Overtraining in Elite Athletes
Review and Directions for the Future

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Contents

Summary .................................................................................................................. 79
1. Definition of Overtraining, Over-Reaching and Staleness .................................. 80
2. Clinical and Laboratory Findings in Overtraining .............................................. 81
   2.1 Over-Reaching and Short Term Overtraining .............................................. 81
   2.2 Clinical Features of Staleness ................................................................... 82
   2.3 Exercise Testing, Laboratory Findings and Staleness ................................. 83
   2.4 Diagnosis of Overtraining ....................................................................... 84
   2.5 Factors That Contribute to Overtraining ................................................... 85
   2.6 Prevention of Overtraining ...................................................................... 86
   2.7 Treatment of Overtraining ...................................................................... 87
3. Hormonal Factors and Overtraining .................................................................. 87
   3.1 Mechanisms of Overtraining Syndrome ..................................................... 88
   3.2 The Exercise-Abstinence Syndrome .......................................................... 89
4. Conclusions and Directions for Future Research .............................................. 90

Summary

Overtraining is an imbalance between training and recovery. Short term overtraining or 'over-reaching' is reversible within days to weeks. Fatigue accompanied by a number of physical and psychological symptoms in the athlete is an indication of 'staleness' or 'overtraining syndrome'. Staleness is a dysfunction of the neuroendocrine system, localised at hypothalamic level. Staleness may occur when physical and emotional stress exceeds the individual coping capacity. However, the precise mechanism has yet to be established. Clinically the syndrome can be divided into the sympathetic and parasympathetic types, based upon the predominance of sympathetic or parasympathetic activity, respectively. The syndrome and its clinical manifestation can be explained as a stress response. At present, no sensitive and specific tests are available to prevent or diagnose overtraining. The diagnosis is based on the medical history and the clinical presentation. Complete recovery may take weeks to months.

Although sports medicine has made considerable progress in recent years, many questions still remain. For example, knowledge about physiological mechanisms involved in training adaptations is still incomplete, and for coaches and athletes more questions remain than scientists can answer. Physical exercise causes a disturbance of homeostasis in cells and organs, which may result
in decreased mechanical output and fatigue. In the recovery phase homeostasis has to be re-established. The regenerative processes still continue after restoration of the previous homeostatic situations, which results in an overcompensation or supercompensation (Harre 1973; Viru 1984). Ideally, subsequent training should not take place until supercompensation has occurred (Harre 1973). Most sports require a large volume of training at high intensity, which increases the risk of overtraining and the accumulative effect of fatigue (Michael 1961). It is the art of coaching to provide the optimal amount and intensity of training without exceeding the athletes' exercise tolerance and recovery capacity. However, unanticipated premature fatigue that affects performance is commonly observed.

Chronic fatigue and overtraining in the athlete is a major problem for coaches. Since overtraining often occurs in the preparation phase of important competitions, many athletes have the bitter experience of a completely wasted season. In spite of its frequent occurrence, the pathophysiological mechanisms of fatigue and overtraining are far from clear. Researchers have only recently become interested in recovery, mechanisms of adaptation and overtraining, which may explain why most of the articles about overtraining published to date have been in scientific journals.

In this article we intend to review the available data on fatigue and overtraining and will discuss the proposed pathophysiological mechanisms.

1. Definition of Overtraining, Over-reaching and Staleness

In athletic training, workloads are gradually increased, thereby exceeding the previously employed workload. This 'overload principle' is an important component of modern training and is considered to provide an optimal stimulus for adaptation (Harre 1973). When the overload is too great and recovery and adaptation do not occur within the anticipated time, the athlete is overtraining or 'over-reaching'. With decreased training complete recovery and supercompensation will usually occur within 1 or 2 weeks in over-reached or overtrained athletes. When the imbalance between training and recovery exists for a longer period of time, the athlete is continuously overtraining. At an early stage, overtraining is only reflected by increased fatigue and decreased performance, but with accumulation of fatigue other objective and subjective symptoms appear and we may speak of 'overtraining syndrome' or 'staleness'. Complete recovery from staleness may take weeks or months.

In this review we will use the term 'over-reaching' for mild, short term overtraining, while 'staleness' or 'overtraining syndrome' is used for severe overtraining which is accompanied by a number of physical and psychological symptoms (Councilman 1955) [see Glossary of Terms].

No uniform terminology is used in published studies of overtraining. Confusion arises because most investigators do not discriminate between the process of overtraining and the outcome, which may be over-reaching or staleness. The general term 'overtraining', and the more specific terms 'staleness' and 'overtraining syndrome' are often used synonymously (Eegeraat 1986; Riedman 1950). The term 'staleness' is used only in American studies and is synonymous with 'overtraining syndrome' (Wolf 1971). In Europe the term 'overtraining' is used for staleness or overtraining syndrome. Overtraining can be considered a general term expressing an imbalance between training and recov-

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<th>Glossary of Terms</th>
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<td><strong>Overtraining and physical overstrain</strong> General term for any short term or long term condition in which there is an imbalance between exercise and recovery, resulting in severe and prolonged fatigue.</td>
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<td><strong>Muscular overstrain</strong> Exercise exceeding the muscular stress tolerance, resulting in transient local fatigue and muscle soreness.</td>
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<tr>
<td><strong>Overtraining syndrome or staleness</strong> Chronic overtraining resulting in the occurrence of behavioural, emotional and physical symptoms.</td>
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<td><strong>Over-reaching</strong> Short term overtraining, sometimes resulting in a mild form of staleness.</td>
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