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Exercise training reduces alcohol consumption but does not affect HPA-axis activity in heavy drinkers

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ABSTRACT

Background: It has been suggested that physical exercise could have potential beneficial effects in substance abusers, which are based on both physiological and psychological theories. Although a few studies have examined the effect of exercise on alcohol intake and fitness in individuals with alcohol use disorders (AUDs), there is a gap in the literature concerning the physiological and biochemical mechanisms that could be affected by physical exercise in this population.

Purpose: The purpose of the present study was to examine physiological and biochemical responses to exercise after an 8-week supervised exercise training (ET) intervention in heavy drinkers. The investigation was mainly focused on the relationship among exercise, opioids, the hypothalamic-pituitary-adrenal axis (HPA) activity and heavy alcohol drinking.

Methods: Eleven (Age: 30.3 ± 3.5 yrs; Body Mass Index: 28.4 ± 0.86 kg/m^2) male heavy drinkers volunteered to participated in an 8-week supervised intervention of moderate intensity exercise (50–60% of Heart Rate Reserve). All participants were exhibiting low physical activity and used to drink heavily. Before intervention, the participants were asked to record their daily alcohol intake without changing their physical activity levels for 4 weeks (control condition). During the 8-week supervised ET intervention, participants were recording their daily alcohol intake and were motivated to increase gradually the duration and frequency of ET. Blood samples were collected prior to and after 4 weeks of the control condition, the day before the beginning of the ET intervention, and at the end of the 4th and 8th week of ET intervention. Blood samples were analyzed for β-E, epinephrine, norepinephrine, adrenocorticotropin, cortisol, gamma-glutamyl transferase (γ-GT), aspartate transaminase and alanine transaminase. Physiological and alcohol-related indices were also examined.

Results: The 8-week supervised ET intervention resulted in reduced alcohol consumption, reduced γ-GT levels, and fitness improvement in heavy drinker. ET intervention did not significantly change the hormonal responses.

Conclusion: The results indicate that physical exercise could act as a healthy habit that can help individuals with AUDs reduce alcohol intake and improve health status; however, this is not related with changes in hormones associated with the HPA-axis.

1. Introduction

Light to moderate alcohol use is thought to have a beneficial impact on health (e.g., [1]), whereas uncontrolled and excessive alcohol consumption can negatively affect mental and physical health, and social aspects of humans [2]. Alcoholism and other disorders related to alcohol use are a major health concern, with alcohol abuse accounting for about 4.5% of all diseases and injuries worldwide [3].

Alcohol use has been reported to influence the activity of the endogenous opioid system of humans [4,5]. Acute exposure to alcohol may result in a fast and transient release of β-endorphin (β-E) by the pituitary and hypothalamus [6,7] in a dose-dependent manner [8].

Abbreviations: AUD, Alcohol Use Disorder; AUDIT, Alcohol Use Disorders Identification Test; ET, Exercise Training

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Increased β-E levels, in turn, activate μ and δ receptors, possibly playing an important role in the reinforcing properties of alcohol intake. On the other hand, there may be a decreased β-E release as well as lower density and activity of the opioid receptors after chronic exposure to alcohol that may be responsible for feelings of discomfort and negative reinforcement [4,5]. This is based on reports that chronic alcohol abuse resulted in low concentration of β-E in the cerebrospinal fluid and plasma of alcoholics [8,9]. The endogenous opioid system is involved in the modulation of the HPA-axis. Since chronic alcohol abuse influences the activity of the endogenous opioid system, it may also be associated with impaired activity of the HPA axis and consequently increased levels of glucocorticoids. Indeed, excessive alcohol drinking is one of various stressful conditions that result in increased release of cortisol from the adrenal cortex and may be negatively associated with cognitive function [10]. Consequently, changes in HPA-axis activity may influence changes in the behavior towards alcohol use in individuals with alcohol use disorders (AUDs).

The low success rates of alcohol abuse treatment programmes and the high relapse rates are problems of great significance [11]. Substance abuse treatment includes changing deeply imbedded behaviors, involving lifestyle modifications. One lifestyle modification that has been proposed as an adjunct method for alcohol abuse cessation and prevention of relapse in alcoholics is physical exercise [11–14]. This statement is supported by research data indicating that pleasure ratings after exercise are higher compared to drinking alcohol in alcohol dependent patients [15]. Physical exercise is beneficial in many different ways; it enhances mood and psychological wellbeing [16], improves health and wellness, can be cost-effective, flexible, accessible, and have minimal side effects compared to pharmacological treatment [17].

There is limited research on the use of exercise as an adjunctive strategy in treatment programmes of AUDs. Available data from human studies have provided inconsistent results regarding alcohol abuse cessation, whereas fitness gains are more evident. The present study attempts to elucidate physiological responses to chronic exercise in heavy drinkers in order to understand the mechanisms that could potentially make physical exercise a promising tool in the treatment of AUDs.

2. Material and methods

2.1. Subjects

Subjects who participated in this study were recruited through flyers, posters, newspaper press releases, and word-of-mouth recruiting all over the region of Thessaly, Greece. To avoid confusion related to physiological differences between genders, all participants were men.

Exclusion criteria included: serious health conditions or physical disabilities or any other medical condition compromising safe participation in exercise; any person with a history of drug abuse other than alcohol; any person aged sixty and over.

All subjects were informed about the study protocol, the associated risks and benefits, and signed an informed consent form. They were all exhibiting low physical activity, as assessed by the Greek version of the International Physical Activity Questionnaire (IPAQ-Gr) [18], and they were identified as heavy alcohol drinkers by fulfilling at least one of the following criteria: (1) Drinking > 14 drinks/week or 4 drinks per occasion; (2) Drinking 5 or more drinks on the same occasion on each of 5 or more days in the past 30 days; with 1 drink containing 14 g of pure alcohol [19]. Moreover, subjects completed the Alcohol Use Disorders Identification Test (AUDIT, [20]), which is a tool for identifying individuals with hazardous and harmful patterns of alcohol consumption [21]. AUDIT consists of 10 questions (scored individually from 0 = never to 4 = four or more times per week) about recent alcohol use, alcohol dependence symptoms, and alcohol-related problems [21]. Scores from 8 to 15 indicate hazardous drinking, which is a pattern of alcohol consumption that increases the risk of harmful consequences for the user or others [22]. Scores from 16 to 19 suggest harmful drinking, which is a pattern of alcohol consumption that leads to consequences to physical and mental health and maybe social consequences [22,23]. Scores of 20 or above indicate alcohol dependence [21].

After screening, 13 subjects fulfilled the criteria for participation. During the protocol intervention two of them dropped-out; one subject left the programme after completing the first 3 weeks of the protocol intervention due to personal reasons and another one was excluded from the study following the first five weeks of the protocol intervention due to low compliance with the programme. These subjects were identified as heavy drinkers according to the AUDIT and at baseline 4, 3 and 4 had a score of 8–15, 16–19, and 20 or above, respectively (17.45 ± 1.60; mean ± SD). 73% of them were smokers, while no history of other substance abuse was reported. In regards to employment, 27% of the subjects had been employed as professionals or skilled workers, 27% had been employed as unskilled workers, and 46% were university students at the time of enrolment to the study. Concerning personal life, 27% of the subjects were married, 9% were living with a partner, 18% were living with their parents and/or siblings, and 46% were living alone being single. Almost three quarters (73%) of the subjects had secondary education according to the United Nations Educational, Scientific and Cultural Organization [24].

Moreover, baseline measurements were also conducted in a control group (CG), in order to set the normal values of β-E. The CG consisted of 11 matched controls (age: 34.1 ± 2.0 yrs) who were exhibiting low physical activity as well, but did not exceed the limits of moderate alcohol use and had a score of < 8 at the AUDIT. Heavy drinkers and controls were also matched for smoking status; eight subjects in each group were current smokers.

2.2. Experimental design

Medical history was reviewed and a resting electrocardiogram (ECG) was performed on each subject in order to detect any heart abnormalities and contraindications to exercise. The procedures were in accordance with the 1975 Declaration of Helsinki and ethics approval was received from the University of Thessaly review board. This trial was registered at ClinicalTrials.gov as NCT02664766[25].

Before intervention, during a control condition period of 4 weeks all subjects were asked to record their daily alcohol intake while receiving no treatment. Subsequently an 8-week supervised exercise training (ET) intervention was carried out. During this intervention period, all subjects were also asked to record their daily alcohol intake and were motivated to gradually increase the duration and frequency of ET. All measurements of anthropometric, physiological, biochemical and alcohol-related parameters were performed prior to and after the control condition (pre/post) and prior to, after 4 and 8 weeks of the ET intervention (pre/mid/post) (Fig. 1).

2.3. Anthropometric and physiological measurements

Body weight was measured to the nearest 0.1 kg (Tanita Body Fat Monitor/Scale TBF-521; Tanita, Inc., IL, USA), with subjects lightly dressed and barefoot. Standing height was measured to the nearest 0.1 cm (Stadiometer 208; Seca, Birmingham, UK). Percentage body fat was assessed using the bioelectrical impedance analysis technique (Tanita Body Fat Monitor/Scale TBF-521; Tanita, Inc., IL, USA). Blood pressure (BP) was measured with a manual sphygmomanometer (FC-101 Aneroid Sphygmomanometer; Focal Corporation, Japan). Heart rate was monitored by short-range telemetry (Polar RC3 GPS HR; Polar Electro Oy, Kempele, Finland) and was recorded every 5 min during exercise sessions. Body Mass Index (BMI) was calculated by the equation: BMI = (weight in kg) / (height in m)^2. Waist to hip ratio (WHR) was calculated by the equation: WHR = (waist circumference in cm) / (hip circumference in cm). Maximal oxygen uptake (VO_{2max}) was estimated based on a Single Stage Submaximal Treadmill Walking Test