Physical Activity Review vol. 4, 2016

Original Articles

DOI: http://dx.doi.org/10.16926/par.2016.04.01

The blood levels of Serotonin and Dopamine and physical fitness factors in active and inactive men addicted to opium during rehabilitation

Authors' Contribution:

A – Study Design
B – Data Collection
C – Statistical Analysis
D – Manuscript Preparation
E – Funds Collection

Hamid Arazi[1ACDE], Rahim Mollazadeh[2BCDE], Seyedeh Shiva Dadvand[1CD], Maryam Davaran[3DE]

[1] Department of Exercise Physiology, Faculty of Sport Sciences, University of Guilan, Rasht, Iran.

[2] Department of Psychology, Faculty of Humanities Sciences, University of Guilan, Rasht, Iran.

[3] Department of Physical Education, Islamic Azad University, Rasht Branch, Rasht, Iran.

Abstract

Addiction to drugs is one of the significant problems in many countries. Opium is a kind of drug that its use goes back to many years ago .Dopamine and serotonin are neurotransmitters involved in the process of addiction. As a result, this study aimed to investigate the blood levels of serotonin, dopamine and physical fitness factors in active and inactive men addicted to opium during their rehabilitation period. This study is a descriptive and Causal after the occurrence. A total of 34 men addicted to opium referring to rehabilitation center had been admitted voluntarily as samples were available in the study. According to a questionnaire answered by them, 16 of them did exercise during their rehabilitation period (active group) and 18 of them did not do any physical activity during this period (inactive group). 5 cc of peripheral blood samples were obtained from both groups and were tested their aerobic capacity, muscular endurance, flexibility, body composition, blood pressure and heart rate. Statistical analysis showed that blood levels of serotonin and dopamine in active group were significantly more than inactive group ($p<0.05$). In addition, the active group compared with the inactive group had low body fat percent, more muscular endurance, more flexibility, and low resting heart rate ($p<0.05$). According to the findings, we can conclude that low physical activity but as regular walking can affect blood levels of serotonin and dopamine, and health-related fitness factors of addicted men and as a non-drug treatment is helpful.

Keywords: Exercise, Opium, Serotonin, Dopamine, Addiction.

INTRODUCTION

Addiction as one of the social problems, is especially common among young people that can lead to different hazards such as social and health harms, the destruction of personal property, increased violence, and increased risk of human immunodeficiency virus (HIV), delinquency, joblessness, mental disorders and suicidal ideation [1]. Opium cultivation history goes back to long ago and is one of the oldest plants cultivated by humans; In addition, opium contains about eighty different combinations of alkaloids which morphine is the most important of them [2].

Highest effects of drug abuse are on the central nervous system, autonomic nervous system and the intestines. While the abuse of drugs affects other body systems including the cardiovascular system and respiratory system [3]. Usage of substances that is addictive will change the amount of neurotransmitter systems in particular dopamine and glutamate. It has been shown that glutamate increases the desire to return and rapid tendency toward addictive drugs [4]. On the other hand it is known that Dopaminergic neurons are involved in the development of natural behaviors associated with motivation and reward [5]. Amino acid tyrosine is used to build Dopamine neurotransmitter and the location of its construction is terminal of dopaminergic axons [6]. It is serotonin neurotransmitter that helps strengthens the symptoms of a brain region to other region. Serotonin is substance produced in the brain; however, 95 percent of the cells and platelets in digestive tract are synthesized [7]. Exercise can compensate reduce in production of dopamine, serotonin and norepinephrine that are created due to drug abuse and play a role as a catalyst in promoting growth of neurodevelopmental. Thus, it is possible that exercise to be used as a valuable aid in the treatment of addiction and recovery of addicts [8]. It seems this is one of the most effective and cost-effective methods to treat addiction. Based on the evidence obtained voluntary exercise, by affecting reward systems has incentive effects. Thus it is proposed that exercise could possibly be used as a useful tool in the prevention and treatment of addiction [9]. Thus, the aim of this study was to determine the level of serotonin and dopamine in the active and inactive men addicted to opium that had attended to counseling centers for their addiction treatment.

METHODS

In this descriptive study, 34 addicted men attending to addiction centers in Guilan province participated in the present study after explanation of the situation and also completing the consent form purposefully and voluntarily. After submitting necessary clarifications, Subjects were divided in two active (with exercise) and inactive (no exercise) groups. Sedentary group had routine life and had no physical activity during their addiction treatment. Active group on the basis of information extracted from Beck questionnaire mainly had aerobic exercise 2 to 3 times a week and each session 20 to 30 minutes in form of walking. Anthropometric and field measurements including height, weight, flexibility, muscular endurance, body fat percentage, aerobic power and heart rate and blood pressure measured at rest was executed in the form of a predetermined program and at certain times of the day. It is worth noting that chosen subjects were people who 3 to 6 months have passed from their addicted period and approximately used the same drugs in this period. The procedures were approved by the Institutional Ethics Review Committee of the University.

Height of subjects was measured using a tape made in Iran with an accuracy of one millimeter; weight was measured using Seca model digital scales with a sensitivity of 1.0 kilogram. After measuring height and weight of subjects, by dividing weight in kilograms by the square of height (m) Body mass index was calculated. In order to determine the amount of body fat using a caliper (YAGAMI Yuken type model made in Japan), subcutaneous fat in the chest, abdomen and thigh on right side of the body were measured and using Jackson and Pollock equation for men, fat percentage was calculated [10]. Cardiorespiratory fitness was done through walking a mile test and running using a timer and Polar pulse meter. Subjects had gone this distance with the desired speed and by measuring elapsed time and the heart rate at the end of distance determined by the following formula; the maximum oxygen consumption was estimated [11]:

$$Vo_{2max}\ (ml.kg^{-1}.\ Min^{-1}) = 100.5 + (8.344\times sex) - (0.1636\times Kg) - (1.438\times time) - (0.1928\times HR)$$

"Gender: Male 0, Female 1" "Weight = Kg" "time = time for jogging a mile "
"HR = Ending heart rate."

Blood pressure measurement was done using mercury sphygmomanometer and stethoscope (ALPK2 model made in Japan). In order to measure the Subjects Heart rate Beurer rate monitor device (PM80 model made in Germany) was used. The sensor located in the strap of this machine was placed on chest of subject and slightly to the left and strap rate monitor was tightened until it did not cause discomfort to the subject. Transmitter of stethoscope automatically starts when placed on the skin. At this time marks were sent to the receiver which had been closed on the wrist of subject and the number of Heart rate per minute appeared on the screen of the receiver and it was noted by researcher. Also, to measure the muscle strength of the legs closed legs sit-ups were used in this way; Person lied down on the back, knees bent and heels on the ground, hands beside head. In each correct move top of the elbow should touch the knee and then the bottom of shoulder blades have contact with the mattress. Correct movements within a minute were registered as the record. To determine the levels of serotonin and dopamine after the period of exercise trainings, after fasting overnight and at rest at 8-10 in the morning with the presence of an expert amount of 5 ml blood were taken from Subjects brachial vein in the sitting position. Blood collected was placed in sterile tubes and was sent to the laboratory. Then, using centrifuges, serum was isolated from plasma. In order to determine serotonin and plasma dopamine ELISA methods and LDN kits (made in Germany) were used.

Statistical Analysis

Normality of distribution of data was evaluated using Kolmogorov-Smirnov test. Descriptive statistics was used in order to report the average and the dispersion index data and independent t-tests to compare data between two groups. Data was analyzed using SPSS version 20 at significant level of $P \leq 0.05$.

RESULTS

Descriptive characteristics of subjects are presented in table 1. Also, results of independent t test comparing blood indicators related to health and physical fitness of the participants in both active and inactive, is presented in table 2. According to the data presented in table 1, no significant difference was observed between basic characteristics such as age, height, and weight and body mass index of active and inactive groups. ($P>0.05$).

Table 1. Mean and standard deviation of the primary characteristics of subjects in both active and inactive groups

Variable	Inactive group	Active group	p value
Age (years)	29.50±4.70	28.83±6.68	0.74
Height (cm)	175.75±6.02	174.11±7.09	0.47
Weight (kg)	72.18±11.82	75.47±12.26	0.43
BMI (kg/m^2)	23.62±4.34	24.94±4.07	0.36

According to the data presented in table 2, the results of independent t-test showed that average blood levels of dopamine and serotonin, body fat percentage, muscular endurance, flexibility and resting heart rate in the active group had significant difference compared to inactive group (P<0.05) while The average systolic blood pressure, diastolic blood pressure and aerobic capacity did not have a significant difference (P>0.05).

Table 2. Blood levels of serotonin and dopamine, Blood pressure and indices of health related physical fitness of the active and inactive groups

Variable	Inactive group	Active group	p-value
Serotonin (ng/ml)	221.44±95.24	312.25±79.52	0.005*
Dopamine (pmg/ml)	83.11±20.45	104.56±23.89	0.008*
SBP (mmHg)	127.50±15.49	120.12±11.85	0.13
DBP (mmHg)	68.88±8.67	81.37±6.46	0.46
VO_{2MAX} (ml.kg.min)	34.88±6.73	36.81±7.85	0.44
Body fat percent	22.66±3.61	18.37±4.28	0.003*
Muscular endurance (repetitions)	26.05±7.21	32.87±11.05	0.039*
Flexibility (cm)	19.88±6.22	25.13±8.03	0.034*
RHR (bmp)	81.00±5.58	74.93±6.57	0.007*

*Shows significant differences between the active and inactive groups in p≤0.05 level. DBP; Diastolic blood pressure, SBP; Systolic blood pressure, RHR; Resting heart rate.

DISCUSSION

The aim of this study was to determine blood levels of serotonin and dopamine of active and inactive men addicted to opium in rehabilitation period. Research findings show that aerobic exercise in form of walking can cause a significant increase in blood levels of dopamine and serotonin, muscular endurance, flexibility and a significant reduction in body fat percentage and resting heart rate in the active group compared to inactive men addicted to opium in rehabilitation period.

Cosgrove et al. [12], showed that voluntary run model in mice and possibly voluntary exercise in humans as a natural reward may be an alternative to reduce drug abuse. Evidence suggests that the same reward pathways that are activated by addictive drugs can be activated by exercise as well. Exercise increases brain dopamine concentration constant, receptor density (D2) and compensatory changes in dopamine binding proteins. Therefore, chronic exercise leads to less sensitive organisms to the effects of positive reinforcement of morphine by creating functional changes in the reward pathway of Mesolimbic and Meso-cortical. Aerobic exercise causes induced increase in vascular endothelial growth factor and is likely to be done by help of the damage caused by the way stimulation of angiogenesis and a direct effect on neurotrophic growth factor which causes reconstruction and restoration of damaged monoamine anticholinergic of dopamine and serotonin [13]. Exercise makes liberalization of certain neurotransmitters in the brain that reduce and relieve physical and mental pain possible. Most of the research that has been done in this regard, focused on running but all kinds of aerobic exercises have these benefits. It has been found that the impact on the brain applies through many mechanisms, including neurogenesis, increased mood (the temperament) and the release of endorphins [14]. Further evidence shows that the release of opiate androgens during the exercise suggests that mice that have been exercising for a while and after physical activity received naloxone, showed mild withdrawal symptoms [15]. Exercise approximately 30 minutes after the start of activity stimulates the release of endorphins. Released endorphins tend to minimize the suffering from physical activity and are associated with a feeling of euphoria and pleasure. But is that endorphins are directly responsible or Neurotransmitters such as dopamine and serotonin cause these effects, is questionable [14].

Research findings showed that physical exercise in form of aerobic in opium addicted men in rehabilitation period, increases serotonin and dopamine. MacRae et al. [16] and Vučcković et al. [17], concluded that by the effect of aerobic exercise dopamine levels increased. Chaouloff et al. [18] in their study concluded that dopamine activity in the brain can be effective on responses of brain serotonin during exercise. In this study, a large amount of dopamine was found in areas that serotonin levels increased. Langford et al [19] reported an increase in serotonin in the effect of aerobic exercise which is consistent with research results. Dey et al. [20], examined the effects of a severe and prolonged exercise time swimming (4 pools week, 6 days a week) and the level of serotonin in different brain regions. An acute exercise session increased serotonin in the brain stem and hypothalamus, but did not change Serotonin levels in the cerebral cortex and hippocampus, while prolonged exercise increased serotonin in all brain regions and a week after the last exercise session this changes still remained.

Results obtained associated with high blood pressure suggest this issue that Being active in form of mainly aerobic exercise 2 to 3 times a week and each session 20 to 30 minutes in form of walk and exercise haven't had a significant effect in reducing systolic and diastolic blood pressure. Our findings about the effect of exercise on blood pressure is antithetic with findings of Pescatello [21], and Swain and Franklin [22], that observed a reduction in systolic and diastolic blood pressure with exercise, but it is consistent with Williams [23], research. The reason for inconsistency in the findings of the research may be some different training variables such as the difference in the form of aerobic exercise, intensity of the activity, number of exercises, number of repetitions, resting between sets, resting between movements, muscle groups involved in the activity, time of activities, the period of exercises as well as other factors such as the subject's age, physical condition of participants during recovery.

Bassuk and Manson [24], Parizkova [25] and Wimberly et al. [26], showed that Physical exercise in the form of Aerobic and walking can reduce body fat percentage that is consistent with results. Parizkova [25], also in his research showed that groups active, have more favorable body composition and fat content compared with less active group. Wimberly et al in 2001 considered the comparison of resting metabolic rate and body composition of middle-aged women (50-35 years) active (exercising 9 hours per week) and inactive (less than 1 hour of physical activity per week) . Research results show the percentage of fat and fat weight in the active group (18.9% and 11.1 kg) significantly was lower compared with the inactive group (28.8% and 18.8 kg). Weight and BMI were similar in both groups. Bassuk and Manson studying on men 25 to 35 years old concluded that regular physical activity improves body composition of people. Skinner [27], pointed out to the effect of exercise on heart rate that is consistent with our findings. This means that exercise is effective on the reduction of heart rate at rest and increases the efficiency of the heart that according to various studies receiving more blood volume and increasing the contractile strength of the heart's blood pumping can be a reason to reduce the resting heart rate due to regular physical activity to reduce the production and secretion of catecholamine and vagal stoppage [28].

Dolezal et al. [29], studied the effect of 8 weeks of training on the amount of physical fitness in patients dependent to mAMPH, the results of the study showed significant improvements in muscular strength by endurance training. Several studies have examined the effects of exercise training on muscle strength in trained and untrained people [30-31]. What has been observed in most studies, is that exercise training can improve muscle strength in untrained people similar to trained people [30]. The results of the present study was in coordination with the finding. According to the findings of this study, no significant difference was observed between the Aerobic Power of both active and inactive groups. Macek et al. [32], Research results confirmed that the trained men and women have a higher aerobic power than untrained persons. This finding is antithetic with the results of the present study and its possible reason can be the difference in exercise duration, intensity and frequency of activity and the state of preparedness of research subjects. Because in the present study there was no precise control over the implementation of the activities in question. Other findings of this study showed that the active group had greater flexibility than inactive group. Shahana et al [33] showed that Aerobic exercises was effective on health components and improved flexibility which is consistent by research results.

CONCLUSSION

Overall, the findings of this study showed that physical activity as a therapeutic strategy can have beneficial effects on serotonin and dopamine levels in men addicted to opium in rehabilitation period and improved indicators related to their health in order to improve the quality of life, fatigue and of course a sense of confidence and will necessary to avoid abuse of opiates.

ACKNOWLEDGEMENTS

Authors hereby express gratitude to all the participants and all those who helped in this study.

REFERENCES

1. Reed E, Amaro H, Matsumoto A, Kaysen D: The relation between interpersonal violence and substance use among a sample of university students: Examination of the role of victim and perpetrator substance use. Addictive Behaviors, 2009; 34(3): 316-318.
2. Karam GA, Reisi M, Kaseb AA, Khaksari M, Mohammadi A, Mahmoodi M: Effects of opium addiction on some serum factors in addicts with non-insulin-dependent diabetes mellitus. Addiction Biology, 2004; 9(1): 53-58.
3. Le Moal, M, Koob GF: Drug addiction: pathways to the disease and pathophysiological

perspectives. European Neuropsychopharmacology, 2007; 17(6): 377-393.
4. Hicks RR, Boggs A, Leider D, Kraemer P, Brown R, ScheffS W, Seroogy KB: Effects of exercise following lateral fluid percussion brain injury in rats. Restorative Neurology and Neuroscience, 1998; 12(1): 41-48.
5. Floresco SB, Blaha CD, Yang CR, Phillips AG: Modulation of hippocampal and amygdalar-evoked activity of nucleus accumbens neurons by dopamine: cellular mechanisms of input selection. The Journal of Neuroscience, 2001; 21(8): 2851-2860.
6. Sadock BJ, Sadock VA, Levin ZE: Kaplan and Sadock's Study Guide and Self-Examination Review in Psychiatry. Lippincott Williams & Wilkins, 2007; 468.
7. Gold M: The neurobiology of addictive disorders, bore miller the principal and practice of addictions psychiatry. Philadelphi WB Saunders, 1997; 57-69.
8. Micheal S: Changing brain chemistry with intense exercise for drug addiction prevention and recovery. Research Confronts Reality, 2002; 1: 716-51.
9. Ehringer MA, Hoft NR, Zunhammer M: Reduced alcohol consumption in mice with access to a running wheel. Alcohol, 2009; 43(6): 443-452.
10. Alex F: Assessment of body anthropomtric. In: Timoth G, Reynaldo M. Anthropometric standardization referencemanual. 2nded. New York: Human Kinetics Press. 1988; 423-516.
11. George JD, Vehrs PR, Allsen, PE, Fellingham GW, Fisher AG: VO2max estimation from a submaximal 1-mile track jog for fit college-age individuals. Medicine and Science in Sports and Exercise, 1993; 25(3): 401-406.
12. Cosgrove KP, Hunter RG, Carroll ME: Wheel-running attenuates intravenous cocaine self-administration in rats: sex differences. Pharmacology Biochemistry and Behavior, 2002; 73(3): 663-671.
13. O'dell SJ, Galvez BA, Ball AJ, Marshall JF: Running wheel exercise ameliorates methamphetamine-induced damage to dopamine and serotonin terminals. Synapse 2012. 66(1): 71-80.
14. McGovern MK: The Effects of Exercise on the Brain. Biology 202, second web papers on serendip. 2005.
15. Alaei H, Esmaeili M, Nasimi A, Pourshanazari A: Ascorbic acid decreases morphine self-administration and withdrawal symptoms in rats. Pathophysiology, 2005; 12(2): 103-107.
16. MacRae PG, Spirduso WW, Cartee GD, Farrar RP, Wilcox RE: Endurance training effects on striatal D 2 dopamine receptor binding and striatal dopamine metabolite levels. Neuroscience letters, 1987; 79(1): 138-144.
17. Vučcković MG, Li Q, Fisher B, Nacca A, Leahy RM, Walsh JP, Petzinger GM. Exercise elevates dopamine D2 receptor in a mouse model of Parkinson's disease: in vivo imaging with [18F] fallypride. Movement Disorders, 2010; 25(16): 2777-2784.
18. Chaouloff F, Laud, D, Meringo D: Amphetamine and alpha- methyl p- tyrosine affect the exercise induced imbalance between the availability of tryptrophan and senthesis of serotonin in the brain of the rat. Neuropharmacology, 1986; 26(8): 1099 – 1106.
19. Langfort J, Barańczuk E, Pawlak D, Chalimoniuk M, Lukačova N, Maršala J, Górski J: The effect of endurance training on regional serotonin metabolism in the brain during early stage of detraining period in the female rat. Cellular and Molecular Neurobiology, 2006; 26(7-8): 1325-1340.
20. Dey S, singh R, Dey P: Exercise training: signification of regional altrrations in serotonin metabolism of rat brain in relation antidepressant effect of exercise. Physiology and Behavior, 1992; 52: 1095- 10099.
21. Pescatello LS: Exercise and hypertension: recent advances in exercise prescription. Current hypertension reports, 2005; 7(4): 281-286.
22. Swain DP, Franklin BA: Comparison of cardioprotective benefits of vigorous versus moderate intensity aerobic exercise. The American Journal of Cardiology, 2006; 97(1): 141-147.
23. Williams, P. T: Relationships of heart disease risk factors to exercise quantity and intensity. Archives of Internal Medicine, 1998; 158(3), 237-245.
24. Bassuk SS, Manson JE: Epidemiological evidence for the role of physical activity in reducing risk of type 2 diabetes and cardiovascular disease. Journal of Applied Physiology, 2005; 99(3): 1193-

1204.
25. Parizkova J: Total body fat and skin folds thickness in children. Metabolism, 1961; 10:794-801.
26. Wimberly MG, Manore MM, Woolf K, Swan PD, Carroll SS: Effects of habitual physical activity on the resting metabolic rates and body composition of women aged 35 to 50 years. Journal of American Diet, 2001; 101(10): 36-41.
27. Skinner JS: Physiological response of men to l, 3 and 5 day per week training programs. Journal of Research in Sport, 2005; 57(2): 62-75.
28. Kohrt WM, Obert KA, Holloszy JO: Exercise training improves fat distribution patterns in 60-to70-year-old men and women. Journal of Gerontology, 1992; 47(4): 99-105.
29. Dolezal BA, Chudzynski J, Storer TW, Abrazado M, Penate J, Mooney L, Cooper C.B: Eight weeks of exercise training improves fitness measures in methamphetamine-dependent individuals in residential treatment. Journal of Addiction Medicine, 2013; 7(2): 8-122.
30. Aagaard P, Andersen JL: Effects of strength training on endurance capacity in top-level endurance athletes. Scandinavian Journal of Medicine & Science in Sports, 2010; 20(2): 39-47.
31. Tanaka H, Swensen T: Impact of resistance training on endurance performance. Sports Medicine, 1998; 25(3): 191-200.
32. Macek M, Bell DI, Rutenfranz J, Vavra J, Musopust J, Neidhart B, Schmidt KH: A corparison of coronary risk factors in groups of trained and untrained adolescents. European Journal of Applied Physiology and Occupational Physiology (Berlin, FRG), 1998; 58(6): 5-577.
33. Shahana A, Nair US, Hasrani SS: Effect of aerobic exercise program on health related physical fitness components of middle aged women. British Journal of Sports Medicine, 2010; 44(1): 19-29.

Address for correspondence:

Hamid Arazi - Department of Exercise Physiology, Faculty of Sport Sciences, University of Guilan, Rasht, Iran. E-mail: hamidarazi@yahoo.com

Recevied: 17.11.2015; Accepted: 15.12.2015; Published online: 04.01.2016