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INTENSE PHYSICAL EXERCISE AND ALCOHOL CONSUMPTION AS AN OXIDATIVE STRESS INDUCER: A REVIEW[1]

INTENSE PHYSICAL EXERCISE AND ALCOHOL CONSUMPTION AS AN OXIDATIVE STRESS INDUCER: A REVIEW

Zenon Ratzlaff Júnior[2], Pauline Brendler Goettems Fiorin[3]

[1] Work developed at the Regional University of the Northwest of the State of Rio Grande do Sul (Unijuí);
[2] Academic of the Bachelor degree in Biological Sciences of Regional University of the Northwest of the State of Rio Grande do Sul (UNIJUÍ), zenon.ratzlaff@gmail.com;
[3] Lecturer, Department of Life Sciences - UNIJUÍ, PhD Student in the Postgraduate Program in Health Sciences (UFCSPA).

Introduction

Regular physical activity is well documented as a useful and effective means of reducing the risk of morbidity and mortality, along with widespread improvements in physical and mental health. Recent evidence suggests that physical activity is important to reduce the risks associated with metabolism disfunction (eg. diabetes), osteopathy (eg. osteoporosis), cardiovascular (eg. coronary artery disease, congestive heart failure, heart attack and stroke) and neurovascular diseases (eg. dementia and Alzheimer's), as well as some cancers (eg. breast, prostate and colon cancer) (AREM *et al*., 2015; MCKINNEY *et al*., 2016; SWAIN & FRANKLIN, 2006). In addition, vidence suggests that the most frequent physical activity is related to the improvement of anxiety, depression and stress-related disorders (AREM *et al*., 2015).

However, in most cases, intense physical exercise (IPE) can lead to cellular and / or tissue damage, such as increased oxidative stress (OS). In addition to IPE, there are other exogenous OS modulating factors, such as alcohol consumption (ethanol - EtOH) exposure (WARD *et al*., 1989).

Excessive alcohol consumption is a condition strongly associated with the development of liver damage. Alcoholic liver disease (ALD) is one of the most serious clinical consequences of chronic alcohol use, accounting for 4% of global mortality (LOUVET; MATHURIN, 2015; MATHURIN; BATALLER, 2015; SINGAL; ANAND, 2013)

To date, several mechanisms underlying the pathogenesis of ALD have been identified (ALBANO, 2008; GAO; BATALLER, 2011; OSNA; DONOHUE; KHARBANDA, 2017). Among these mechanisms, ethanol metabolism and increased OS have been reported to play critical roles in the development of ALD (CEDERBAUM, 2012; CENI; MELLO; GALLI, 2014). Although substantial efforts to explore potential therapeutic targets for ALD have been made for decades, effective therapies for any stage of ALD are still lacking (YUAN *et al*., 2019).

Therefore, this paper presents a review of the practice of IPE and EtOH consumption on the OS

aspect, seeking to support future studies on these factors.

Methodology

In the electronic databases (SciELO and PubMed) the following descriptors were used: oxidative stress intense physical exercise and oxidative stress ethanol. The requirements for the results to be used in the review were that the studies should present the IPE and EtOH as OS inducers, and respect the 30-year timeframe, which covered the period from 1989 to 2019.

For the treatment of the data, a description of the main bibliographic analysis of OS induced by IPE and EtOH was made, focusing on the most relevant results.

Results and Discussion

The development of OS stems from the existence of an imbalance between oxidant and antioxidant compounds, in favor of excessive generation of free radicals or to the detriment of their speed of removal. Such process leads to the oxidation of biomolecules with consequent loss of their biological functions and / or homeostatic imbalance, the manifestation of which is the potential oxidative damage against cells and tissues (HALLIWELL & WHITEMAN, 2004).

During an IPE, total oxygen uptake is increased by approximately ten to twenty times baseline (at rest) consumption. Such changes in oxygen metabolism favor the generation of free radicals and / or non-radical reactive species.

Intense physical activity is capable of generating the species in question by activating at least three major mechanisms: mitochondrial, cytoplasmic, and production of iron and copper ions (KOURY & DONANGELO, 2003). Intense physical activity, due the increase in oxygen consumption, is a factor that predisposes to the generation of oxidizing agents. However, it is also able to promote adaptation mechanisms that reduce oxidative damage caused by the action of such agents. These mechanisms are related to the enzymatic and non-enzymatic defense system (SCHNEIDER & OLIVEIRA, 2004).

Due to the adaptive response mediated by physical activity, the generated reactive species have the action of cellular signalers capable of activating gene regulation pathways related to the expression of specific enzymes and proteins responsible for maintaining the intracellular balance between oxidants and antioxidants agents.

In addition to IPE, there are other exogenous factors that modulate oxidative stress, such as exposure to EtOH.

The effects of EtOH on oxidative stress may be direct or mediated by its secondary metabolites, and its action is mainly reduc plasma or serum levels of antioxidants, including α-tocopherol, ascorbic acid and selenium (WARD *et al*., 1989). EtOH metabolism is directly involved in the generation of reactive oxygen and nitrogen species, as well as in the depletion of antioxidant

system components and increase in specific marker levels, especially malondialdehyde (DAS & VASUDEVAN, 2007).

EtOH catabolism involves enzymatic activities (eg catalase, alcohol dehydrogenase and cytochrome (P450) and naturally produces reactive oxygen species (ROS) (eg hydrogen peroxide, hydroxyl radicals and superoxide free radicals) (HAORAH *et al*., 2008; HIPÓLITO *et al*., 2007; ZAKHARI, 2006). However, excessive ROS production can promote disfunction in the central nervous system (CNS) redox state, impairing DNA, lipid and protein metabolism (BONDY, 1992; COMPORTI *et al*., 2010). Animals chronically intoxicated with EtOH show significant changes in activities of superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx) and glutathione reductase (GR) (AUGUSTYNIAK *et al*., 2005; HERNÁNDEZ *et al*., 2016; ZIMATKIN & BUBEN, 2007).

Conclusion

The practice of IPE and EtOH consumption involves enzymatic actions and naturally produces ROS. However, excessive ROS production can affect CNS redox state, damaging DNA, lipids and proteins, and consequently promote behavioral and cognitive changes. On the other hand, regular exercise and produce antioxidants, which are able of delaying or inhibiting oxidation of the oxidizable substrate. However, even with the immune system responding in this way, it is recommended to practice medium intensity exercise and moderate consumption of EtOH, which, if so, present minimal (oxidative) collateral damage.

The factors described in this review (practice of IPE and EtOH consumption) is a topic addressed in human investigations. However, the researchs with humans is limited when it comes to cell metabolism assessment.In this sense, animal models may be extremely relevant for analysis of cell metabolism and effect of IPe and EtOH consumption.

Keywords: physical activity, ethanol, reactive oxygen species.

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