Training load responses modelling in elite sports: how to deal with generalisation?

Frank Imbach[1,2,3,*], **Stephane Perrey**[2], **Romain Chailan**[1], **Thibaut Meline**[4], **and Robin Candau**[3]

[1]Seenovate, Univ. Montpellier, Montpellier, 34000, France
[2]EuroMov Digital Health in Motion, Univ. Montpellier, IMT Mines Ales, Montpellier, 34090, France
[3]DMeM, Univ. Montpellier, INRAe, Montpellier, 34000, France
[4]Laboratoire Européen Performance Santé Altitude, Univ. Perpignan Via Domitia, Font-Romeu, 66120, France
[*]frank.imbach@umontpellier.fr

Appendix

Specific training

On-ice sessions refer to specific training. Session TLs were calculated from Power Output (PO, W), volume and ice properties. Individual PO depends on power required to change kinetic energy (P_{kin}), power required to overcome air and ice resistance (P_{aero} and P_{ice} respectively). Let us define

$$P_{kin} = \frac{\frac{1}{2}(mv_f^2 - v_i^2)}{t},$$
$$P_{aer} = \frac{1}{2} AC_D\, \rho\, v^3 \quad \text{and}$$
$$P_{ice} = C_f\, m\, g\, \bar{v}.$$

In this context, m denotes the mass of the athlete and that of the equipment, v_f is the maximal velocity reached during the run, v_i is the initial velocity being null, $\bar{v}$ is the mean velocity and t is the exercise duration. The effective frontal area AC_D is a standardised fixed value of $0.25\,\text{m}^2$ according to subjects corpulence and Van Ingen Schenau[56]. Also, ρ denotes the air density recorded at 1850 meters above sea and is equal to $1.029\,\text{kg.m}^{-3}$. The friction coefficient C_f is standardised as $C_f = 0.006$, according to maximal values found by De Koning *et al.*[57] and due to a track with sharper turns. Finally, g denotes the acceleration due to the gravity, equal to $9.80665\,\text{m.s}^{-2}$.
Thus,

$$PO = P_{kin} + P_{aer} + P_{ice}.$$

Relative intensity of the session (I_{ice}, as a percentage of the maximal PO) can now be determined as

$$I_{ice} = \frac{I_{ice}^f N_f + I_{ice}^b (N - N_f)}{N}. \tag{S1}$$

This relative exercise intensity includes both forward and backward positions denoted I_{ice}^f and I_{ice}^b respectively, with

$$I_{ice}^f = \frac{PO}{\max PO} + C,$$
$$I_{ice}^b = I_{ice}^f - E\, I_{ice}^f.$$

Here, C denotes the ice impact on skating for an ice quality (Q_{ice}) arbitrary measured by athletes on a 0-10 Borg scale and averaged. If Q_{ice} is below 7.5 arbitrary units (a.u), a linear penalisation is attributed such as $C = -0.008\, Q_{ice} + 0.06$, where α

and β coefficients were estimated from at least two equal performances with different values of Q_{ice}. In addition, E denotes the skating economy due to drafting and N denotes the overall number of laps with also a distinction for the forward position (N_f). Finally, ice session training load is

$$TL_{ice} = I_{ice}\,V\,K\,(\frac{I_{RPE}}{\max I_{RPE}})\,\rho, \tag{S2}$$

where V is the volume parameter defined as the product of the number of laps run and the distance of a lap; K depends on the subject's gender with $K = 0.64\,e^{1.92\,I}$ for males and $K = 0.86\,e^{1.67\,I}$ for females respectively and according to Banister *et al.*[5]; I_{RPE} is the rate of perceived exertion quoted on a 6-20 Borg scale, $\max I_{RPE}$ is the maximal value that can be quoted ($\max I_{RPE} = 20$); ρ denotes the density parameter, such as $\rho = \frac{1}{2}\,\rho_s$ with ρ_s the density of the session (%) which represents the effective work done by the athlete.

Non-specific training

Training loads of resistance training (TL_{RT}), aerobic training (TL_{aer}), repeated sprint training (TL_{RS}) and activation sessions (TL_{act}, specific warm-up) were also quantified as

$$TL_{RT} = I_{RT}\,V\,K\,(\frac{I_{RPE}}{max\,I_{RPE}})\,\rho, \tag{S3}$$

$$TL_{aer} = I_{RPE}\,T\,K\,\rho_s\,k_{aer}, \tag{S4}$$

$$TL_{RS} = I_{RS}\,V\,K\,(\frac{I_{RPE}}{max\,I_{RPE}})\,\rho \quad \text{and} \tag{S5}$$

$$TL_{act} = I_{RPE}\,T\,K\,\rho_s\,k_{off}. \tag{S6}$$

Here I_{RT} denotes the intensity in percentage of the maximal repetition, V is the volume defined by the number of repetitions, T is the total time of exertion, k_{aer} and k_{off} denote a weighting factor for aerobic and activation exercises such as $k_{aer} = 5$ a.u (empirically defined by the coach) and $k_{off} = 15$ a.u respectively. Any of the training sessions are weighted by I_{RPE}. However, a specific intensity was only quantifiable for TL_{RT} and TL_{RS} and further considered in the training load calculation. According to the training condition, Equations S2 – S6 respectively define the discrete function $w(t)$.