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Original Article

The Effect of Resistance Training on Some Neurotransmitters and Men's Pulmonary Function After Leaving Addiction

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Abstract

Background: Addiction is now recognized as a global problem facing all countries. Reducing neurotransmitters in addicts is an important barrier to drug addiction. The purpose of this study was to investigate the effect of resistance training on some neurotransmitters and the pulmonary function of men after quitting the addiction.

Materials and Methods: In this regard, 20 subjects were selected as the statistical samples of this research and were randomly divided into control (10 people) and resistance training (10 people) groups. The experimental group performed 3 sessions of circular resistance training for 8 weeks and weekly with 50%-65% intensity in one maximal repeat. Then, the subjects' blood sample (4 cc blood) was taken in order to study the variables of the research 48 hours before and after the implementation of the protocol. Next, all biochemical variables of dopamine and serotonin were measured by enzyme-linked-immunosorbent assay. Finally, all statistical calculations were performed using SPSS software, version 16 and $P \leq 0.05$ was considered as a significant level.

Results: The results of the study showed that 8 weeks of resistance training significantly increased dopamine levels ($P=0.0001$), serotonin ($P=0.0001$), maximum ventilation volume ($P=0.0001$), and vital capacity ($P=0.0002$). Eventually, the results indicated that 8 weeks of resistance training did not significantly change the forced expiratory volume in seconds ($P=0.628$).

Conclusion: According to the results of the study, it seems that 8 weeks of resistance training can increase neurotransmitters and pulmonary function in men who are addicted to drugs, and therefore, it can be used as a non-pharmacological approach to help these people to quit the addiction.

Keywords: Resistance Training, Neurotransmitters, Pulmonary function, Addiction

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Introduction

Today, addiction is known as a global problem facing all countries (1). Substance use disorder and drug dependence have become one of the major problems in the world and, after the nuclear crisis, population explosion, and environmental pollution, have ranked the fourth global human crisis (2). Drug addiction is to be held captive by narcotic drugs that affect one physically and psychologically, overwhelming one's individual and social behavior thus it is social damage to any human community (3). In Iran, the number of drug users is estimated to be between 1.8 and 3.3 million people and opiate is the most used substance (4). Studies show that 20 to 90% of drug addicts undergo relapse (4). In addition, addiction is a chronic disease that needs treatment. Alternative medicine, generally available to drug users in order to prevent them from going back to using, has not so far been successful (5). After quitting the substance use, returning and using drugs again is a serious problem in the whole treatment process. An estimated, 70% of drug users, in the first year after quitting, return to using again (6). This is a very high relapse rate. Drug abuse is a disease that affects both the brain and the behavior and is caused by a disorder in several neurotransmitters of the central nervous system. The most important of these systems can be referred to as "dopaminergic and serotonergic systems" (7). Drugs inhibit dopamine delivery and increase the release of dopamine and suppress serotonin

reuptake and increase it in the extracellular environment (8). Dopamine is a neurotransmitter that begins with the tyrosine amino acid and is produced in the terminus of dopaminergic exons. Tyrosine hydroxylase is the enzyme that controls the amount of dopamine production (9). Further, serotonin is another important hormone which has a psychological role in addiction. This hormone is made at the ends of the axon and tryptophan is the precursor amino acid. The synaptic effect of serotonin is terminated, through its reabsorption, into the pre-synaptic terminal of the carrier molecule in the plasma membrane (10). This neurotransmitter plays an important role in controlling sexual behaviors, mood, sleep apnea, appetite, aggressive power, and the cardiovascular system (11). The results of some studies indicate that addicts have low serum levels of dopamine and serotonin (12-14). Furthermore, scientific findings suggest that in alternative medicine treatment, medicines with short- and long-term physiological effects influence dopamine, serotonin, and beta-endorphins by stimulating neurotransmitters on the brain, which has a function similar to the exercise and causes a natural increase in these neurotransmitters and physiological changes in a long-term period (11). Arazi et al examined the effect of aerobic training on the serotonin levels and depression of addicted men in the rehabilitation period. The results of their research showed that 8 weeks of aerobic training increased serotonin while decreasing depression in methamphetamine addicts during rehab (15). In another study, Dadvand and Arazi found that physical activity and exercise training can have an effect on the circulatory levels of both neurotransmitters such as serotonin and dopamine in drug-addicted people. They can also be helpful factors with respect to the considerations in the treatment of addiction, as well as the physical and mental improvement of addicted people (8). Exercise also stimulates the secretion of endorphins, causes the feelings of comfort and tolerance of the stress associated with the quitting of addiction, and shifts the individual's attention from negative cases to positive and relaxing ones (15). O'Dell et al in a helpful study examined the effect of physical exercise on improving dopaminergic and serotypic terminal damage in amphetamine addicted mice. The results of their research demonstrated that repeating the intake of methamphetamine medications reduces dopaminergic and serotypic terminals in addition to their receptors and enzymes. However, after quitting substance use in mice and performing 7 days of exercise, significant changes were observed in the levels of serotonin and dopamine and their receptors in the regions of the brain (16). Therefore, physical exercise can be helpful in reducing the damage of the monoaminergic terminals of dopamine and serotonin and increasing their levels in the blood as a non-pharmacological approach to treatment. Moreover, respiratory disorders are considered as one of the problems that addicted people face while taking and leaving addiction (17, 18). When using drugs, steaming morphine quickly reaches the bloodstream through the lungs and reaches the brain within seconds. Additionally, its rate is approximately equal to the rate of the delivery of injectable morphine to the brain. Using the drugs affects the respiratory center, reduces the depth and rate of respiration, and finally, reflexes (17). Considering that no research has so far investigated the effect of resistance training on neurotransmitters and the pulmonary function of addicted persons, the aim of this study was to examine the effect of resistance training on some neurotransmitters and the pulmonary function of men after quitting the addiction.

Materials and Methods

The present field research was conducted in the laboratory. It should be noted that this research was registered in the University of Qom under the ethical code of IR.QOM.REC.1398.004. The statistical population of this study was all men who were quitting addiction in rehabilitation centers in Khorramabad, Narcotics Anonymous (NA). To select research samples, a general call was initially announced at all drug addiction centers. Following finding volunteers to collaborate, the research sample was chosen, which consisted of 20 individuals who had no history of surgery, specific heart and orthopedic diseases, or any conditions that prevented exercise during the course. Then, these twenty addicted men were randomly divided into control (10 people) and resistance training (10 people) groups. Before the beginning of the study, the goals and risks of this study were explained to the participants at a meeting, and they all signed written letters of consent for participation in this study. Based on the physician's examination and confirmation, all subjects were physically healthy. Next, subject homogenization was performed (except for hereditary cases) in order to reduce the probability of the effect on dependent variables. The general characteristics of the subjects such as age, height, weight, and body mass index were measured before performing the protocol. Then, 48 hours prior to the beginning of the training sessions, research variables were examined and blood samples (4 mL) were taken from the participants in 2 groups in a 12-hour fasting state. Serums were immediately centrifuged in 3000 rpm and kept in a freezer at 70°C until analysis. Then, the interventions were performed for 8 weeks during which, the experimental group carried out resistance exercises while the control group performed the routines of their normal life without having to participate in regular sports activities.

Exercise Practice Protocol

Resistance training included 8 weeks and 3 sessions per week. In addition, the exercise program included 10 minutes of warm-ups with a variety of stretching exercises and then 8 circular training workouts for 75-90 minutes. Finally, 10 minutes of cooling down were considered as well. The training stations included doing leg and chest

presses, parasite movements, bending the knees (behind the thighs), headrest, the back of the arm, as well as opening the knees (the front of the thighs) and the front of the arm. The training program in each session consisted of 3 rounds with twelve repetitions with an intensity of 50% to 65% of a maximal repetition. The rest time between the stations was 45 to 60 seconds and the rest time between each round was 90 seconds. The overload principle was designed so that, after every 2 weeks of training, a maximum repetition test was considered for each exercise with a 5% weight gain. The following formula was used to determine maximum repetition (19).

Tools and Process of Data Collection

This study made use of Beurer heart rate monitor, the SECA height measuring instrument (Germany), the Digital SECA scale (Germany) for measuring weight, and laboratory tools such as lab tubes, tourniquet, Vinoject (for blood sampling), plastic gloves, tube holders, BD anticoagulant capped tubes, a timer (Japan) with a precision of 0.01 second to measure time, and Hitachi centrifuge device to remove the serum from blood samples.

Statistical Methods

Independent and dependent *t* tests were used to evaluate the effect of interventions and $P \leq 0.05$ was considered as the significance level. All statistical calculations were done using SPSS software, version 16 and Excel 2003 statistical software was also used to draw statistical charts.

Results

The comparison of pre- and post-test changes between experimental and control groups showed that the dopamine levels ($P=0.001$), serotonin ($P=0.001$), maximal voluntary ventilation ($P=0.000$), and forced vital capacity ($P=0.002$) were significantly different after 8 resistance training weeks compared to the control group (Table 1). Further, the comparison of pre- and post-test demonstrated 8 weeks of severe periodic exercise on forced expiratory volume in 1 second in men after drug withdrawal, which did not significantly change in both experimental and control groups ($P>0.05$).

Discussion

The purpose of this study was to investigate the effect of 8 weeks of resistance training on some neurotransmitters and the pulmonary function of men after drug quitting. The results of this study revealed that 8 weeks of resistance training significantly increased the levels of serum dopamine and serotonin in men who were discontinuing addiction. The results of this study are consistent with those of Vafamand et al that examined the effect of 8 weeks of aerobic training on serotonin and dopamine levels in addicted women (9). In another study, Vafamand et al found that 8 weeks of aerobic exercise significantly increase serotonin and dopamine levels in addicted women. Similarly, Arazi et al concluded that aerobic exercise significantly increases the levels of dopamine and serotonin in addicts (20), which is in line with the findings of the current study. Moreover, O'Dell et al investigated the effect of exercise on improving the damage of serotonergic terminals in addicted mice and concluded that significant amounts of serotonin and their receptors are found in the brain after quitting the substance use and doing 7 days of exercise. They further indicated that improving drug-induced injuries through resistance exercise can have therapeutic effects because

Table 1. Comparison of Changes Before and After 8 Weeks of Intervention in the Measured Variables in the Resistance Training Group and the Control Group on the Resting Levels of Some Neurotransmitters and Lung Function of Men After the Withdrawal of Addiction

Variable	Group	Pre-test	Post-test	Intra-group *P* Value	Inter-group *P* Value
Weight (kg)	Control	74.2 ± 4.2	75.2 ± 3.1	0.566	0.578
	Experimental	72.1 ± 3.2	75.6 ± 2.6	0.612	
Body mass index	Control	20.1 ± 3.72	20.97.1 ± 2.1	0.624	0.741
	Experimental	23.11 ± 3.2	20.1 ± 2.13	0.554	
Serotonin (ng/mL)	Control	265.13 ± 44.2	270.19 ± 40.36	0.715	0.001*
	Experimental	245.65 ± 53.36	353.73 ± 40.19	0.001*	
Dopamine (pg/mL)	Control	93.55 ± 12.39	91.9 ± 16.63	0.617	0.001*
	Experimental	85.2 ± 13.44	119.1 ± 8.3	0.001*	
Maximum ventilatory volume	Control	6.15 ± 1.77	6.36 ± 1.79	0.634	0.001*
	Experimental	6.1 ± 1.24	9.64 ± 1.15	0.001*	
Forced vital capacity (L)	Control	2.75 ± 75	2.73 ± 0.83	0.668	0.002*
	Experimental	2.97 ± 0.59	2.75 ± 75	0.0001*	
Forced expiratory volume in second (L/S)	Control	2.33 ± 0.68	2.36 ± 0.71	0.589	0.628
	Experimental	2.25 ± 0.55	2.66 ± 0.50	0. 551	

Note. *Significant difference ($P<0.05$).

drug use leads to an increase in the reaction between oxygen and nitrogen and poses damage to monoamino-venereal terminals (16).

On the other hand, long-term sports practice increases the activity of endogenous antioxidants (21). However, resistance exercises increase intrathoracic endothelial growth factors (22) and may be done by stimulating angiogenesis and have a direct effect on the neurotrophic growth factor, helping to cause drug-related injuries, which leads to the reconstruction and repair of the terminal damaged monoaminergic and serotonin (16).

Regarding the side effects of the alternative medicine treatment of addicts, resistance training is a non-drug method that can interact with the dopaminergic reward system. Sports activities trigger the same mechanism in the brain that seeks to consume drugs through increased dopamine and its receptors. Therefore, physical exercises, including resistance exercises, are a protective way to prevent the return to drug use and result in neurohormonal adaptation (23). It is hypothesized that the reduction in beta-endorphins and drug dependence are related to each other. This means that when it comes to discomfort because β-endorphin levels are not released at normal levels, one wants to artificially build it in the body (24). In fact, if exercise can increase serum beta-endorphin levels, it can affect the brain reward system by increasing the available dopamine (25). In addition, the effect on receptors will be able to increase tolerance, especially exercise pressure. As a result, a person will need less extraneous external substances because exercise activity actually provides these materials with more efficiency in the brain reward system (25). Additionally, performing physical activity and exercising can potentially be part of an addiction-prevention and treatment process. Similarly, exercise generally reduces the effectiveness of used opioids, but its effectiveness varies with the stages of addiction. At the onset of the addiction-quitting process, the exercise works through interaction with dopamine in reward paths while, in later stages, it may be acted upon by interaction with glutamate, dopamine, and chromatin and prevent the relapse of the addicts (26). Another result of the study is the effect of resistance training on men's pulmonary function after quitting the addiction. The results of this study showed that 8 weeks of resistance training increased significantly forced vital capacity and forced expiratory volume in 1-second levels in men after drug quitting. The results further indicated that drug use leads to pulmonary edema resulting from endothelial dysfunction and affects sodium channels, as well as ganglia and their permeability. Morphine has also been shown to increase the concentration of nitric oxide and reactive oxygen free species, which causes the apoptosis of the endothelial cells of the lung vessels (26) all of which can make it harder for people who are consuming and leaving addiction. It seems that the reasons for the increase in respiratory performance indicators in this study are increased bronchial asthma and airways following 8 weeks of resistance training in people after the withdrawal of addiction. Resistance exercises increase muscle involvement and the amplitude and depth of respiration. Similarly, they improve indexes and oxygen consumption and increase their release (27). An increase in cortisol is another cause of increased performance indicators. Moreover, resistance exercises increase cortisol which increases the secretion of surfactant and results in better and deeper breathing (28). These exercises with the increased use of respiratory muscles improve ventilation, prevent the accumulation of secretions and atelectasis (the sleeping of the part or entire lung), and increase the strength and coordination of the respiratory muscles, especially those responsible for tailoring. On the other hand, resistance exercises reduce the bronchospasm of airways. Indeed, these excercises reduce the inflammation of airways (29). Additionally, resistance exercises are likely to activate the transverse abdominal and diagonal internal muscles. The ventricular or abdominal respiratory tract is responsible for exhaling although it has a secondary role in postural regulation after the postural respiratory tract. Likewise, neurons in pentactic and apneustic centers that are located in the upper and lower parts of the bridge of the brain, respectively, can provide the coordination of respiratory depth necessary for transmission from the tail into exhaled. This results in deep and prolonged breathing in addition to physical abilities in addicted and addicted people (30).

Conclusion

In general, the results showed that 8 weeks of resistance training increased dopamine and serotonin hormones, along with the pulmonary function in the addicts. Therefore, resistance training should be considered as a non-drug component in the treatment of addiction.

Conflict of Interest Disclosure
None.

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Ethical Approval
This research was registered under the ethical code IR.QOM.REC.1398.004 in the University of Qom.

Author Contributions
MA: Exercise methodologist/statistical analyzer; FFS: Article writer/researcher; HM: Auxiliary researcher.

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The authors were responsible for the financial costs of this research.

Informed Consent
After explaining the study objectives to participants, the volunteers signed informed consent.

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