which were similar results to the present study. Otherwise, Soares [31] and Steinberg *et al.* [32] compared serotonergic alterations between sedentary and trained people and reported no



significant differences in the 5-HT concentrations basal levels. Nevertheless, after an acute physical exercise test, they realized that trained subjects presented greater 5-HT concentration values than the non trained ones.

The reduction of plasmatic 5-HT concentrations verified in this study may be due to a possible relation between body mass and body fat reduction. These changes may be related to biochemical alterations reported by Costill [12], in which an increase in plasmatic concentrations of free fatty acids is observed after long-term exercises, due to lypolysis. The FFA dislocates the Tryptophan albumin, increasing the Tryptophan-1 (Trp-1) concentrations, responsible for the 5-HT synthesis. Besides, the main competitors of the Trp-1 go beyond the hemato-encephalic barrier, the branched chained amino-acids (BCAA) undergo a reduction in their plasmatic concentrations, in consequence of the gain in its caption and oxidation by the exercised muscles. This BCAA plasmatic decrease induces a Trp-1/BCAA ratio increase. Therefore, the probability of having Trp-1 in central levels becomes higher, which consequently raises the 5-HT concentrations.

According to Chaouloff *et al.* [10] and Chaouloff [9], only the Trp-1 levels are elevated, not altering therefore, the total Tryptophan concentrations. This statement makes us believe that when reducing the Trp-1 levels, to peripheral levels, the 5-HT peripheral concentrations will be reduced. Possible adaptation mechanisms are chained to chronic effects of physical exercise arising from the training period.

Chaouloff [7] states that the neural-endocrine and neural-modulators influence the individual ability to exercise by means of efforts from the central nervous system as well as the peripheral nervous system. It is believed that during a training period, our organism has the capacity to adapt or minimize the homeostatic unbalance produced by an acute physical exercise session. According to Emerson *et al.* [16], chronic stress has been presented for turning the serotonergic and noradrenergic more sensible to acute stress. Ferreira *et al.* [18], based on other studies, affirm that the increase of the metabolic demand required for physical exercises may result in the adaptation of many nervous routes, including the serotonergic routes, observing a reduction of these neurotransmitter levels in the motor control areas and an increase in humor areas.

Conclusion

The results showed in this study indicate peripheral metabolic alterations and possibly central nervous system alterations in women from 50 and 72 years old, after being submitted to an oriented physical exercise program. Finally, it is concluded that moderate 8 weeks aerobic physical exercise were effective in



rendering an improvement in the state of humor observed by the Beck Depression Inventory (BDI); the decrease of relative body fat; and the reduction of 5-HT plasmatic levels, of older women from 50 to 72 years.

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