



## Relation Between Training Load and Recovery-Stress State in High-Performance Swimming

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**Background:** The relation between training load, especially internal load, and the recovery-stress state is of central importance for avoiding negative adaptations in high-performance sports like swimming. The aim of this study was to analyze the individual time-delayed linear effect relationship between training load and recovery-stress state with single case time series methods and to monitor the acute recovery-stress state of high-performance swimmers in an economical and multidimensional manner over a macro cycle. The Acute Recovery and Stress Scale (ARSS) was used for daily monitoring of the recovery-stress state. The methods session-RPE (sRPE) and acute:chronic workload-ratio (ACWR) were used to compare different methods for quantifying the internal training load with regard to their interrelationship with the recovery-stress state.

**Methods:** Internal load and recovery-stress state of five highly trained female swimmers (with a training frequency of 13.6 ± 0.8 sessions per week and specializing in sprint (50 and 100 m), middle-distance (200 and 400 m), or long distance (800 and 1,500 m) events) were daily documented over 17 weeks. Two different types of sRPE were applied: RPE<sup>duration</sup> (sRPE<sup>d</sup>) and RPE<sup>volume</sup> (sRPE<sup>v</sup>). Subsequently, we calculated the ratios ACWR<sup>d</sup> and ACWR<sup>v</sup> (sRPE last week: 4-week exponentially weighted moving average). The recovery-stress state was measured by using the ARSS, consisting of eight scales, four of which are related to recovery [Physical Performance Capability (PPC), Mental Performance Capability (MPC), Emotional Balance (EB), Overall Recovery (OR)], and four to stress [Muscular Stress (MS), Lack of Activation (LA), Negative Emotional State (NES), Overall Stress (OS)]. To examine the relation between training load and recovery-stress state a cross correlation (CCC) was conducted with sRPE<sup>d</sup>, sRPE<sup>v</sup>, ACWR<sup>d</sup>, and ACWR<sup>v</sup> as lead and the eight ARSS-scales as lag variables.

**Results:** A large variation of training load can be observed in the individual week-to-week fluctuations whereby the single fluctuations can significantly differ from the overall mean of the group. The range also shows that the CCC individually reaches values above 0.5, especially with sRPE<sup>v</sup> as lead variable. Overall, there is a large range with

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