Over-training

Grant Harrison MSE, CPT

In any sport, athletes are typically imposing great amounts of stress upon their bodies in order to improve. The stresses of training induced on the body are cumulative and can be detrimental before leading to improvements. Diet, sleep, emotional and psychological stress and other life stresses all add to the total stress of an individual. Ideally, we are able to balance the stresses these stresses and avoid over-training. Before diving too deep into over-training, it is important to examine what it means to be over-trained, compared to similar but less severe conditions.

Before over-training can occur, an athlete must first go through a progression of other conditions. These conditions could happen at any point during the training cycle and are all relative to the previous state of training. From baseline fitness, an athlete must first "over-reach" or push beyond a given previously demonstrated performance evaluative. Over-reaching is defined as an accumulation of training and/or non-training stress resulting in short-term decrement in performance with or without related physiological and psychological signs and symptoms of over-training in which restoration of performance capacity may take several days to several weeks (Kreider, Fry, & O'Toole, 1998). Over-reaching is something athletes strive to do in order to make improvements, where the nature of the stimulus determines how and if the athlete is able to recover and function at a higher level. Functionality is a key word here as over-reaching can be further broken down into two categories: functional over-reaching and non-functional over-reaching. Functional over-reaching is accompanied by a "super-compensation" effect whereby a period of intensified training with adequate recovery elicits an increase in physiological and/or performance parameters. Given prolonged intensified training without adequate recovery, super-compensation may not occur and thus lead to no actual improvement, also known as non-functional over-reaching.

Non-functional over-reaching may have very few indicators. However, a steady decrement in performances may be one of many indicators of overtraining. Although over-training may occur in a short amount of time, longer-term over-training or over-training Syndrome (OTS) is defined as "As accumulation of training and/or non-training stress resulting in a long term decrement in performance capacity, either with or without related physiological signs and symptoms. Restoration of performance capacity may take several weeks to several months" (Kreider, Fry, & O'Toole, 1998) Perhaps the most practical way that coaches may be able to prevent over-training is by listening to their athletes for potential signs and symptoms. Common physiological signs of over-training include increased oxygen consumption, metabolic rate, or heart rate at sub-maximal exercise intensities. Common symptoms may include a loss of appetite, nausea, headaches, gastrointestinal disturbances, and increased aches, pains, and soreness (Fry, Morton, & Keast, 1991). There may also be psychological markers of overtraining such as feelings of depression, fear of competition, emotional instability, and decreased concentration.

Regarding how or why overtraining happens, there are several theories that show how over-training might occur. Though these theories represent individual components to a more comprehensive problem, it is

likely a combination of several factors that cause or accentuate the effects of over-training.

As endurance athletes need a large amount of energy to sustain themselves, under-consumption of calories, or the right types of calories, can be problematic. The energy deficit theory represents the overall dietary needs of an athlete and potential consequences if those needs are not met (Kreider, Fry, & O'Toole, 1998). One of the setbacks of insufficient dietary intake is illness. This theory also illustrates that an illness would lead to a loss of appetite, leading to less caloric consumption and in turn greater muscle wasting and continued susceptibility to illness.

The energy deficit theory provides a general framework for a cycle of events that could contribute to overtraining but an understanding of the problem should be comprehensive and is likely linked to several factors. Expanding on the energy intake theory, it is important to discuss the major contributing source of energy to an endurance athlete.

Glycogen is the most abundant and readily available source of fuel in the muscle and is also the stored form of carbohydrates. The glycogen depletion theory (Sherman et al.,1997) suggests that the maintenance of glycogen levels is associated with positive training adaptations, whereas glycogen depletion is associated with overreaching and overtraining. As the preservation of glycogen stores has shown to have a bearing on future performance (Karlsson & Saltin, 1971), low muscle glycogen levels have also shown to affect levels of branch chain amino acids (through oxidation to glucose) potentially leading to central fatigue and over-training. Although glycogen depletion has an effect on energy levels, it may not be the explanation for over-training. A research study that subjected athletes to short-term over-training conditions while controlling muscle glycogen levels through adequate feedings, showed that the athletes suffered from short-term over-training even though muscle glycogen levels were on par with normal levels (Snyder, 1998). Given that glycogen depletion has shown to be associated with central fatigue though not necessarily the cause of over-training, it is important to discuss the central fatigue theory and how glycogen depletion relate to the potential cause of over-training.

The central fatigue theory is defined as "A subset of fatigue that is associated with alterations in CNS function that cannot be reasonably explained by peripheral markers of muscle fatigue (Davis, 1995)." A major tenant of the central fatigue theory is that factors, such as decreased glycogen (peripheral fatigue), lead to diminished blood glucose and increased mobilization of Free-Fatty Acids (FFA's) (Newsholme, Parry-Billings, McAndrew, & Budgett, 1991) Though glycogen depletion may not be the direct cause of overtraining, prolonged depletion without sufficient regeneration may have also have a chronic effect on amino acid metabolism. Of particular interest is the utilization of branch-chained amino acids (BCAA's) by the muscle, which happen during and especially after sustained exercise (Newsholme, Parry-Billings, McAndrew, & Budgett, 1991; Blomstrand, Hassme'n, Ek, Ekblom, & Newsholme, 1997). This process increases the tryptophan: BCAA ratio in the blood, which favors the transport of tryptophan into the brain. Heightened amounts of tryptophan in the brain lead to an increased neural excitability of post-synaptic neurons in the brain, thus inducing fatigue at the neuron (Newsholme, Acworth, & Blomstrand, 1987). A more simplistic interpretation of this theory is that when we undergo intense exercise conditions, we change the chemistry of the blood that has an inhibiting effect. This effect may be temporary although it is reasonable to assume that chronic conditions may not allow for sufficient

regulation and/or regeneration of amino acids needed to prevent neural fatigue

Another contributing factor towards overtraining is the effect of hormonal regulation from excessive exercise or inadequate energy intake (Kreider, Fry, & O'Toole, 1998). The hormone dysregulation theory suggests that inadequate energy intake or excessive exercise down-regulates the hypothalamic-pituitary axis (HPTA). The anterior pituitary regulates several hormones that target organs such as the thyroid, adrenal glands, and kidneys to name a few. Fluctuations or changes in the functioning of these organs inevitably lead to decrements in performance but also diminished functioning at resting conditions as an altered hormonal status slows recovery from exercise. Beyond exercise induced hormonal changes, overtraining might just as easily occur in an individual whose hormones are already unbalanced.

A final point to consider is that the above theories describe separate pathways in which overtraining might occur. However, it is more than likely a combination of these factors, or some more than others, that cause overtraining, whether acute or chronic. With any illness or otherwise debilitating condition, adequate recovery and sometimes extended periods of time off may be necessary to avoid making the condition worse. As the above theories present different potential causes to overtraining, each theory is centered around one central concept, Recovery. Without adequate recovery all of the bodies systems are at risk of being under an amount of stress that could cause any given system to decline in functioning. In general, it is possible harder workouts should require not only just a longer period of recovery, but perhaps higher quality recovery.

Recovery is in essence an encompassing term that not only applies physical rest, but adequate energy intake. Sustaining the dietary needs of athlete should be comprehensive to consider his or her basal metabolic rate (BMR) in addition to their caloric needs of their exercise bout. Beyond pure caloric consumption, many athletes may need supplementation to compensate for the increased demand or stress on the body, or may need supplementation regardless of training. An athlete should have an understanding of what their dietary needs are, perhaps through consultations with a registered dietician (RD), in order to optimize daily functioning and in turn, training and racing performances. As a certain percentage of calories are derived from protein, fat, and carbohydrates it also important for an athlete to know recommended as well as additional intake of vitamins, minerals, and other macro-molecules.

Beyond nutritional considerations, it is important for the athlete to train systematically and with some form of measurement to help guide training, gauge progress, and hopefully prevent overtraining. The use of power-meters can make gauging individual workout efforts easier and when compared to other variables such as heart rate (HR) or even rate of perceived exertion (RPE), can provide very useful information to help guide a coach and/or athlete through the training process. As a prevention strategy, coaches should work closely with athletes and seek to minimize the risks of overtraining while optimizing the time spent training. Planned progression and periodization are key elements to the structure of training, but by no means prevent an athlete from overtraining. As blood and/or saliva tests have indicators and potential markers of overtraining, repeating these on a regular basis could be counterproductive in reducing stress. With a large number of factors contributing to the risk of overtraining, the coach and athlete should seek to communicate frequently in order to avoid missteps in training and develop a cooperative training strategy to include nutritional and recovery

modalities that best fit the athlete's needs.

SOURCE ENDURANCE

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Quiz Questions

Name:
USAC #:
Email:

1. Overtraining in athletes may be largely due to:

A) Not enough over-reaching
B) Too much super-compensation
C) Under-recovering
D) Functional over-reaching

2. Which of the following may be signs or symptoms of overtraining?

A) Delayed Onset Muscle Soreness (DOMS)
B) Headaches, nausea, or emotional instability
C) Decreased appetite and concentration
D) All of the above
E) Only two of the above

3. Which of the following is not likely to occur without adequate recovery:

A) Under-reaching
B) Over-reaching
C) Non-functional over-reaching
D) Super-compensation

4. Decreased muscle glycogen from an exhaustive workout increases the Tryptophan:BCAA ratio in the blood. An increase in tryptophan has what effect on the post-synaptic neuron?

A.) Inhibitory, leading to neurological damage
B.) Excitatory, leading to neurological fatigue
C.) Tryptophan has no effect on the Post-synaptic neuron
D.) Inhibitory, causing further breakdown of muscle glycogen

5. Which of the following are potential effects of overtraining?
A.) Unbalanced hormones
B.) Decreased muscle glycogen levels
C.) Increased cortisol levels
D.) All of the above

6. Avoiding over-training might be achieved by:
A.) Sufficient diet and supplementation
B.) Adequate caloric consumption
C.) Consulting with a registered dietician
D.) All of the above

7. A useful tool to help guide training could be:
A.) Underwater weighing
B.) The YMCA sit and reach test
C.) Use of a power meter and heart rate monitor
D.) A carbon fiber frame with aero-wheels

8. A major tenant of avoiding overtraining is the emphasizes of
A.) Knowing your strengths and what your dominant muscle fiber type is.
B.) Adequate recovery between workouts and between training blocks
C.) Tapering two weeks before a major event
D.) Unplanned periodization