Chapter 1:

Introduction

Background and Significance

Overtraining is an athlete-specific syndrome characterized by a long term persistent inability to perform at expected optimums even though intense training is being completed.[1,2] It can lead to mood disturbances,[3] tissue inflammation,[4] and an increase in illnesses.[5] Complete rest from the sport is often the prescribed treatment which can take months to years for a full recovery.[6] Overtraining has been found to occur at least once in a large percentage of athletes during their careers,[1] including up to 66 percent of elite distance runners[2] and up to 10 percent of swimmers.[2]

Many biomarkers have been suggested as predictors of overtraining but the only thing previous investigators agree on is that no one clinically-specific predictor has been identified.[7] Additionally, many of the proposed biomarkers require invasive testing and lengthy result turnaround times, leaving significantly decreased athletic performance as the only reliable overtraining predictor.[4,8,9] Athletic staffs (coaches, physicians, trainers, and athletes) would benefit from a clear, rapid, and simple method for clinically predicting the onset of overtraining.

Exercise increases oxygen metabolism and reactive oxygen species (ROS) production. The negative effects of ROS are mitigated by an elaborate antioxidant defense system but oxidative stress occurs when this defense system is no longer able to maintain homeostasis within the body. Oxidative stress has been linked to muscle fatigue and may lead to overtraining.[10] It has been detected in expired air as hexane, pentane, and ethane which result from lipid peroxidation.[10]

Ancient medical practitioners used bodily smells to prescribe treatments for the ill.[11] Electronic nose (enose) technology was designed to mimic the human nose. Enoses are not like other analytical methods that identify specific volatiles present in samples. Instead the main component of an enose is an array of a varying number of sensors, each having a different specificity to a range of volatile molecules.[12] When exposed to a sample, a pattern of all sensor responses, or smellprint, is recorded. To identify an unknown sample, the enose compares the unknown sample's smellprint to stored library of known sample smellprints.

Enose technology has been suggested as a rapid, clear, and simple method for clinically diagnosing overtraining. The enose could also assist in making real-time training regimen adjustments to improve training load optimization. A pilot study found a Cyranose® 320 (C320) enose is able to discriminate between breath smellprints, or breathprints, of athletes after acute training loads.[13]

Study Objective

The objective of this preliminary study was to use data standardization techniques to improve the Cyranose® 320's model for predicting training stresses in breathprints of athletes after experiencing cumulative and acute training loads.

Dissertation Summary

This dissertation will explore the use of a C320 enose to discriminate between breathprints of athletes. The effects of cumulative (competitive training season) and two acute (low intensity and high intensity) training loads on mood state, blood antioxidant enzyme activity levels, and volatile organic compounds (VOC) in the breath were observed in athletes actively involved in a collegiate long distance running program. Chapter 3 focuses on the changes in mood and oxidative stress states in the athletes. Chapters 4, 5, and 6 focus on the breath volatiles. Chapter 4 explores the use of a baseline sensor purge sample as a direct method for standardizing breath data. Chapter 5 explores the use of different mathematical techniques for standardizing breath data. Chapter 6 uses the selected data standardization technique to review the C320's specificity for discriminating between VOCs in the breath of long distance runners as a result of different training loads. Appendices A and B present two Standard Operating Procedures (SOP) developed for use with the C320 unit. Appendix C presents the Institutional Review Board (IRB) approval of the study protocol which can be found in Appendix D. Appendix E presents the subject consent form while Appendix F presents the Profile of Mood States (POMS) survey. The pre-study questionnaire is presented in Appendix G and a detailed summary of subject responses to this questionnaire is presented in Appendix H.

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