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## Monitoring Workloads in Collision Sports: External Load Measures Alone May Not Provide the Full Picture

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**PURPOSE:** To compare the external loads and external:internal load ratios (EL:IL) during match-play of adolescent collision sport athletes playing at both elite (i.e., academy) and sub-elite (i.e., school) standards. **METHODS:** Following ethics approval, seventeen elite adolescent male rugby union players (mean  $\pm$  SD age =  $17 \pm 1$  years) were recruited for this study. Global positioning system (GPS) locomotor (i.e., relative distance [RD;  $\text{m}\cdot\text{min}^{-1}$ ], low speed activity [LSA; relative distance  $<61\%$  maximum velocity [Vmax]], high speed running [HSR; relative distance  $\geq 61\%$  Vmax]), and accelerometer (relative PlayerLoad<sup>TM</sup> [RPL;  $\text{AU}\cdot\text{min}^{-1}$ ],  $\text{PL}_{\text{SLOW}}$  [relative accelerations  $<2 \text{ m}\cdot\text{s}^{-1}$ ],  $\text{PL}_{\text{FAST}}$  [relative accelerations  $\geq 2 \text{ m}\cdot\text{s}^{-1}$ ]) external loads, and session rating of perceived exertion (sRPE) internal load measures were obtained from 22 matches resulting in 86 match files (39 sub-elite and 47 elite match files;  $5 \pm 2$  match files per subject). Perceptual wellbeing measures (i.e., fatigue, sleep quality, upper-body and lower-body soreness, stress, and mood) were also recorded using a 5-point Likert scale on the mornings pre- and post-match. Data were analysed using Cohen's  $d$  effect sizes ( $d$ ) and magnitude-based inferences. **RESULTS:** Differences in external loads were *unclear* between playing standards for RD ( $d = -0.2$ ) and RPL ( $d = 0.0$ ). However, subjects' EL:IL were *very likely* lower during elite compared to sub-elite matches for both RD:sRPE ( $d = -1.0$ ) and RPL:sRPE ( $d = -0.8$ ), due to the *very likely* greater sRPE during elite matches ( $d = -1.1$ ). There were *unclear* differences between sub-elite and elite matches for distribution of GPS and accelerometer variables (i.e., LSA, HSR,  $\text{PL}_{\text{SLOW}}$ , and  $\text{PL}_{\text{FAST}}$ ; Table 1). Changes in total perceptual wellbeing were *possibly* greater following elite compared to sub-elite matches, with *unclear* differences for changes in sleep quality, lower-body soreness, stress and mood. However, changes in perceptual fatigue and upper-body soreness were both *likely* greater following elite matches. **CONCLUSIONS:** Adolescent rugby union players had similar locomotor and accelerometer external loads (i.e., RD, LSA, HSR, RPL,  $\text{PL}_{\text{SLOW}}$  and  $\text{PL}_{\text{FAST}}$ ) during both elite and sub-elite standard matches. However, EL:IL was substantially reduced in higher standard matches, indicating a higher perception of effort for a given external load. Greater changes in perceptual fatigue and upper-body soreness following elite match-play may be related to greater magnitude of collision-based activity at higher playing standards. This may be due to the increased body mass and running velocities of opponents at higher playing standards, which may not be fully accounted for using external load measures alone. **PRACTICAL APPLICATION:** As collision sports require more than just movement and acceleration demands, the inclusion of subjective load measures (i.e., sRPE) or EL:IL may provide a further insight to the true demands of training or match-play than GPS and accelerometer data alone.

**Table 1.** External load, EL:IL, and perceptual wellbeing differences between sub-elite and elite playing standard matches in adolescent rugby union.

	<b>Sub-Elite Matches</b>	<b>Elite Matches</b>	<b>Cohen's <i>d</i> ±90% CI</b>	<b>Magnitude Based-Inference</b>
<b>RD (m·min<sup>-1</sup>)</b>	70.7 ± 7.8	69.0 ± 8.3	-0.2 ± 0.6	Unclear
<b>RPL (AU·min<sup>-1</sup>)</b>	6.6 ± 1.1	6.6 ± 0.9	0.0 ± 0.5	Unclear
<b>sRPE (AU)</b>	5.1 ± 1.0	6.3 ± 1.4	1.1 ± 0.6	Elite Matches Very Likely ↑
<b>RD:sRPE (m·min<sup>-1</sup>:AU)</b>	15.0 ± 3.2	11.7 ± 2.8	-1.0 ± 0.5	Elite Matches Very Likely ↓
<b>RPL:sRPE (AU·min<sup>-1</sup>:AU)</b>	1.4 ± 0.3	1.1 ± 0.3	-0.8 ± 0.5	Elite Matches Very Likely ↓
<b>LSA (m·min<sup>-1</sup>)</b>	66.2 ± 7.2	64.1 ± 7.0	-0.3 ± 0.6	Unclear
<b>HSR (m·min<sup>-1</sup>)</b>	4.5 ± 2.3	4.8 ± 2.3	0.2 ± 0.6	Unclear
<b>PL<sub>SLOW</sub> (AU·min<sup>-1</sup>)</b>	3.2 ± 0.6	3.1 ± 0.4	-0.2 ± 0.5	Unclear
<b>PL<sub>FAST</sub> (AU·min<sup>-1</sup>)</b>	3.5 ± 0.8	3.5 ± 0.8	0.1 ± 0.6	Unclear
<b>Fatigue Change (AU)</b>	-0.3 ± 0.8	-0.8 ± 0.5	0.6 ± 0.5	Elite Matches Likely ↓
<b>Sleep Change (AU)</b>	-0.2 ± 0.7	0.0 ± 0.9	-0.3 ± 0.6	Unclear
<b>UB Soreness Change (AU)</b>	-1.0 ± 0.8	-1.4 ± 0.8	0.5 ± 0.5	Elite Matches Likely ↓
<b>LB Soreness Change (AU)</b>	-1.2 ± 1.1	-1.4 ± 0.8	0.2 ± 0.5	Unclear
<b>Stress Change (AU)</b>	-0.1 ± 0.7	-0.1 ± 0.5	0.0 ± 0.5	Unclear
<b>Mood Change (AU)</b>	-0.4 ± 0.7	-0.4 ± 0.6	0.0 ± 0.5	Unclear
<b>Wellbeing Change (AU)</b>	-3.2 ± 2.7	-4.1 ± 1.8	0.3 ± 0.5	Elite Matches Possibly ↓

Data presented are mean ± standard deviation, Cohen's *d* effect sizes with 90% confidence intervals (CI), and magnitude-based inferences. UB = Upper Body, LB = Lower Body.