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PERFORMANCE POINT

BALANCING TRAINING WITH RECOVERY TO AVOID OVERTRAINING

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Overtraining (OT) is an accumulation of training and non-training stress resulting in long-term decrement in performance capacity, which may take several weeks to months of recovery (Meeusen et al. 2012). A critical factor in describing the OT phenomena is if training results in decreased performance capacity, not simply manifestations of reported signs and symptoms of OT.

In search of optimal performance, many athletes complete large volumes of intensive physical training. Unfortunately, excessive physical training, incomplete recovery, and high general stress may translate into unavoidable performance reduction and altered mood state, which are now referred to as overreaching (OR). In a similar vain to OT, OR is defined as an accumulation of training and non-training stress resulting in a short-term decrement in performance capacity in which restoration may take from several days to several weeks. The only distinction between OT and OR would therefore be the time needed for the decrement in performance to recovery. Accurate diagnosis of either OR or OT is problematic and can only be made when performance is reduced through a recovery period that is longer than a few weeks or months (Meeusen et al. 2012). In search of optimal adaptation, OR is sometimes deliberately induced in athletes prior to a period of recovery to stimulate performance supercompensation (Halson & Jeukerap, 2004). To add to the terminology confusion, this planned short-term OR has been labeled functional OR (FOR; Meeusen et al. 2012). If adequate recovery is not allowed during periods of intensified training, then non-functional overreaching (NFOR) may occur and in extreme cases can led to fully blown overtraining syndrome (OTS). Often, OT and NFOR are used interchangeable but for clarity it has been suggested that NFOR is the process that leads to the outcome of OT (Meeusen et al. 2012).

For the athlete, coach, and sport scientist, the relevance of OR and OT has been emphasized by the increase of reporting and documentation in high performance sport. (Lamberts Phd). Equally noticeable is the remarkable lack of well-researched and effective treatment or diagnosis of OT. Reflected in treatment programs, which typically lack a scientific basis, the exact pathophysiological mechanisms leading to OT are still largely unknown.

Undertraining would seem the surest way to avoid chronic fatigue and prevent OT. However, undertraining will certainly lead to less than maximal and optimal performance. In order to reach full potential at the highest level, performance, and consequently training stress, must be optimized. Optimal performance can only be achieved through the precise, but individualized balancing act of all stressors and recovery. Unfortunately, the line separating optimal training and overtraining remains undefined. With so many elite athletes being required to tolerate increasingly excessive training regimes in search of Olympic medals and world records, the need has never been greater for careful monitoring of their training for early diagnosis and prevention of OT.

Various theories surrounding metabolic, hormonal, physiological and/or immunological system dysregulation have emerged in the study of overreached/overtrained athletes (Krieider et al., 1998). However, there is still no consensus regarding simple tests which can be used to provide an early warning of impending NFOR or OTS (Meeusen et al. 2012). Based on current literature this Performance Point will provide brief rationale and recommendations for a number of basic OTS markers and procedures that should be incorporated into a comprehensive monitoring system (Table. 1). It should be acknowledged that careful tracking of both training load and competitive results are required in combination with these measures in order to provide a holistic perspective of an athlete's response to all stressors and avoid overtraining.

Monitoring Measures	Test Frequency	Direction Indicator		Reference
		FOR	NFOR/OTS	
Performance				Strock et al., 06
~ Time Trial etc.	Phasic	↔ or ↓	↓↓	
Psychology/Recovery				
~ Recovery-Cue	Daily/Weekly			Kellman 02
· Perceived Exertion		↑	↑↑	
· Perceived Recovery		↓	↓↓	
· Recovery Efforts		↑	↑ or ↔or ↓	
~ RESTQ-Sport	Phasic			Coutts et al., 08
· Stress Subscale		↑	↑↑	
· Recovery Subscale		↓	↓↓	
Physiology				
~ Resting HR	Daily	↑	N/A	Bosquet et al, 08
~ Max Oxygen Uptake	Phasic	↔ or ↓	↓	Halson & Jeukendrup 04
~ Max HR	Phasic	↔ or ↓	↓	Bosquet et al, 08
Biochemistry				
~ Max Blood Lactate	Phasic	↔ or ↓	↓	Halson & Jeukendrup 04
Nutrition/Anthropometrics				Petitbois et al., 02
~ Nutrition Log	Daily	N/A	N/A	
~ Lean Mass Measures	Daily	↔ or ↓	↓	
~ Bodyweight	Daily	↔ or ↓	↓	
~ Blood Glucose	Phasic	↔ or ↓	↓	

TABLE 1 Example of basic monitoring battery for the high performance sport
FOR = Functional overreaching; NFOR = Non-functional overreaching;OTS = Overtraining Syndrome; ↑, ↔, ↓ = increase, no change, decrease; TT = Time trial; HR = Heart Rate;

PERFORMANCE MEASURES

Currently, the only reliable method of diagnosing NFOR or OTS is through a decrease in sport-specific performance (Krieider et al., 1998). While competition can be considered the ultimate monitoring tool, maximal effort or performance based trials should also be utilized regularly to establish performance capacity (Smith, 2003). Due to the taxing nature of maximal effort trials, these tests should be shorter in distance/time and sequenced within the training plan as to coincide with training objectives. These sport-specific performance tests can also be used to establish heart rate (HR) zones or lactate thresholds where possible, as well as RPE, power/velocity measures, which can all be used to interpret the effectiveness of longitudinal training adaptations. Therefore, longitudinal tracking of performance metrics validated to success in a sport are imperative, not only to assess training adaptation, but also the potential of NFOR and OT.

PSYCHOLOGY AND RECOVERY STATUS

It has been suggested that changes in behavior and mood due to stress can precede any impairments in athlete performance (Meeusen et al. 2012). Questionnaires are both cost effective and non-invasive therefore an ideal tool to monitor early warning signs of possible NFOR. Indeed, there are a number of valid questionnaires that assist with identification of athlete's sources of excessive physical and mental stress, as well as the extent of the current recovery activities. The shorter Recovery-cue (Botteril & Wilson, 2002) is ideal for weekly administration, whereas the slightly more time consuming and detailed Recovery-Stress Questionnaire (RESTQ-Sport; Kellmen & Kallus, 2001) can be utilized at the end of a training phase or prior to competition.

PHYSIOLOGICAL MEASURES

A recent meta-analysis revealed significant fatigue related modifications in resting HR and maximal HR after short-term (less than two weeks) and long-term (more than two weeks) intensified training (Bosquets et al., 2008). However, HR fluctuations during the training process must be interpreted in line with other objective markers of NFOR and OTS as expected difference may fall within day-to-day variability (Bosquets et al., 2008). Similarly, maximal oxygen uptake (Halson & Jeukendrup, 2004) and hemoglobin concentration (Zapioc et al., 2007) has been reported to decrease after intensified periods of training in endurance cyclists. While resting HR can be collected daily in a standardized fashion, the other variables are collected during or after maximal exercise and used to validate training or tapering strategies.

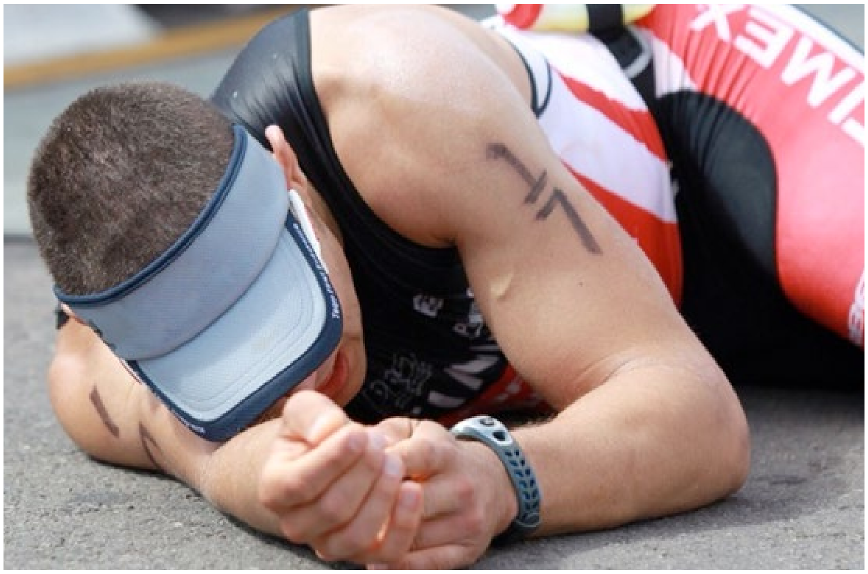
BIOCHEMICAL PROFILING

While blood lactate monitoring during incremental tests has long been used in endurance sports to guide training, it also indicates states of NFOR in athletes (Krieder et al., 1998). Maximal lactate responses have shown to decrease up to 50% after periods of intensified training and smaller decreases were evident in submaximal levels (Halson & Jeukendrup 2004). However, as a diagnostic tool, blood lactate monitoring may be limited as it is equally clear that a normal training response would produce similar changes in submaximal lactate and maximal tests can only be used sparingly. Therefore, it is suggested that blood lactate profiling be used primarily as a marker to guide training and maximal measures should be taken if and when a performance test is incorporated into the training process.

NUTRITIONAL STATUS AND ANTHROPOMETRICS

Nutrition is paramount for all athletes in order to meet the massive training demands to be competitive on the world stage. Recording daily nutritional logs allows estimation of caloric intake which can be confirmed by daily bodyweight and regular lean mass assessments (Norris & Smith, 2002). Additionally, tracking blood glucose levels pre and post-exercise provides an indication of dietary status as well as muscle glycogen levels.

MONITORING ROUTINE & SCHEDULE



Scheduling of monitoring tests or procedures should consider all aspects and objectives of the annual training plan including competitive sequencing and down periods (Bompa, 2005). Timing of assessment is vital and an entry-exit testing format is recommended for all measures in order to track daily, weekly, phasic and competitive responses of the athlete to all stressors as well as validate the training process (Norris & Smith, 2002). For instance, while standardized daily measures reflect an athlete's response to the previous six months along with the objectives of the annual training plan and days training, it also indicative of preparedness before moving forward to the next training session. Equally, weekly evaluation of training tolerance may occur through inspection of daily trends as well as the week ending assessments. Maximal or more focused measures, such as the two-bout exercise protocol or RESTQ-Sport, should be scheduled in order to avoid negative training impact and to illustrate changes over a specific period where certain responses are expected i.e. tapering or high intensity training camps (Norris & Smith, 2002). These measures are particularly crucial in assessing appropriate recovery between races during a competitive triathlon season. Re-evaluation of monitoring schedules and test appropriateness should occur at least every six months along with the objectives of the annual training plan.

INDIVIDUALIZATION OF MONITORING SYSTEMS

While age and gender should be considered, central to the application of any monitoring battery is a dynamic in line with increasing competitive stress and athletic development. Therefore, highly competitive athletes can be exposed to the entire battery of measures as long as 1) all athletes are aware of the maximal and intrusive nature of some measures, and 2) a comprehensive schedule is created to avoid effecting optimal training, recovery or performance. The novice athlete may be served better by following a tiered approach whereby a set of basic and minimally invasive tests (e.g. resting HR and RESTQ-Sport) are used (Norris & Smith, 2002). This tactic will gradually heighten the awareness of novice athletes to the importance of monitoring, without overwhelming them with paperwork or invasive protocols early in their athletic career. Over time, ongoing tracking of each athlete should form an individualized database with profiles of comparable parameters in a variety of competitive, stressful and non-stressful situations (Norris & Smith, 2002). Therefore regardless of group, monitoring will provide reference to upper and lower boundaries of various parameters relating to each athlete's overall ability to tolerate all stressors.

In conclusion, the administration of a comprehensive monitoring system is essential in order to avoid the long-term negative performance effects associated with NFOR and OTS. This system can be applied to athletes of any age or gender as long as appropriate modifications in line with athlete development and increased competitive demands are addressed.