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

Frank Imbach1,2,3,*, Stephane Perrey2, Romain Chailan1, Thibaut Meline4, and Robin Candau3

1Seenovate, Univ. Montpellier, Montpellier, 34000, France
2EuroMov Digital Health in Motion, Univ. Montpellier, IMT Mines Ales, Montpellier, 34090, France
3DMeM, Univ. Montpellier, INRAe, Montpellier, 34000, France
4Laboratoire 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 (PKin), power required to overcome air and ice resistance (Pzero and Pice respectively). Let us define

\[ PKin = \frac{1}{2} (mv_f^2 - v_i^2) t, \]

\[ Pzero = \frac{1}{2} AC_D \rho v^3 \]

\[ Pice = C_f m g \bar{v}. \]

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 m\(^2\) according to subjects corpulence and Van Ingen Schenau. Also, \( \rho \) denotes the air density recorded at 1850 meters above sea and is equal to 1.029 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. and due to a track with sharper turns. Finally, \( g \) denotes the acceleration due to the gravity, equal to 9.80665 m.s\(^{-2}\).

Thus,

\[ PO = PKin + Pzero + Pice. \]

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

\[ I_{ice} = \frac{I_{f, ice} N_f + I_{b, ice} (N - N_f)}{N}. \]  

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

\[ I_{f, ice} = \frac{PO_{max} PO}{PO_{max} + C}, \]

\[ I_{b, ice} = I_{f, ice} - E I_{f, ice}. \]

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 \( \alpha \)
and $\beta$ 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

$$T_{L_{ice}} = I_{ice} V K (\frac{I_{RPE}}{\text{max} I_{RPE}}) \rho,$$  \hspace{1cm} (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.\textsuperscript{5}; $I_{RPE}$ is the rate of perceived exertion quoted on a 6-20 Borg scale, $\text{max} I_{RPE}$ is the maximal value that can be quoted ($\text{max} I_{RPE} = 20$); $\rho$ denotes the density parameter, such as $\rho = \frac{1}{2} \rho_s$ with $\rho_s$ the density of the session ($\%$) which represents the effective work done by the athlete.

**Non-specific training**

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

$$T_{L_{RT}} = I_{RT} V K (\frac{I_{RPE}}{\text{max} I_{RPE}}) \rho,$$  \hspace{1cm} (S3)

$$T_{L_{aer}} = I_{RPE} T K \rho_s k_{aer},$$  \hspace{1cm} (S4)

$$T_{L_{RS}} = I_{RS} V K (\frac{I_{RPE}}{\text{max} I_{RPE}}) \rho$$ and

$$T_{L_{act}} = I_{RPE} T K \rho_s k_{off}.$$  \hspace{1cm} (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 $k_{aer} = 5 \text{ a.u}$ (empirically defined by the coach) and $k_{off} = 15 \text{ a.u}$ respectively. Any of the training sessions are weighted by $I_{RPE}$. However, a specific intensity was only quantifiable for $T_{L_{RT}}$ and $T_{L_{RS}}$ and further considered in the training load calculation. According to the training condition, Equations S2 – S6 respectively define the discrete function $w(t)$.