Overtraining remains one of the most controversial topics within the field of strength and conditioning, as it accounts for increased fatigue and can result in performance impairment. One of the many topics that persists among strength and conditioning professionals is the topic of overtraining. A common question that is asked is how does overtraining differ from overreaching? Additionally, some may even question the very existence of overtraining. Although the prevalence of overtraining varies considerably among a variety of sports, the overall occurrence of actual overtraining seen in normal day-to-day resistance trained individuals is very low (11,17,22). The purpose of this article is to address the implications of overtraining and overreaching, the recovery process, signs and symptoms of overtraining, how resistance training and supplementation can affect these outcomes, and future directions within the topic of overtraining.

Understanding the importance of recognizing overtraining is essential because there are numerous physiological conditions that can lead to overtraining. For example, research has reported that individuals participating in endurance training for many hours at a time have been shown to have an overactive pituitary gland, which may result in increased levels of cortisol and a disruption in muscle growth (15). Overtraining is a multifactorial, complex phenomenon. Overtraining is typically discussed in terms of only training; however, a very important and sometimes neglected aspect of training is the recovery process. Another useful way that strength and conditioning professionals might refer to and think of overtraining is “under recovery,” (12). Therefore, attention must be given to the process of recovery.

OVERTRAINING SYNDROME VERSUS OVERREACHING

What is the definition of overtraining syndrome (OTS)? There is currently no single agreed-upon definition of overtraining syndrome; however, a number of alternatives have been used. Halson and Jeukendrup have provided a definition of overtraining as:

“An accumulation of training and/or non-training stress resulting in long-term decrement of performance capacity with or without related physiological and psychological signs and symptoms of overtraining in which restoration of performance capacity may take several weeks or months,” (6).

How does overtraining differ from overreaching? According to Meeusen et al., overreaching is defined as:

“An accumulation of training and non-training stressors that result in a short-term decrement in performance capacity with or without related physiological or psychological signs and symptoms of maladaptation in which restoration of performance may take ranging from days to several weeks to recover,” (14).
These definitions of overtraining and overreaching are nearly identical. One of the only differences is the amount of time to restore performance, not the type or duration of the training stress. Another difference is that overreaching may take several days to several weeks to recover, whereas overtraining likely takes several weeks to several months (6,14).

**RECOVERY AND TRAINING**

Recovery is a fundamentally important process to the overall training program and is vital for maximal performance benefits. If the rate of recovery is enhanced, greater training volumes and intensities are achievable without consequential overtraining (2). Although many strength and conditioning professionals often use different approaches for this process, recovery may not always be addressed fully, particularly in the area of fatigue. Strategies for optimal recovery exhibit individual variability that depends on the type of fatigue (e.g., central or peripheral), training history, and ability to cope with other potential stressors (e.g., emotional or psychological).

Recovery can be defined as the ability to meet or exceed performance in a particular activity (2). Typically, training sessions produce a level of fatigue or depletion that is followed by supercompensation. If the recovery intervals between training bouts are maximized, the next training session will accompany supercompensation and performance may be enhanced (23). There are also other important functions that coincide with recovery, particularly after exercise, including restoration of physiological functions and replenishment of energy sources (9). However, an individual should achieve a balance where adaptation and recovery takes the athlete to supercompensation and may lead to a more physically conditioned state.

The onset of recovery develops during and after exercise. This is exhibited by the removal of metabolic end products such as lactate. Throughout exercise, recovery is crucial in order to restore blood flow, not only for the delivery of oxygen which stimulates adenosine triphosphate (ATP) resynthesis, but also for the recovery of muscle membrane potential, and to reestablish intramuscular pH (20). Furthermore, a greater increase in excess post-exercise oxygen consumption (EPOC) occurs.

Initial recovery, referred to as “immediate recovery,” occurs throughout exercise. Bishop et al. provides an example of a race walker with one leg in immediate recovery between each stride (2). During this immediate recovery period, the lower extremities regenerate ATP. If each leg recovers more rapidly, the walker will more quickly be able to accomplish the stride with efficiency. The second type of recovery is termed “short-term recovery.” This method of recovery generally takes place between exercise sets or between interval training bouts (18). The final form of recovery is referred to as “training recovery,” which is characterized by the recovery between various training sessions or athletic competitions (2). If individuals engage in continuous training (e.g., multiple training sessions in the same day or multiple events in a single competition) without an adequate recovery period, then performance impairments are more likely to occur (2,18). As a result, the individual is unlikely to be prepared for the subsequent training bouts. Overtraining is most often related to the form of training recovery.

**SIGNS AND SYMPTOMS OF OVERTRAINING**

The onset of overtraining develops due to a specific training schedule or more particularly, a sequence of training bouts that is abruptly increased, exists for an extended period of time, and/or exhibits high volume or high-intensity exercises with inadequate recovery and regeneration time. The responses to overtraining are usually characteristic of fatigue, stress, and exhaustion. The extent to which specific training loads induce overtraining is uncertain. Additional training loads and insufficient recovery can be the primary factors for the occurrence of overtraining. Notwithstanding, it would be incorrect to assume that training load and inadequate recovery account for every circumstance of overtraining, as it is important to consider other factors that may be involved, such as nutrition, sleep, illness, overall health, and emotional or physical stress.

A decrease in performance is often the hallmark of an overtrained athlete. However, the level of performance impairment that has to occur in order to classify one as overtrained is currently unknown. Other common characteristics of overtraining include a change in the role of exercise-induced immunosuppression as well as an increased incidence of illness, particularly in the upper respiratory tract (e.g., upper respiratory tract infection [URTI], swollen lymph glands, flu-like symptoms, bruising, and decreased recovery) (6,13).

Even highly trained individuals may be vulnerable to illness or injury as a result of a sudden increase in training volume or intensity. This timeframe of immunosuppression is known as the “open window,” as an individual is more susceptible to infections or injury directly after and throughout various stressors (15). The open window is described as a period of 3 – 24 hr after prolonged endurance training when host defense is reduced and more susceptible to URTIs (15). Therefore, any accelerated increase in training volume or training intensity can compromise the exercise-induced immune system response.

Early reports have listed more than 90 different signs and symptoms that have been reported from overtrained athletes (4). Below are just some of the more common physiological and psychological factors from recent reports (5):

1. Muscle weakness and soreness
2. Decreased exercise performance
3. Decreased appetite
4. Reduction in quality and/or quantity of sleep
5. Gastrointestinal abnormalities
6. Increased risk of infection
7. Increased resting heart rate
8. Increased time required for recovery
9. Decreased desire to train
RESISTANCE TRAINING AND OTS

The fundamental nature of resistance training programs should be designed to incorporate a specific and selective combination of variables including choice of exercise, sequence effect, training intensity or load, training volume, and rest intervals. As mentioned previously, the two principle factors that induce overtraining are training volume and intensity (1,3). It is common for beginning and intermediate trainees to accumulate large amounts of training volume and increase the magnitude of training intensity early in their programs, which also may lead to them extending the period before adequate recovery can be achieved. Research suggests that excessive training volumes usually produce a reduction between the testosterone-to-cortisol ratio, which may lead to performance declines (1). This ratio is believed to show the balance of action between anabolic and catabolic activity. However, recent research suggests that cortisol is not entirely a negative aspect, but may actually depict a quality training session, and that acute cortisol is more related to anabolism after weight training (21). It should be noted that it becomes a challenge to formulate any conclusions regarding alterations in hormonal levels due to various performance assessments and modifications in training intensity and length.

SUPPLEMENTATION

Protein and amino acid supplementation are believed to protect against many harmful effects of overtraining. Research has reported that adding protein to a moderate carbohydrate meal stimulates glycogen synthesis and increases exercise performance after an initial exercise session, compared to a moderate carbohydrate-only meal (7,8). In addition, evidence shows that supplementing with amino acids attenuated performance reductions in the bench press and squat during periods of overtraining (16). In addition, creatine supplementation has been shown to be effective for maintaining muscular performance during the initial phase of overreaching using high-volume resistance training (19).

IDENTIFYING AND MEASURING OVERTRAINING

It is imperative that strength and conditioning professionals have the ability to identify and anticipate the onset of overtraining so they can reduce its negative effects or potentially avoid it altogether. One instrument that can assist in identifying the onset of overtraining is the Profile of Mood States, which serves as an easy assessment for early markers of overtraining. In addition, the concept of total quality recovery focuses attention of the relationship between training and recovery, and can be very useful to consider (17). Keeping this aspect in mind is essential in designing effective training programs and promoting strategic recovery. Lastly, the Recovery-Stress Questionnaire for Athletes can be used, which acknowledges the recovery stress conditions based off several different general and specific recovery scales (10). Professionals should investigate these tools and learn how to utilize them properly before implementing them with any potential clients or athletes.

CONCLUSION

Many questions currently remain about identifying the aspects of overtraining. However, it is clear that additional research is warranted to explain the complicated nature of overtraining. During all training programs, the recovery period should be tailored to the needs of the individual in order to determine the period of time needed to elicit optimal recovery.

The following questions provide some awareness and direction for future research into overtraining:

• Is there a general and/or specific timeframe by which changes in performance occur to assist in detecting signs of overtraining?
• Is there a threshold for a specific training volume or intensity required to induce overtraining?
• What detrimental performance measures occur through training, which would better identify overtraining (i.e., in-season, off-season)?
• To what degree do protein and amino acid supplementation play a role in reducing the overtraining response?
• Are there similarities and differences that exist between and within a variety of sports?
• Are there gender differences when it comes to overtraining?

Although it may be difficult to answer these important questions regarding overtraining and overreaching currently, acknowledging and seeking solutions to these questions can serve as a model and guide in helping to reduce or even prevent overtraining.

REFERENCES


**ABOUT THE AUTHOR**

Jonathan Mike is in the final stages of completing his PhD in Exercise Physiology from the University of New Mexico in Albuquerque, NM. He received his Bachelor’s and Master’s degrees in Exercise Science from Western Kentucky University in Bowling Green, KY while also serving as a Strength and Conditioning Assistant. He also worked at the University of Louisville as a Strength and Conditioning Assistant and has been a frequent contributor and guest host of several websites and radio shows. He is a member of the National Strength and Conditioning Association (NSCA) Exam Development Committee for the NSCA-Certified Personal Trainer® (NSCA-CPT®), Job Analysis Committee, and a member of the Personal Trainers Special Interest Group (SIG). Mike has authored or coauthored various works related to sports nutrition and strength and conditioning. Further, he has been published in the Strength and Conditioning Journal and has both authored and coauthored multiple book chapters in areas of sports nutrition and strength training and conditioning. His research interests include strength and power development, functional movement, exercise and energy metabolism, and areas of sports nutrition. In addition, he writes for numerous fitness and bodybuilding consumer magazines and outlets.