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An investigation of the underlying mechanisms of overtraining in a natural experimental model

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Abstract

According to the definitions described in the literature 'overtraining' is used as a verb, a process of intensified training with possible outcomes of functional overreaching [FOR], nonfunctional overreaching [NFOR] or overtraining syndrome [OTS] (Halson 2004; Urhausen 2002). The distinction between (N)FOR and OTS can only be made retrospectively when the time course of recovery can be viewed in context. In the case of OTS, the recovery can take a very long time, and can end an athlete's season or even career. FOR is used by coaches to increase performance, but there is no clear line between FOR and maladaptive training responses (NFOR and in extreme severe cases OTS). The transition is gradual and includes a state of overreaching necessary to improve performance because of supercompensation of the affected physiological systems. If the balance between training load and recovery is inappropriate, this might result in persistent maladaptations to the training program. People with (N) FOR and OTS suffer from several psychological (e.g. mood disturbances (Morgan 1987)) and physical (e.g. performance decrement (Urhausen 1995)) symptoms. Since it seems impossible to treat NFOR/OTS (except rest), the emphasis must be on prevention and early diagnosis of NFOR/OTS.

The most recent consensus statement by the European College of Sport Science (ECSS) and the American College of Sports Medicine (ACSM) (Meeusen 2013) provided an overview of the state of knowledge on the several possible causes and symptoms of NFOR/OTS. Several hypotheses have been proposed, but scientific support for any of the proposed causes is lacking. In general, only a few prospective studies have been performed to investigate a theory and the available data are inconclusive. NFOR/OTS is remarkably difficult to define because there are no known experimental models that have successfully tested hypotheses on NFOR/OTS. Further, because of its profound impact and lack of effective therapies, it would be unethical to deliberately induce NFOR/OTS. Spontaneous training and competitive situations are the only potential naturally occurring models that might be used. Lastly, because NFOR/OTS is possibly related to other chronic fatigue conditions (e.g. chronic fatigue syndrome, burnout syndrome), an effective understanding of NFOR/OTS might provide insight into conditions that are much broader than the athletic meaning of NFOR/OTS. In the international consensus statement it is concluded that the underlying mechanisms of NFOR/OTS are unknown and that there is no definite diagnostic tool for its detection. Also, it is stated that since no single marker can be taken as indicator of NFOR/OTS, the best way to identify athletes developing NFOR/OTS is to monitor performance, physiological, biochemical, immunological and psychological variables. Therefore, the aim of this study was to use a naturally occurring experimental model (an 8-day cycling tour, 1264 km with 18.550 altitude meters, the Tour for Life, TfL) to study the underlying mechanism, identify markers and develop a diagnostic tool for early detection of NFOR/OTS. In addition, we will test several of the proposed hypotheses of overtraining.

A multistage cycling tour such as TfL provides an excellent, ecological, experimental model to study intensified training possibly leading to NFOR/OTS. Participants are well-trained cyclists but unfamiliar with this magnitude of exercise. The exercise volume during the event was approximately 9 times their self-reported training volume in preparation for the event. Their responses before, during and after the TfL can inform us about signs, symptoms and possible markers that can be considered as precursors of (N)FOR or OTS. The TfL model allows us to study a large set of parameters that are central in the proposed theories on NFOR/OTS in a large cohort.

Thirty cyclists participated in the study (19 male), with an average age of 41y; BMI of 23.6 kg/m²; and self-reported training of 140 km per week (range 60-230 km) before the Tour for Life.

Laboratory tests: In this study we performed sequential pre- and post measurements of performance during the 2014 edition of the TfL. All measurements were integrated in a single lab session based on the 2-bout exercise protocol as described by Meeusen et al (2004). One lab session was performed before the TfL to get insight in the pre-TfL characteristics. In addition, 2 sessions were performed after the TfL to study the physiological and psychological disturbances (1 week after the TfL) and to study which cyclists have developed a state of NFOR/OTS (5 weeks after the TfL). During each laboratory measurement, subjects brought their 12h-urine and blood and saliva samples were taken. Also, heart rate variability (HRV) was measured using a portable ECG device (VU-AMS). These measurements were followed by the first maximal incremental test on a cycle ergometer. Directly after, a second blood and saliva sample was taken. Four hours after the start of the first test a second maximal incremental test was performed. Also before and after this test blood and saliva samples were taken.

During the recovery between both exercises the subjects were provided a lunch and they performed a psychomotor speed (reaction time) task.

Tour for Life measurements: Training load and mood were monitored daily starting 2 months before the TfL and ending 2 months post TfL. Also temperature and resting heart rate were monitored weekly in this period. During the TfL blood, saliva and 12h-urine samples were taken in the evening and morning before the first, fifth and final stage. In addition, subjects performed a psychomotor speed task and filled in a Profile of Mood States (POMS) questionnaire. Weight, body temperature and heart rate at rest were measured every morning. Weight and general mood were measured and participants completed a nutrition diary directly after each stage.

Currently we are analyzing the physiological, performance, and psychological data and in the spring we will start the biochemical analyses on the blood, saliva and urine samples. The results of these analyzes will generate knowledge on the hormonal and immunological response before, during and after a natural occurring experimental model of overtraining. With the results we hope to shed light on the underlying mechanism, identify markers and develop a diagnostic tool for early detection of NFOR/OTS. Also, because we included many different parameters we are able to test several of the proposed hypotheses on overtraining.

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