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The application and utility of wearable sensors for athlete monitoring in biathlon

Background

- Training compliance refers to an athlete's conformity to a coach's planned training programme.
- Imperfect training compliance (i.e., discrepancies between coach prescription and athlete execution) could cause maladaptation to the training program and either under- or over-training (Wallace et al., 2009).
- Differences between the coaches' intended perception of effort and the athletes' actual perceptions of effort are widely acknowledged (Brink et al., 2014; Brink et al., 2016; Staunton et al., 2020).
- *These studies have been conducted in team sport athletes,* with lesser attention paid to individual endurance sports, such as *biathlon*.

Aim

This study will utilise objective measures of exercise such as GNSS sensors, accelerometers and HR monitoring measured from wearable technologies advancing the understanding of the application and utility of wearable sensor technology for athlete monitoring in biathlon, with a particular focus on training compliance.

Method

- Over a 5-week training block, 10 elite youth biathletes (6 females; 4 males) wore GNSS sensors with integrated accelerometers and HR monitors during all coach-led training sessions.
- The coaches' planned training sessions were collected through an online training platform (Maxpulse).
  - *This information included a plan of duration within five heart rate-based exercise intensity zones (Table 1), in addition with the total prescribed training time.*
- The total time athletes spent completing very-slow speed movements (<1 m/s) as well as higher speed skiing efforts (≥ 4 m/s; Speed3+) were determined from GNSS sensors.
- PlayerLoad™ (PL) and PL per minute (PL/min) were calculated from the integrated accelerometer within the wearable GNSS device (Equation 1).

Zones	RPE	Typical HR (%max)	Blood lactate
A1	10-14	54-73	< 1.2
A2	14-16	74-83	1.3-2.0
A3-	16-18	84-88	2.1-3.6
A3	18-19	89-93	3.7-5.7
A3+	19-20	>94	>5.8

Table 1. *The 5 zone training model used by the Swedish Biathlon Federation*

Data Analyses

- Training sessions were divided into those performed:
  - *Without (0) or with (1) the biathlon rifle*
  - *Low-intensity training (LIT) or high-intensity training (HIT).*
  - LIT was defined as any training planned within zones A1 and A2. HIT was defined as any training session that involved any prescription with zones A3- or higher.
- Analyses have examined the effect of training session intensity and rifle carriage on training compliance.

Eq. 1 PlayerLoad™=

$$\sqrt{\left(a_{x_{t=i+1}} - a_{x_{t=i}}\right)^2 + \left(a_{y_{t=i+1}} - a_{y_{t=i}}\right)^2 + \left(a_{z_{t=i+1}} - a_{z_{t=i}}\right)^2}$$

Results

- In total, data from 13 training sessions were collected (range 5 – 13), with a total of 107 individual training session observations.
- Performed training duration as a proportion of planned duration is shown below for session with or without the rifle (Panel A), as well as for LT/HIT (Panel B).

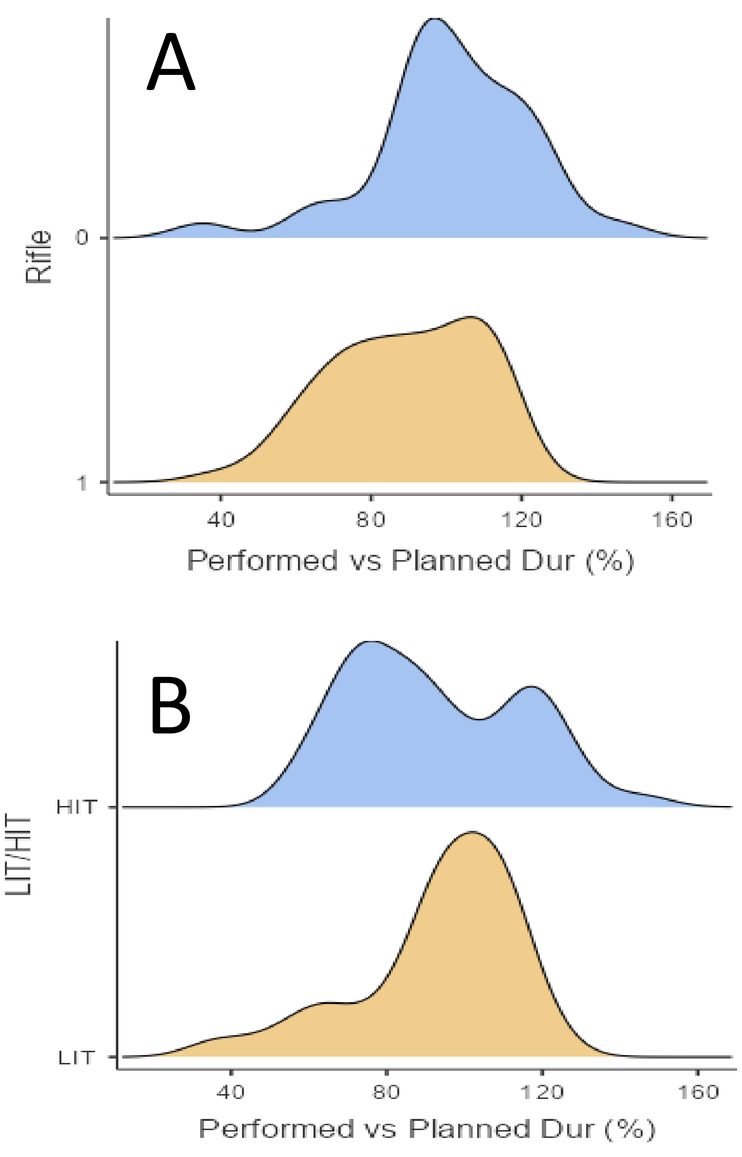

Figure 1: *Performed training duration as a proportion of planned training duration for training sessions without-rifle (0; blue) and with-rifle (1; beige; Panel A) or for training sessions with high-intensity (HIT; blue) and low-intensity (LIT; beige; Panel B).*

- Training time spent performing very-slow speed movements (<1 m/s) was influenced by training session type (LIT/HIT or Rifle/no-Rifle; Figure 2).
- For LIT sessions performed without-rifle, these training sessions were designed to be long, continuous low-intensity training sessions. But were still associated with an average of 17.5 ± 8.1 minutes of very-slow speed movements.

Results (cont.)

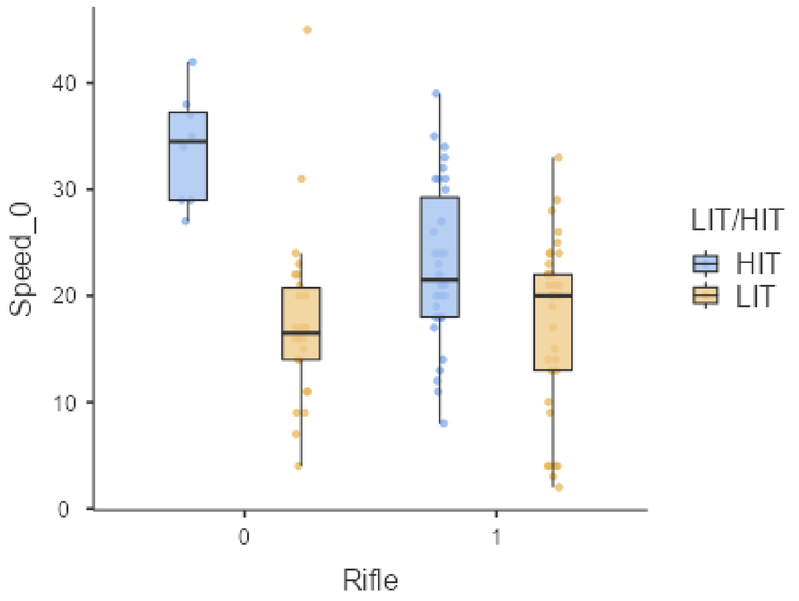

Figure 2: *Training duration (in minutes) spent performing very-slow speed movements (<1m/s) separated by training session without rifle (0) or with-rifle (1) and for training sessions with high-intensity (HIT; blue) and low-intensity (LIT; beige).*

- Strong positive relationships were shown between PL/min and higher speed skiing efforts speed3+ ($r = 0.512$, $p < 0.001$) indicating that PL/min might have convergent validity as a surrogate for training intensity during a biathlon training programme (Figure 3).

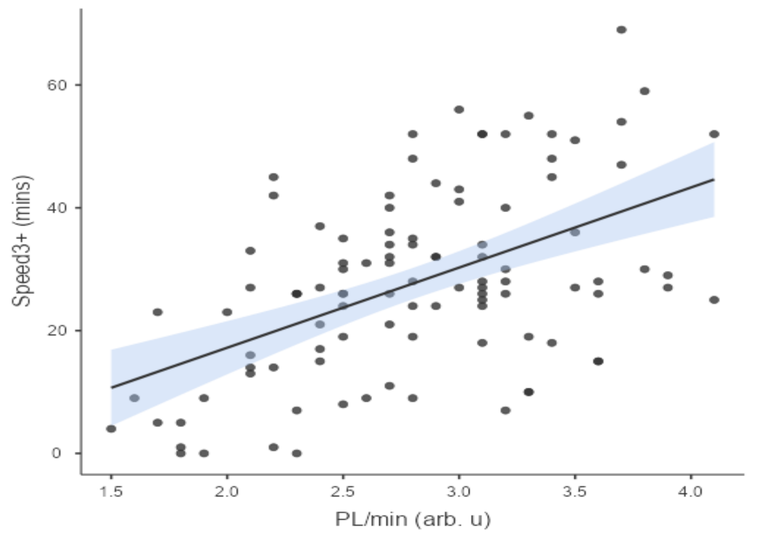

Figure 3: Scatterplot showing relationship between PL/min and Speed3+.

Conclusions and Practical Applications

- Wearable technology proved highly useful for athlete monitoring in biathlon.
- Coaches' training plans significantly influence training compliance, impacting the actual training dose executed by athletes.
- Wearable GNSS sensors, accelerometers, and HR monitoring provide objective data with convergent validity, offering insights into training quality and exercise dose in the training program.

References

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Acknowledgements

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