



# AI-based multiparametric recovery monitoring in elite ice hockey

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## SO WHAT?

- 10–30% of youth and adult high-level athletes experience overtraining throughout their career (1).
- Measuring multiple parameters in combination is necessary for accurate picture of athletes' recovery state.
- Measurements are easy to assess, low-cost, and only last 10–20 minutes.

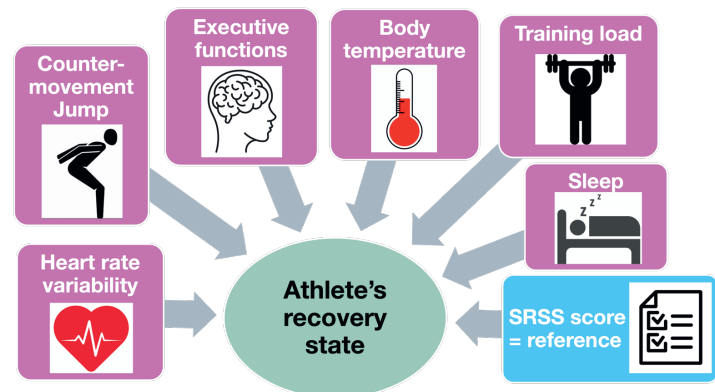


Figure 1: Recovery measurement domains/methods. Heart rate variability (HRV) measured with chest strap, countermovement jump (CMJ) on force plate, executive functions (EF) with computerized tests, core body temperature with in-ear thermometer, training load is athlete's rating of previous week, sleep includes quality and duration.



## THE PROBLEM

Overtraining syndrome (OTS) is characterized by reduced athletic performance over 3–4 weeks up to months. Concurrent symptoms include:

- mood and sleep disturbances, feelings of depression,
  - increased perceptions of effort, respiratory tract infections,
  - loss of appetite, unexplained weight loss, and others (2,3).
- Currently, no reliable measurement system exists for prevention and early diagnosis of OTS (4).



## OUR AIM AND HYPOTHESIS

Develop accurate, time- and cost-efficient measurement systems for recovery monitoring in athletes. We hypothesize that multiparametric measurements predict subjective recovery state with high accuracy (i.e., area under curve,  $AUC > 0.8$ ).

## METHODS



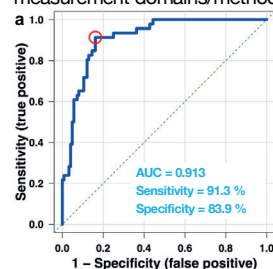
25 male elite ice hockey players of SC Rapperswil-Jona Lakers participated: Swiss National League team,  $n = 11$ , age =  $24.8 \pm 4.1$  years; U20 Elit team,  $n = 14$ , age =  $18.5 \pm 1.5$  years.

- 8–10 measurement days per team over 5–10 weeks during competitive season, after 1 day of recovery or after match-/intensive training day, 170 valid measurement timepoints;
- 40 parameters from mainly objective measurement domains (purple colour figure 1) to predict subjective score of Stress Recovery Short Scale (SRSS, 5) as reference (blue colour). AI-algorithms applied to select important predictive parameters.

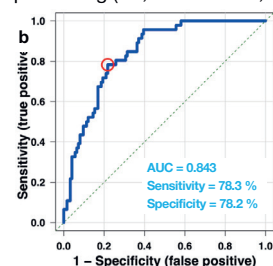
## KEY RESULTS

The two developed measurement systems (figure 2a/b) identify highly stressed athletes (i.e., reference SRSS score  $< 6$ ) with:

- a) very high accuracy, when using all measurement domains/methods;



- b) high accuracy, when only using parameters that don't need data processing (i.e., without HRV, EF).



Figures 2a/b: Predictive accuracy of measurement systems. Red circle further in upper-left corner = higher accuracy.

## CONCLUSIONS

- Parameters from all measurement domains/methods are related to subjective recovery state (figure 3);
- confirms multisystemic nature of OTS;
- multiparametric measurement systems might be most reliable for accurate recovery monitoring in athletes.

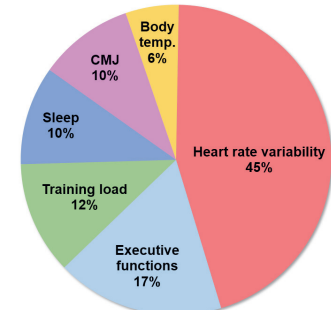


Figure 3: Relative predictive importance of parameters in measurement system a) (% of AUC). Number of parameters: HRV 15, EF 5, training load 1, sleep 2, CMJ 2, body temperature 1.

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