Reduced Maximal Oxygen Consumption and Overproduction of Proinflammatory Cytokines in Athletes

Mauro Vaisberg a  Marco Tulio de Mello b  Marília Cerqueira Leite Seelaender d
Ronaldo Vagner Thomatieli dos Santos c  Luis Fernando Bicudo Pereira Costa Rosa d, †

Departments of a Medicine and b Psychobiology, and c Department of Health Sciences, Baixada Santista Campus, Federal University of São Paulo, and d Department of Histology and Embryology, Institute of Biomedical Sciences, University of São Paulo, São Paulo, Brazil

Key Words
Physical training · Maximum oxygen consumption · Hormone production · Proinflammatory cytokines

Abstract
Objective: It was the aim of this study to evaluate whether chronic pain in athletes is related to performance, measured by the maximum oxygen consumption and production of hormones and cytokines. Methods: Fifty-five athletes with a mean age of 31.9 ± 4.2 years engaged in regular competition and showing no symptoms of acute inflammation, particularly fever, were studied. They were divided into 2 subgroups according to the occurrence of pain. Plasma concentrations of adrenaline, noradrenaline, cortisol, prolactin, growth hormone and dopamine were measured by radioimmunoassay, and the production of the cytokines interleukin (IL)-1, IL-2, IL-4, IL-6, tumor necrosis factor-α, interferon-α and prostaglandin E2 by whole-blood culture. Maximal oxygen consumption was determined during an incremental treadmill test. Results: There was no change in the concentration of stress hormones, but the athletes with chronic pain showed a reduction in maximum oxygen consumption (22%) and total consumption at the anaerobic threshold (25%), as well as increased cytokine production. Increases of 2.7-, 8.1-, 1.7- and 3.7-fold were observed for IL-1, IL-2, tumor necrosis factor-α and interferon-α, respectively. Conclusions: Our data show that athletes with chronic pain have enhanced production of proinflammatory cytokines and lipid mediators and reduced performance in the ergospirometric test.

Introduction

High-performance athletes are subjected to strenuous training and competition routines and are therefore highly susceptible to muscle injury [1]. Some of these injuries are caused by trauma, but those related to overuse make up the largest percentage requiring medical treatment [2]. When prolonged, excessive training stress is associated with inadequate recovery, musculoskeletal lesions as well as performance decrements, and chronic maladaptations are likely to occur [3]. The link between lesions and underperformance has only been established in states of overtraining syndrome [4].

The underperformance syndrome can be associated with the overtraining syndrome or even with a state of overreaching [4]. As with any other syndrome, many signs and symptoms are associated with the state of overtraining. Among these are neuroendocrine disturbances, muscle pain, alteration in mood state and a decrease in performance. The latter is the only alteration that is present in all studies on overtraining [4]. There are many hy-