



## **Investigating the effect of chronic stress on motor function and the role of non-pharmaceutical interventions of aerobic exercise and rhythmic-melodic stimuli**

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### **ABSTRACT**

The increase of motor function is one of the main goals of cognitive and motor sciences. The aim of this research is to investigate the impact of chronic stress on motor function and the role of non-pharmaceutical interventions of aerobic exercise and rhythmic-melodic (music) stimuli on male rats. To achieve this, 80 Albino Vistar rats were randomly put into 8 main and interactive groups. The rats of aerobic exercise group (21 days, 30 minutes a day), stress group (21 days, 2 hours a day), music (21 days, 2 hours a day), they were all put under intervention. After finishing intervention, open field test was applied in order to evaluate their motor function. In order to describe statistical variables of the research, Mean and Standard Error of the Mean (SEM<sub>+M</sub>) were applied as well as TUKEY and ANOVA for deductive analysis of data. Results showed that stress causes decrease in motor function ( $P=0.026$ ) whereas aerobic exercise ( $p=0.008$ ) and music ( $p=0.023$ ) cause increase in motor function. Besides, in groups of under stress, aerobic exercise intervention could prevent the decrease in motor function ( $p=0.016$ ) whereas music didn't have such an impact. With the help of aerobic exercise interventions and music it is possible to improve motor function and also neutralize destructive effects of stress.

**Key words:** motor function, rat, music, aerobic exercise, stress

### **INTRODUCTION**

Motion and motor behavior is one of the most sophisticated physiological phenomena which plays important role in the life and survival of the creature. motor function is of high significance in some fields such as environmental competitions, flexibility in responding to social changes and non-social situations, aggressive behaviors, fight, escape, and specially reproduction(1). Various biological parameters like nutrition, kind of diet, age, genetic and racial factors, and sexual differences also add up to the sophistication of the subject. (2) Besides motor activities, stress as a behavior has been considered an important field in psychopharmacological researches over the past decade. motor activity and stress are organized in various nervous systems such as: Basal ganglia (3), Tegmental(4), Ventral Tegmental area(5), Hypothyroidism(6), hypothalamus, amygdala(7), striatum(8). Stress is a reaction to percept stimuli that are accounted as threat for Homeostasis state of an organism (9). Stressors are physical or psychological stimuli that affect homeostasis. In different researches, pharmaceutical and non-pharmaceutical methods have been investigated for managing stress. Recently, music has been considered as one of the countering methods in order to deal with destructive effects of stress. Using music is also one way of stress and anxiety relief. Music can decrease subsequent responses of stress, as well as cause relaxation in time of stress (10). Physiological impacts of music have been also explained which includes: decrease in blood pressure (11), increase of endurance in physical activities (12), fortifying positive resistance impact on body immune system (13, 14). Positive effects and music applications in pedagogical fields have been of high significance. These effects have also been observed during mice infancy, so that under music effect, there are documents related to improvement in acquisition and motor behaviors in advance (15). On the other hand, sport has been proved to be effective as a consistent non-pharmaceutical method like psychotherapy, and even been considered more than behavioristic interventions (16). Studies have shown that physical activity may effectively decrease stress disruptions and improve attitude and self-cognition (17). Besides, reports confirm that physical exercise can prevent chemical nervous and behavioristic changes in rodents (18). Other researches show that sport, through producing protective components of nerve, increasing blood circulation to brain, improving growth and survival of neurons, and decreasing

risk of cardiovascular diseases (19). Gatin(1973) states that impact of physical exercise is modified sophistication of cognitive task and duration of the activity (18). In the field of physical activity, one of the features that has been dealt with during the research is the acuteness and time of the exercise as well as its being optional (20, 21, 22) that the results various researches in this field are sometimes controversial and in complete. In most of researches, the effect of sport has been reported optional (23, 24, 25); However, it should be taken into account that obligatory and optional exercise has different effects (26). For instance, the exposure of rat in a rich environment (form aspect of activity) and allowing them for optional activity cause increase in the rate of neurotic cells production, as well as increase of acquisition task operation related to hypothyroidism (23). Moreover, in both human and rat, there have been observed controversial effects which are due to the applied protocol, acuteness, and duration of sport (27). On the other hand, it seems that there is a relationship between cognitive operation and motor function, so that any disruption in cognitive factors affects motive operations and lead to disruption in motive operation whereas, vice versa, it is possible that increase of physical potentials affect cognitive function (28).

## METHODOLOGY

### Type of research

This research is interventional and has been conducted applying experimental method. The rats have been replaced randomly in 8 groups. Sometimes the size of the sample in behavioristic studies is considered 6 to 10. In this research, the size of the sample has been chosen 8 in each group. This behavioristic research was conducted in biology and pharmacology Pastour institute of Iran in 2013. Albino Vistar rats of the same institute were used with the weight domain of 200-250 grams. The animals were put in the situation of 12/12 light cycle (form 7:00 am to 7:00 pm) in controlled temperature ( $22 \pm 2$  c) in 8 groups (with the size of  $42 \times 26 \times 15$  cm). Controll groups (without intervention), sport (30 min a day). 24 hours after the end of the activity process, open field test was applied in order to evaluate motive activity of rats.

### Open field device:

Open field device is a square box with size of  $30 \times 68 \times 68$  plexiglass that constitutes the black background of the test environment. The movement of the rats in the device is traced and discriminated with the help of an infrared ray camera installed on top of it. Digital symbols enter the computer tracer system and store the movement of the animal and the specific index such as the traversed distance (centimeter), average speed movement (cm/s) , and time of movement (s). This device is used for evaluating various activity indexes for rats, as mentioned earlier (29, 30).

### Motor function evaluation test

In order to execute the test, the rats were taken to the laboratory about 1 hour before the beginning to get familiar with the atmosphere. Afterward, before the start of the process, for the sake of familiarization with the experiment box, each rat was allowed to move freely in it. Meanwhile, their movements were traced through tracer system. After the process, each rat of the experiment box was decontaminated with Ethanol 90%. In this test, traversed distance indexes, duration of movement, and speed were evaluated.

### Statistical methods

For statistical description of the research variables, mean and standard error of the man ( $SEM_{+M}$ ) was applied, as well as ANOVA and TUKEY for deductive analysis of the data. Also, statistical calculations were executed through statistical software program SPSS16; a meaningful level of  $\alpha=0.05$  was considered.

### Findings:

In the present research, for determining the effectiveness rate of motionless stress, examine's weight was also measured. Since researches have confirmed that the rats exposed to chronic stress gain less weight throughout the stress period in comparison to Control group (19).

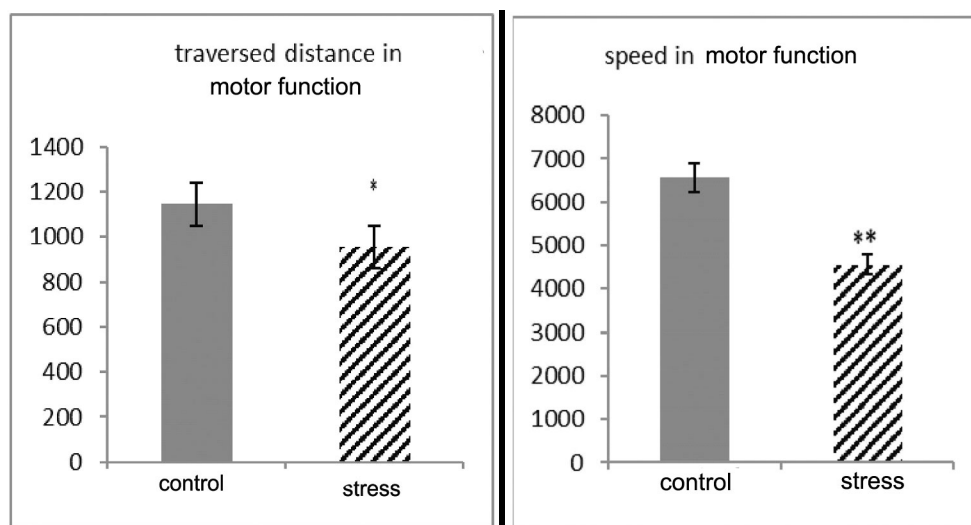
One this basis, the weight of the animals was measured some days before protocol execution, as well as after 21 days of the process. Table 1 illustrates that the rats in groups of stress (Stress, exercise +Stress, Music+ Stress, Music+ exercise+ Stress) have lost weight. According to t-correlated test, it was concluded that in control groups , which were not exposed to stress, increase in weight has significant difference in comparison to other groups.

**Table 1 weight changes in stress groups**

| M<br>Post-test | M<br>Per-test | S.E.M<br>Post-test | S.E.M<br>Pre-test | groups  |
|----------------|---------------|--------------------|-------------------|---------|
| 287.35         | 241.30        | 7.12               | 3.53              | control |

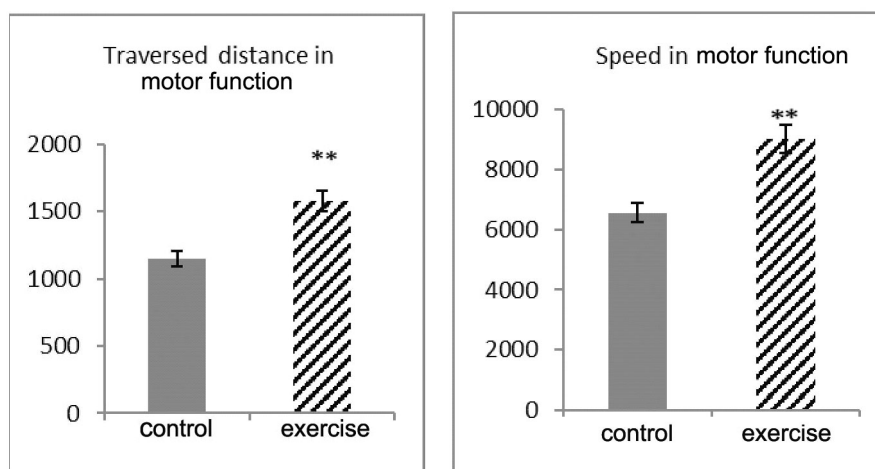
|        |        |       |      |                          |
|--------|--------|-------|------|--------------------------|
| 228.42 | 225.06 | 3.86  | 2.59 | stress                   |
| 233.42 | 227.36 | 3.37  | 4.37 | exercise+ stress         |
| 235.55 | 222.64 | 10.42 | 5.24 | Music+ stress            |
| 241.74 | 228.26 | 6.82  | 3.36 | Music+ exercise + stress |

Findings showed that motionless stress lessened significantly the traversed distance in motive operation. For the case of traversed distances, there was a significant difference between control groups and stress groups ( $p=0.026$ ). For the issue of speed, there was a significant difference between control group and stress group, which means that Stress has caused decrease in motor function.



**Figure 1, the effect of stress on motor function, \* is indicant of  $p \leq 0.05$ . The number of samples in each group is 8.**

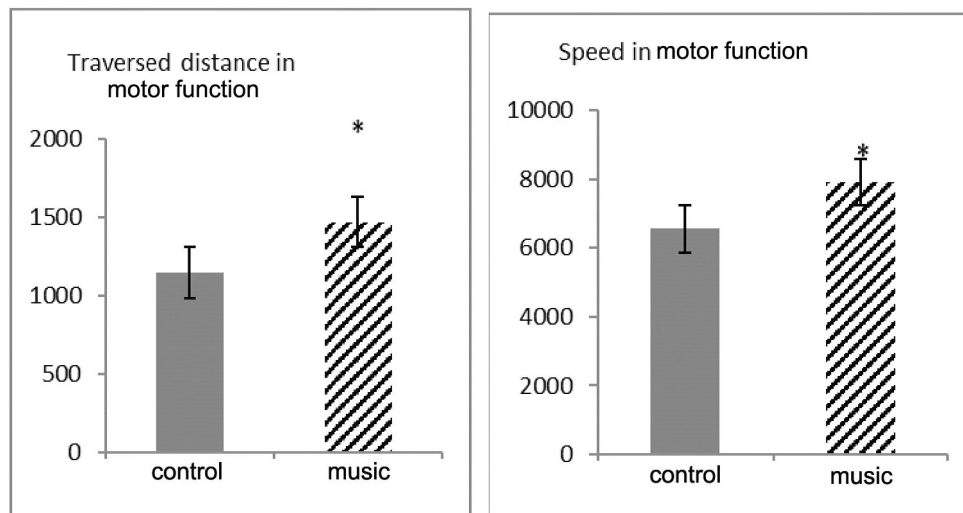
Aerobic exercise significantly increased the traversed distance in motor function. In the case of the traversed distance, there was a significant difference between control group and aerobic exercise ( $p=0.008$ ). For the issue of speed, the difference was also significant between control group and aerobic exercise ( $p=0.005$ ), which means aerobic exercise caused increase in motor function.



**Figure 2, effect of aerobic exercise on motive operation, total traversed distance and motion speed, \*\* is indicant of  $p \leq 0.01$ , the given amounts are based on  $M \pm S.E.M$**

Music also increased the traversed distance in motor function. For the issue of the traversed distance, there is a significant difference between control group and music ( $p=0.023$ ). For the issue of speed, there

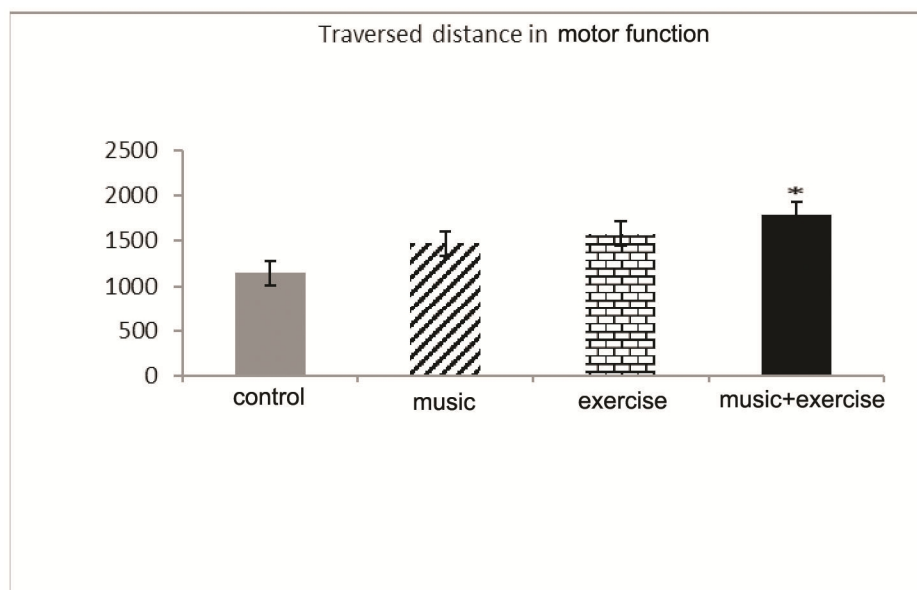
also existed significant difference between control group and music ( $p=0.046$ ), which means music has caused motor function to improve.



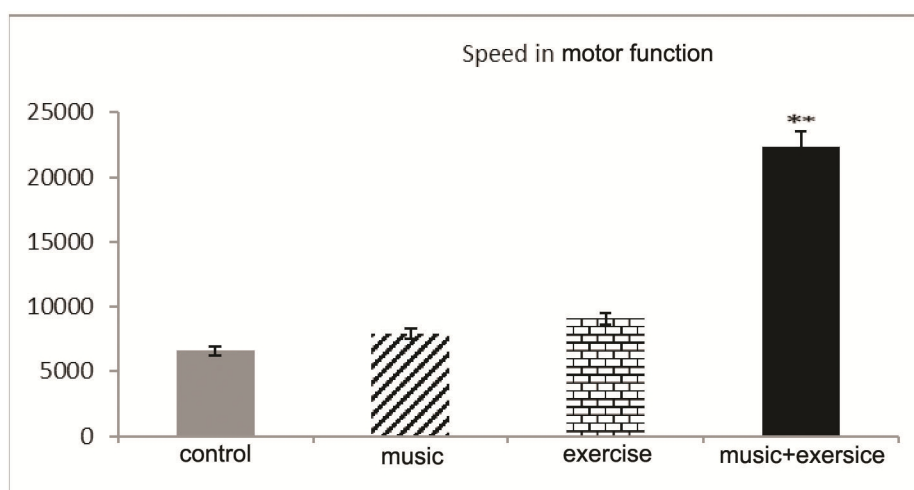
**Figure 3, effect of music on motor function, total traversed distance and speed, \* is indicant of  $p \leq 0.05$ .**

The number of samples is 8 in each group. The given amounts are based on M+S.E.M

Also, exercise and music interaction significantly increased motor function. There existed significant difference between control group, music, exercise, and exercise+ music ( $p=0.012$ ). For the case of speed, there was a meaningful difference between control group, music, exercise, and exercise+ music ( $p=0.005$ ).

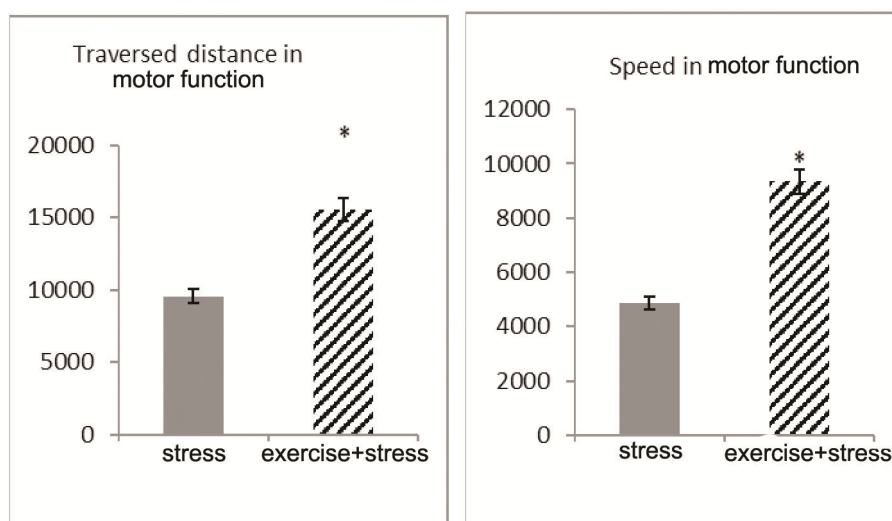


**Figure 4, effect of music on motor function, total traversed distance, \* is indicant of  $p \leq 0.05$ . The number of the samples is 8 in each group. The given amounts are based on M+S.E.M**



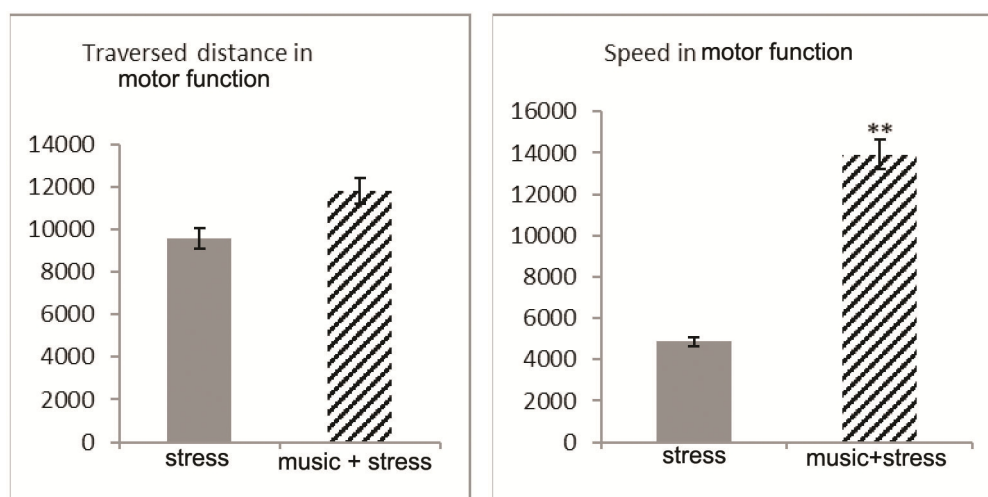
**Figure 5, effect of music on motor function, speed, \*\* is indicant of  $p \leq 0.01$ . The number of the samples is 8 in each group. The given amounts are based on  $M \pm S.E.M$**

Aerobic exercise, also, improved significantly the traversed distance of motor function in stress group. For the case of the traversed distance, there existed a significant difference between stress group and stress+ aerobic exercise group ( $p=0.016$ ). For the issue of speed, also, there was a significant difference between stress group and stress+ aerobic group ( $p=0.025$ ).



**Figure 6, effect of exercise on motor function in stress groups, total traversed distance and speed, \* is indicant of  $p \leq 0.05$ . The number of the sample is 8 in each group. The given amounts are based on  $M \pm S.E.M$**

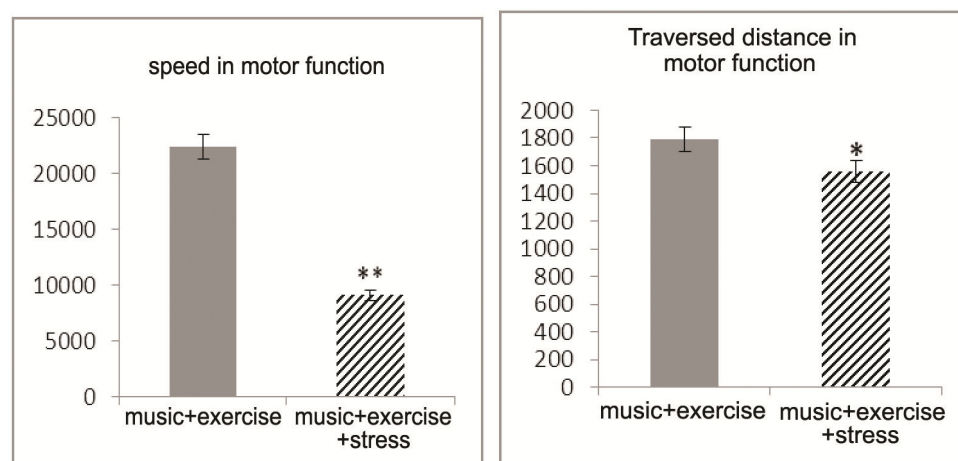
Findings showed that music didn't manage to improve the traversed distance of motor function in stress group. For the case of traversed distance, there was not any significant difference between stress group and stress+ music group ( $p=0.083$ ). However, for speed case, there existed significant difference between stress group and stress+ music group ( $p=0.004$ ), which means music causes speed to improve in groups of stress.



**Figure 7, effect of music on motor function in stress groups, total traversed distance and speed, \*\* is indicant of  $p \leq 0.01$ . The number of the samples is 8 in each group. The given amounts are based on  $M \pm S.E.M$**

T-independent results showed no significant difference between music+ exercise group and stress+ music+ exercise, regarding the traversed distance ( $p=0.013$ ).

T-independent results of speed showed no significant difference between music+ exercise and stress+ music+ exercise ( $p=0.0070$ )



**Figure 8, effect of music+exercise on motor function in stress groups, total traversed distance and speed, \*\* is indicant of  $p \leq 0.01$ . The number of the samples is 8 in each group. The given amounts are based on  $M \pm S.E.M$**

## DISCUSSION

Previous researches have shown that exercising on treadmill causes increase in hypothroidism through leveling up cardiovascular potentials (31). On the basis of oxygenation theory, and blood circulation, physical activity causes increase in blood flow to brain in motor cortex and cerebellum, consequently happens motor function increase (32). These are evidences confirming blood circulation increase to motor and sensory part after exercising on treadmill (Schneider hole et. al, 2002) which is parallel with activity increase of neurons of motive parts during the exercise (Wessing et al, 1996) (30). The conducted researches in this field on animals show that blood circulation in motive cortex of the rats during physical activity increases, as well as angiogenesis in motor cortex and cerebellum of rats accompanied with optional running (33, 34). The research results of Ding et al made it clear that in open field test, there was not any significant difference between exercise groups and control group related to the test features. Fernando Lopez et al found out in their research that findings of Rotarod Test shows significant decrease in motor ability and balance in Ischemia non practicing animals, which is consistent with the research history (35, 36). However, practicing animals have proved to possess weaker motive ability compared

with control group, which can be attributed to short period of impetus, as well as high motor requirement of the test. Paul et al showed that intensive exercise on treadmill did not correct the behavior related to open field, which is inconsistent with previous researches implying changes in relocation activities after exercising on treadmill (37). Aguiar et al (2009) came to the conclusion that physical activity from light to medium intensity could be considered effective for preventing motor disruptions related to decrease in monoaminergic of nervous system (38). Additionally, Dishman et al (1996) showed that treadmill exercise decreased relocation movements on open field in central part \_a measurement could be an index for anxiety-like or defensive behavior. Therefore, difference in impact of treadmill exercise on open field can be justified through applying habitual attempts, as well as individual designed test. Skalik et al reported that intensive exercise on treadmill prevents automatic activity decline on open field which occurs with the rise in age. One probable reason for motive disruptions and Parkinson symptoms is insufficient or lack dopamine activity in striate bodies by stimulating motor cortex (39). It is evident that physical exercise is somehow connected with the increase of neurotrophic factors related to survival, distinction, and nervous synopsis changes (31). Protective nervous resolutions like physical activities for Parkinson patients cause decrease process of dopaminergic neurons to decline, as well as improve the function of remaining neurons (34). It seems that positive effect of physical exercise on motor function, at least, to some extent, is maintained through adoptive changes in dopaminergic system in basal ganglia and motion circuit. For instance, Potinger et al (2007) showed increase of dopamine in striate body, and also, adjusting both dopamine and tyrosine hydroxylase on the rats medicated with MPTP which ran 28 days on treadmill (32). Just some parts of basal ganglia take part in motor function, whereas other parts are engaged in memory and cognitive functions which may be affected by doing exercise (30).

## CONCLUSION

In total, this research showed that the rats simultaneously exposed to aerobic exercise intervention and music possessed better motor function compared to other groups that is always true in both stress and without-stress situations. Besides, aerobic exercise intervention proved to be more effective than music, and also, aerobic exercise could neutralize limiting effects of stress. These findings indicate that aerobic exercise can be employed to modify destructive effects of stress, if accompanied by music, it would be more effective.

## ACKNOWLEDGMENTS

This research is the result of experimental works conducted in physiology & pharmacology center of Pastour Institute, Iran. Deepest gratitude is acknowledged to Ms. Choupani for her invaluable cooperation.

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