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Itaperuna, Brasil

Available in: http://www.redalyc.org/articulo.oa?id=93001204
The Overtraining Syndrome: Neuro-endocrine Imbalances in Athletes

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Submitted for publication: may 2007
Accepted for publication: june 2007

Abstract

HACKNEY, A. C.; BATTAGLINI, C. The Overtraining Syndrome: Neuro-endocrine imbalances in athletes. Brazilian Journal of Biomotricity. v. 1, n. 2, p. 34-44, 2007. The purpose of this review paper is to present a brief overview of the neuro-endocrine imbalance hypotheses associated with the development of the Overtraining Syndrome in athletes, and to discuss mechanisms for treating-preventing of the syndrome condition. The intent of the paper is to provide background knowledge and information primarily for allied health professionals, coaches and athletes who pursue the enhancement of human performance; but, who may have limited sports medicine educational background. Specific topics addressed are: (a) defining what the Overtraining Syndrome is, (b) how athletes develop the Overtraining Syndrome, (c) neuro-endocrine hypotheses as to the development of Overtraining Syndrome development, (d) treatment and prevention of the Overtraining Syndrome.

Key words: Hormones, Dysfunction, Sportsmen, Training
Introduction

There are many factors that contribute to the improvement of human performance in sporting events. Present day coaches working with athletes have more knowledge because of advances in the fields of sports medicine and coaching pedagogy. Sporting equipment changes have also led some improvements in certain select events. It is generally accepted, however, that the principle cause for the contemporary improvement in human performance is the level of exercise training that athletes are undergoing, particularly within events that require high levels of endurance capacity or superior physical conditioning (RAGLIN & BARZDUKAS, 1999). Some exercise scientists who study sporting events have estimated that the exercise training loads of athletes have increased on average by 20-25% over the past decade (KUIPERS & KEIZER, 1988; RAGLIN & BARZDUKAS, 1999).

Limits exist, however, to the human body’s ability to adapt and endure intense exercise training for sport. Once this adaptation threshold is exceeded, the body fails to improve appropriately, and physical - mental performance tends to decline. Investigators estimate that 10 to 20% of all elite level athletes who are involved with intensive sports training programs may fall prey to the disorder referred to as the “Overtraining Syndrome” (sometimes also referred to as “Staleness” by psychologists) (LEHMANN et al, 1999; RAGLIN & BARZDUKAS, 1999). Athletes who suffer from the Overtraining Syndrome are typically not able to train at their desired or prescribed level, and their sporting performance is compromised and degraded. Moreover, they suffer a variety of psycho-physiological symptoms that severely affects their personal life and emotion-physical well being.

In many countries around the world athletes are maintaining their competitive years well beyond their early adulthood because lucrative professional and semi-professional contacts allow them to support themselves adequately. This occurrence has increased the likelihood of allied health professionals encountering athletes in their clinical practice who may have been training at high intensive levels for a number of years; thus, they are more susceptible to the development of the Overtraining Syndrome. Unfortunately, not all allied health professionals or coaches receive adequate education the areas of sports medicine and in particular exercise endocrinology related to the syndrome. Therefore, the specific purpose of this brief review paper is to consolidate some of the research information on the topic of Overtraining Syndrome, specifically related to the neuro-endocrinology area and thus provide background for allied health professionals. Furthermore, while there has been extensive research published on the Overtraining Syndrome, the information is in some cases conflicting, contradictory and, or confusing. Thus, an additional purpose of this paper is to try and clarify some the ambiguity within this research literature. Key points to be addressed in this paper are:
I. to present a working definition of the Overtraining Syndrome and its symptoms;
II. explain the developmental causes of syndrome;
III. overview the neuro-endocrine hypotheses addressing the potential causes of the syndrome; and finally,
IV. discuss mechanisms for treating and preventing the condition.

- Overtraining Syndrome – Working Definition

Part of the confusion which exist in this area of research stems from the fact there is a lack of consistent and precise terminology. The terms Overtraining Syndrome and Overtraining are frequently used interchangeably. It is highly advisable to reserve the used of the term "Overtraining" for referring to the process of heavier than usual exercise training. The term "Overtraining Syndrome" should be reserved for referring to the product of the overtraining (or overreaching training [see below]) process (KUIPERS & KEIZER, 1988; HACKNEY et al., 1990; LEHMANN et al., 1993; LEHMANN et al., 1995; KENTTÄ & HASSMEN, 1998). The Overtraining Syndrome is a pathological disorder, where there is consistent and persistent exercise performance incompetence in an athlete that does not reverse itself after a few days of rest and recovery. Furthermore, there is no underlying medical reason or explanation for the finding of declining performance. That is, the athlete has no overt illness to medically treat. This exercise performance impairment associated with the syndrome can manifest itself within athletic competition as well as during training. Furthermore, the decline in physical performance is usually followed by a host of other psycho-physiological consequences that initiate the development of a series of different symptoms that can further attenuate performance and the health of the athlete. Some of those most general and commonly reported consequences – symptoms are listed in Table 1.
- Overtraining Syndrome - Cause of Development in Athletes

The physiological cause to the Overtraining Syndrome is already known - the exercise training load placed upon an athlete is too great (GALBO, 1983; MORGAN et al., 1987). To be precise, the athlete is being exposed to a stress level that exceeds their ability to adapt. Conceptually this view is modeled after Selye’s “General Adaptation Syndrome”. While the cause of the syndrome is recognized, however, it is difficult to determine on an individual basis what too much stress is.

Normally, exercise training load refers to the dosage to which the athlete is exposed. Such dosage is a function of exercise "intensity", "frequency", and "volume" of activity performed by the athlete. Exercise intensity refers to the degree to which the exercise is performed in relation to athlete's maximal aerobic capacity (VO$_{2\text{max}}$). Frequency is the number exercise sessions performed on a daily and weekly basis (e.g., it is not uncommon for athletes to train more than once a day, 7 days per week). Volume is the amount of time spent in conducting training. Typically, athletes have their training load adjusted and modified based upon their periodization training plan (i.e., periods of training – preparatory, competitive, and transitory periods; physical fitness level; health status; and levels of competition significance – levels I-V [Olympic Games/Olympic qualifiers, National competitions, State competitions, Regional competitions, and local events]). This modulation of training load is essential in bringing about the desired adaptive physiological and psychological responses in the athlete, which are critical for improved performance.

A training load can be of an “underload” nature, which does not lead to an improved athlete performance but allows only maintenance or in some cases an
actually decline in performance. A training load can be of an “Overload” nature, which research says is necessary to bring about an improved performance. There is also the “Overreaching” training load. This is considered a short-term excessive training overload and can actually result in a transient decline in physical performance. However, overreaching is usually administered for a very short period of time and is followed by reduced training in hopes of achieving super-compensation, and its level of excessiveness is slight. Some coaches and exercise scientists feel that short periods of overreaching are necessary in a training program to result in a super-compensation which allows the athlete to reach higher levels of competitive performance. In contrast, "overtraining" is a training load that is extremely excessive and results in large more permanent performance decline. It should be noted that overreaching could become overtraining if it is administered for too long a period or at too large of a load increase.

It is critical that other forms of stress must also be considered in the life of an athlete besides that of training load alone. Athletes may experience many psycho-social stresses within their educational, personal relationships, occupational, and financial situations (MORGAN et al., 1987). There is as well the stress of traveling to competitions, perhaps competing too frequently, environmental factors, medical conditions, and poor dietary practices (MORGAN et al., 1987; LEHMANN et al., 1995). All of these factors combine to add to the total stress placed upon the athlete and in so doing can impact the effect of the training plan on the desired overall performance outcome. Thus what may have been an appropriate "overload" training dosage could become excessive when combined with the influence of other daily stresses being placed upon the athlete’s physiology.

- Neuro-endocrine Theories – “Hyper-arousal vs. Hypo-arousal States”

Researchers have theorized that the Overtraining Syndrome may actually be a disorder with more than one distinct form or state (KUIPERS & KEIZER, 1988; KENTTÄ & HASSMÉN, 1998; LEHMANN et al., 1999). Current literature proposes two discrete neuro-endocrine varieties for the development of Overtraining Syndrome – a hyper-arousal and hypo-arousal. This conclusion is based upon the finding that in certain physiological parameters diverging symptomology exist.

The hyper-arousal form is also referred to as the “sympathetic” or “Basedow’s” Overtraining Syndrome. It is commonly observed in “power” athletes (e.g., sprinters, weight lifters) and occurs less frequently than the hypo-arousal disorder (LEHMANN et al., 1999). The hypo-arousal form is more common and is also referred to as “parasympathetic” or “Addison’s” Overtraining Syndrome. This form of the disorder is frequently observed in endurance trained athlete (e.g., long distance runners, rowers, swimmers).

Each form of the disorder has some similar characteristics and symptoms (i.e., in particular declining physical performance); but, there also are obvious psycho-physiological differences. The similarities and differences are
It should be noted, that it is still an issue of debate as to whether the neuro-endocrine manifestations of the syndrome are causative factors or symptomology of other etiologies. The current state of research endeavors do not allow for a definitive distinction to be made at this time on that question. Nevertheless, neuro-endocrine disturbances are frequent findings in the athletes who suffer from this syndrome. The reader is directed to select articles by KUIPERS & KEIZER (1988), HACKNEY et al. (1990), FRY & KRAEMER (1997) and SMITH (2000) which discusses in detail other potential hypotheses associated with the development of the Overtraining Syndrome. In particular, some of the recent work by SMITH (2000) linking overtraining, the immune system and the neuro-endocrine system presents highly interesting and promising perspectives on the topic.

- Treatment of the Overtraining Syndrome

Athletes who develop the syndrome can expect to have their competitive season seriously disrupted, if not completely compromised. Current evidence suggests there is no known effective treatment of the disorder other than "rest from training". The amount of rest necessary to restore and regenerate the athlete is an issue of dispute among researchers. Recommendations vary from a few weeks to a few months (KUIPERS & KEIZER, 1988; HACKNEY et al., 1990; FRY et al., 1991; SHEPLEY et al., 1992; HOOPER et al, 1993; FRY & KRAEMER, 1997; KENTTÄ & HASSMÉN, 1998). Furthermore, there is disagreement as to whether this rest period should involve total inactivity or if some degree of recreational activity (unrelated to the athletes’ sport) should be allowed. Members of an U.S. Olympic Committee expert panel who studied
overtraining have recently recommended that the latter is a better approach (RAGLIN & BARZDUKAS, 1999). This is a debatable issue, however, and much further research is necessary to clarify this issue.

Drug therapy and intervention are advocated by some clinicians as a means of dealing with the syndrome, and thus perhaps shortening the time spent resting and being away from sport. Some of the drug agents recommended have been anabolic steroids, anti-depressants, beta-blockers, and 5 HT blockers depending upon the form of the condition an athlete may display. Each of these pharmacological agents could theoretically treat some of the symptoms and physiological changes associated with the Overtraining Syndrome and; thus, facilitate the recovery process of an athlete suffering from the syndrome.

Such an approach, however, has serious ethical and legal considerations. The governing bodies of sports (e.g., International Olympic Committee) could consider the usage of some of these pharmacological agents as potential “doping” violations. The use of such agents even for medical purposes under certain circumstances could result in the athlete being placed on competitive probation or even banned from competition. Thus, their use should be carefully considered by the coach, athlete or allied health professional attempting to treat for the Overtraining Syndrome.

Even placing ethical – legal consideration aside for a moment, the use of these therapies may produce side effects or suppress the underlying pathology of the Overtraining Syndrome to the extent that it may lead to a more refractory disorder. In other words, treat the symptom without treating the cause. Accordingly, at this time the most practical, safe and effective recommendation for the treatment of the Overtraining Syndrome is a prolonged period of rest.

- Prevention of the Overtraining Syndrome

The above discussion of treatment suggests there is little that can be done as an intervention once an athlete develops the syndrome. Consequently, the best treatment for Overtraining Syndrome is prevention. It is the job of the coach, athlete and allied health professional to work together proactively to prevent this condition from occurring (VIRU & VIRU, 1997). There are several basic principles which should be followed to lessen the likelihood of an athlete to develop the syndrome.

First, it is critical that the signs and symptoms of overtraining be readily known by anyone working with an athlete. Anytime that any of these characteristics are noted, careful observation and scrutiny of the athlete is necessary (see Table 1). Detection is difficult, because many of these symptoms may appear almost daily due to the rigors of training. However, when symptoms persist for several days continuously, and are not abated by a day of rest, drastic alteration of a training program may be necessary. Observation should be reinforced by frequent and regular medical evaluations, which can ensure that the athlete is healthy and able to deal with the training load prescribed for them.
Secondly, it is necessary to develop and implement a “well designed, realistic, and scientific based, periodization training plan”. Such a plan must go through constant monitoring and evaluation to minimize the amount of monotonous training, incorporate variations within the training methodology, and make certain that weekly training load increases do not exceed approximately 10% (AMERICAN COLLEGE OF SPORT MEDICINE, 2006). The periodization plan must be designed to make certain that necessary rest and recovery from training is precisely incorporated not only during weekly macrocycles, but appropriate amounts are given to the athlete to fully recover during the transitory period of training, prior to the beginning of the next cycle of competitions (FRY et al., 1991; FRY & KRAEMER, 1997).

Thirdly, it is essential that proper nutrition and hydration be maintained at all times. Athletes can lead busy life-styles and may not allow themselves the time to maintain proper diets. Therefore, athletes should be constantly encouraged to eat and drink what they need, and a key macro-nutrient requirement within the diet is carbohydrate (COSTILL et al., 1991). It is also essential that caffeine and alcohol-based drinks (which are diuretics) are not excessive as they defeat the goal of maintaining adequate hydration.

Finally, interactive coaching is also a necessary principle in the prevention of the Overtraining Syndrome. This means that coaches must talk to their athletes about how they are feeling and about any problems they are having in their lives which could generate "other stresses". Professor John Raglin of the USA has demonstrated that the psychological disturbances associated with the Overtraining Syndrome tend to manifest themselves earlier than do the physiological symptoms (RAGLIN et al., 1996). If the coach talks to their athlete they may be able to detect coping problems before they become serious and affect physiological capacity. While the coach needs to listen to the athlete, it is also important that the athlete listens to his or her own body and acknowledges to the coach when they are feeling overly fatigued, unmotivated, or just tired; and, not feel such an admission is a sign of weakness. The coach then needs to evaluate the athlete, take into account their feelings, and adapt their training accordingly. Table 3 summaries these points mentioned above.
TABLE 3 - Steps to the prevention of the Overtraining Syndrome in athletes.

⇒ Coaches should devise careful training programs (e.g.)
   - monitor training load constantly
   - avoid monotonous training
   - use a periodization plan
   - increase training load no more than 10% per week
   - incorporate adequate rest and recovery

⇒ Athletes should have frequency medical evaluations
⇒ Athletes should maintain proper nutrition
⇒ Athletes should maintain proper hydration
⇒ Coaches should employ interactive coaching style
⇒ Athletes should listen to their body

Conclusion

In conclusion, the research on the Overtraining Syndrome is at best confusing and contradictory. Further, extensive research is necessary on many aspects of this topic. Perhaps the development of other clinical assessment protocols, using blood markers in combination with the suggested protocols mentioned in this manuscript, may facilitate Overtraining Syndrome diagnosis and possibly the development of a minimal necessary treatment timeline for an athlete to resume training and competition. Our laboratory has already initiated studies where blood markers have been explored as means to further understand the syndrome, and to create a clinical tool to assist coaches and athletes in the prevention and diagnosis of Overtraining Syndrome. Hopefully allied health professionals, coaches, and athletes will work together to tackle this complex problem, so that athletes can safely continue to train and pursue their goals of breaking records and pushing the limits of human performance.

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