

# Biological Impacts of Overtraining

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## Hormonal Effects of Overtraining

### Overtraining Syndrome (OTS)

It is a prolonged inability of the muscle to recover from the trauma with declined strength and performance, as well as a degradation of multiple biological, neurochemical and hormonal regulation mechanisms. It is difficult to distinguish between non functional overreaching (NFOR) and (OTS) as both can depict same signs and symptoms. Only a retrospective clinical study can be a distinguishing factor. (Nicoll et al., 2016)

**FIGURE 1—Possible presentation of the different stages of training, OR and OTS.**

PROCESS	TRAINING (overload)	INTENSIFIED TRAINING <span style="font-size: 1.2em;">→</span>		
	OUTCOME	ACUTE FATIGUE	FUNCTIONAL OR (short-term OR)	NON-FUNCTIONAL OVERREACHING (extreme OR)
RECOVERY	Day(s)	Days – weeks	Weeks – months	Months - ...
PERFORMANCE	INCREASE	Temporary performance decrement (e.g., training camp)	STAGNATION DECREASE	DECREASE

### Biochemistry of OR and OT

Research in this regard is divided due to the enormity of preanalytical factors of research, which include, demographics, time of sample, food intake, duration and type of training etc. Secondly, analytical perspectives, measuring methods and equipments are another factor that can alter results. (Nicoll et al., 2016)

The result of overtraining is full depletion of glycogen. Glycogenolysis is depleted in muscle and liver and liver stops producing insulin like growth factor, resultantly, catabolism is induced which is a major cause of OTS. (Nicoll et al., 2016)

Many parameters like blood count, C reactive protein, CK, Creatinine, Ferritin, Urea, sodium, potassium and liver enzymes assist in detecting and distinguishing between OR, OT and OTS and provide a true picture of the health of any athlete. (Nicoll et al., 2016)

Blood lactate is also decreased due to depleted liver and muscle stores, as a result of excessive muscle training. It has been found that athletes who have enhanced strength and endurance as well as OTS, had diminished maximal lactate concentrations in blood and submaximal values were slightly reduced. (Day & Lukman, 1952)

A study conducted on mice, found that synthesis of protein was found to be lower in overtrained muscles as compared to normally trained muscle. In addition, group of overtrained mice showed mTOR signaling as compared to normally trained group by displaying an increment in phosphorylated Akt ratio. Lastly, overtrained group of mice also showed oxidative stress by displaying an increase in carbonylated protein levels. (Ass et al., 2014)

In addition, a cross-sectional analysis of plantaris muscle fiber CSA was conducted, measuring it using tissue sections of HE stained. Results showed an atrophic effect in the plantaris muscle fiber of overtrained group in comparison to the control group. The atrophy in muscles was corroborated by a decrease in the muscle's body to weight ratio. (Ass et al., 2014)

The study also found out that alteration in skeletal muscle fibers is a proof of increase in the protein catabolism/anabolism ratio. This finding also testifies that the induced atrophy in skeletal muscle fiber due to excessive overtraining, is a result of upregulation of catabolic protein

expression (MAFbx) and down regulation of anabolic protein expression (MyoD, myogenin). In spite of the significant role of MAFbx in muscle atrophy, the research is unable to throw light on the molecular system that is responsible for its increase during the phase of overtraining. As a fact, MAFbx transcription is downregulated by IGF-1 by activating P13k and Akt but an increase in IGF-1 protein expression was also found during the time course of muscle regeneration. (Ass et al., 2014)

A study conducted on two groups of humans, one kept at functional overreaching and other allowed to overtrain found that phosphorylation status of mitogen activated protein kinases (MAPK) proteins and total resting content had different alteration in resistance exercise induced overreaching and overtraining. MAPK showed an increment in overreaching group but showed a decrease in overtrained group. This is attributed to an increase and decrease in extracellular signal regulated kinases (ERK) respectively. (Nicoll et al., 2016)

Further more, due to an increased protein synthesis in high power over reaching group, a significant improvement in strength and performance in muscles was physiologically observable and measurable. In contrast, high intensity overtrained group showed a physically observable degradation in muscle strength and performance. (Nicoll et al., 2016)

As far as physiological impact of hormones due to overtraining is concerned, a study conducted on humans, found out that athletes suffering from OTS displayed a 5% reduction in 1-RM strength. It took them 2 to 8 weeks to recover from this condition. However, neuromuscular hormones and vertical jump performance test remain unaffected for this particular overtrained group. In addition, the electromyogram (EMG) to force ratio saw a decrease in the control group. This result is probably due to an increased neuromuscular efficiency which is the outcome

of an adequate training and better training stress management through allotment of appropriate recovery time. (Fry, Schilling, Weiss, & Chiu, 2006)

When Hypothalamus Pituitary Adrenal Axes (HPA) maladapt to over training, the effect can be recognised and measured by decreased ACTH/cortisol ratio during exercise recovery time as pituitary sensitivity to cortisol and modulation of sensitivity of tissue, is increased. (Day & Lukman, 1952)

A measure of concentration level of plasma glutamine has also been suggested as an indicator of overtraining. But, there are a lot of studies that are unable to find decreased concentration level during the time period of increased training. So, they have concluded the absence of a causative relationship between the two. (Day & Lukman, 1952)

It has also been observed that the ratio between cortisol and resting plasma testosterone cannot be used to indicate overtraining state. It is rather a depiction of normal actual physiological strain, caused by training. The ratio also decreases as the duration and intensity of the training decreases. (Day & Lukman, 1952)

It has been long debated that hormonal mediated dysregulation is present in pathogenesis of the OTS. Therefore, the measurements of blood hormones can help in figuring OTS. Apart from this, endocrine system has a distinguished feedback control system of hormones production, some by peripheral hormones and some by other feedback control system. This simultaneous relationship is the reason that procedure and pain are necessary to gauge the impact of any assessment. Moreover, physiological processes, related to hormones often involve more than one hormone in action simultaneously and assessment becomes more difficult. (Nicoll et al., 2016)

## **Bibliography**

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