Association of acute and chronic workloads with injury risk in high-performance junior tennis players

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Highlights

- Our findings demonstrate an association between high values of acute internal workload (using the session-rating of perceived exertion [s-RPE] method) and the risk of injury in high-level tennis players.
- Therefore, special attention must be paid to those weeks in which the players' workloads increase, requiring more emphasis on adequate recovery strategies.
- However, acute workload was a poor predictor of injury, showing weak associations between injury and internal workload markers. This reinforces the need to consider multivariate approaches to improve the predictive power of injury risk analysis in future investigations.

Abstract

This study examined the association and predictive ability of several markers of internal workload on risk of injury in high-performance junior tennis players. Fifteen young, high-level tennis players (9 males, 6 females; age: 17.2 ± 1.1 years; height: 178.5 ± 8.7 cm; mass: 68.1 ± 4.8 kg) participated in this investigation. Data on injury epidemiology and internal workload during training were obtained for one competitive season. The session-rating of perceived exertion (s-RPE) was used to calculate internal workload markers in absolute (acute workload and chronic workload for 2-weeks, 3-weeks and 4-weeks) and relative terms (acute:chronic workload ratios [ACWR] for 2-weeks, 3-weeks and 4-weeks). Associations and diagnostic power for predicting tennis injuries were examined through generalised estimating equations and receiver operating characteristics analyses. During the season, a total of 40 injuries were recorded, corresponding to 3.5 injuries per 1000 h of tennis practice. The acute workload was highly associated with injury incidence (P=0.04), as injury risk increased by 1.62 times (95% CI: 1.01–2.62) for every increase of 1858.7 arbitrary units

(AU) of the workload during the most recent training week. However, acute workload was a poor predictor of injury, and associations between injury and internal workload markers were weak (all $P>0.05$). These findings demonstrate an association between high values of acute workload and the risk of injury in high-level tennis players. However, a high acute workload is only one of the many factors associated with injury, and by itself, has low predictive ability for injury.

Keywords: Racket sport; injury prevention; training load; fatigue; performance

Introduction

Tennis is among the most popular sports globally, with 87 million players (ITF [International Tennis Federation] statistics, October 2019). At the elite level, tennis has evolved from a technical and tactical sport into a high-demanding game requiring fast and explosive movements and continuous changes of direction and sprints, interspersed with recovery periods among points and games. Although the career duration of elite tennis players is now longer than in previous decades, age at the first entrance in the ranking of the Association of Tennis Professionals (ATP)/Women's Tennis Association is still ~23 years for men and ~21 years for women (Gallo-Salazar, Salinero, Sanz, Areces, & Del Coso, 2015). This early entrance into professionalism demands high levels of technical and physical performance in young tennis players aiming to enter the ATP tour (Baiget, Iglesias, & Rodríguez, 2016). The nature of tennis practice, involving the repetition of tennis strokes and movements during several hours, can lead to injuries on musculoskeletal structures, even at early stages. Identifying risk factors for tennis injuries can help these players participate safely in the sport while incrementing their possibility to reach professionalism (Pluim, Groppel, Miley, Crespo, & Turner, 2018). Indeed, it has been estimated that the injury incidence of elite junior tennis players approximates 1.0–2.8 injuries per 1000 competitive games and 1.3 injuries per 1000 h of training (Gescheit et al., 2019; Moreno-Pérez, Hernández-Sánchez, Fernandez-Fernandez, Del Coso, & Vera-Garcia, 2019). Unfortunately, time lost to injury for these players directly impacts their performance and livelihood.

In sport, injury prediction is vexed as injuries are multifactorial (Bittencourt et al., 2016). However, identifying clinically meaningful risk factors remains essential to determining injury prevention models and decreasing the number and severity of injuries. In this regard, through team sport data, inadequate and excessive training and competition loads have been implicated in increased injury rates (Gabbett, 2016). Interestingly, excessive loads may lead to a delayed increased risk of injury. This delay may extend up to 3–4 weeks after the bout of acute overload (Orchard, James, Portus, Kountouris, & Dennis, 2009). Therefore, exercise practitioners might expect elevated injury risk for up to one month after a peak in workload caused by high volumes of training or excessive competition. Commonly, these loads reflect the physical work performed by athletes and can be quantified by electronic tracking systems (external load) and/or as an individualised psycho-physiological response such as a heart rate (internal load). A high absolute load or a sudden increase (> 15%) in the load compared to the previous week might be associated with higher injury risk (Drew & Finch, 2016). For this reason, monitoring week-to-week changes in training loads has been suggested as an effective tool to prevent injury (Gabbett, 2016). However, unlike in other sports, the influence of acute and chronic training and competition loads on the risk of injury in high-performance tennis has not been adequately investigated.

Various statistical interpretations or measures of training and competition load and injury in sports have been explored (Soligard et al., 2016). Recently, the International Olympic Committee supported the acute:chronic workload ratio (ACWR) as the measure of load most associated with injury in athletes (Soligard et al., 2016). The ACWR ratio is calculated by dividing the load for the last week of training/competition (acute workload) to the mean rolling load over the previous four weeks (chronic workload) (Hulin et al., 2014). Research in other sports has shown the likelihood of injury to be low when the ACWR is 0.8–1.3 but twice as likely when the ACWR is >1.5 (Gabbett, 2016). To our knowledge, the association between ACWR and injury has only been examined once in tennis, with Myers et al. (Myers et al., 2019) finding an ACWR >1.5 in the week before injuries were sustained, especially among those players with a previous injury history. This investigation, while novel in the tennis context, is difficult to extrapolate to high-performance junior tennis players owing to the age (12–16 years) and playing (> 3 days of tennis training per week) demographic of the sample. As the weekly training (>16 h on court) and competitive playing schedule (i.e. 60–90 singles matches per year) of high-level young players is considerably more intensive, especially for those aiming to become professional tennis players, more research is necessary to understand this dynamic.

Therefore, the present study aimed to examine if acute workload, chronic workload (for 2-week, 3-week, and 4-week periods) or the ACWR were associated with an increased risk of injury in high-performance junior tennis players.

Material and methods

Participants

From an initial sample of 31 healthy tennis players, 15 players (9 males, 6 females; Mean ± SD, age: 17.2 ± 1.1 years; height: 178.5 ± 8.7 cm; mass: 68.1 ± 4.8 kg) took part in this prospective and descriptive study during one full-season (39 weeks). The remaining sixteen tennis players were excluded from the study because they moved away during the study period. We recruited the participants from a high-performance tennis academy. We categorised the tennis players as high-performance because they all competed at an international level in their category. Forty percent of the participants (*n*=6) played an ATP (Association of Tennis Professionals), and 60% (*n*=9) played an ITF tournament during the 2018–2019 season. Players trained an average of 35 h per week from Monday to Saturday morning. On Saturday afternoon and Sunday, players did not train except when they played tournaments. The training programme included two training sessions per day (morning and afternoon), with each session including a tennis training or tennis match and a fitness training component. The participants were informed of the objectives of the research, participated voluntarily, and could withdraw from the investigation at any time without penalty. All the players, or their parents or tutors for those younger than 18 years, signed written informed consent. We conducted the study according to the latest version of the Declaration of Helsinki (2013), and the local Research Ethics Committee fully approved the protocol before recruitment.

Quantification of load

We assessed workload using the session rate of perceived exertion (s-RPE). This method combines data from internal (effort) and external workload (session duration) (Foster et al., 2001). We obtained s-RPE for each training session and match by multiplying the session intensity rating (RPE value) by the session duration, measured in arbitrary units (AU). The RPE value was determined using the Borg's CR-10 scale (Foster et al., 2001), obtained 30 min after completion of the training session or match. The session duration was collected by the player's coach and recorded in minutes. Total training workloads were reported from all training sessions (i.e. field sessions, gym sessions, and recovery sessions) and matches and categorised into weekly blocks from Monday to Sunday. The data collection and recording process was conducted daily by three coaches of the tennis academy. The coaches had been instructed on how to report the information using a standardised form. The weekly workload consisted of tennis and fitness together. We calculated the workload both in absolute (i.e. acute workload, chronic/cumulative workload), and relative terms (i.e. ACWR) (Soligard et al., 2016). We defined the acute workload as the total workload of all training sessions/matches that took place in one week. We calculated the chronic workload as coupled rolling averages of the total workload performed over the last training period, for 2-week, 3-week, and 4-week periods (Windt & Gabbett, 2019). Although the use of coupled ACWR calculations may generate spurious correlations with acute workloads (Lolli et al., 2019), we used this method for the calculation of ACWR as the evidence for using the uncoupled calculation has not yet provided a superior measure of injury risk in sport (Windt & Gabbett, 2019). Furthermore, recent evidence suggests that ACWRs are associated with greater injury risk, irrespective of whether acute and chronic workloads are coupled or uncoupled (Gabbett, Hulin, Blanch, Chapman, & Bailey, 2019). We defined the ACWR as the proportion of acute workload to chronic workload (McCall, Dupont, & Ekstrand, 2018).

Injury data collection

All injuries were diagnosed by the same doctor of the academy using the classification system developed by Pluim et al. (Pluim et al., 2009). Thus, a tennis-related injury was defined as any physical complaint sustained by a player that resulted from a tennis match or tennis training. A recurrent injury was recorded when an injury of the same type and at the same location occurred after the player had returned to full participation. To simplify injury location, we used four main injury sites: head and neck, upper limb, trunk, and lower limb. Depending on the tissue type affected, the injury was classified as bone, joint (non-bone) and ligament, muscle, tendon and nerve or other type of injury. Injury severity was defined as the number of days from the date of injury to the date of return to full tennis practice and availability for match play (Pluim et al., 2009). The following classification was used for injury time loss: slight, 0 days; minimal, 1–3 days; mild, 4–7 days; moderate, 8–28 days, and severe > 28 days. Finally, match exposure was defined as tennis play (including on-court warm-up) between players competing in singles or doubles. Training exposure was defined as the player's physical activities aimed at maintaining or improving a player's tennis skills or physical condition.

Statistical analysis

Categorical data (type, location, severity, region, recurrences) were described using frequencies and percentages. The injury incidence rate was calculated as the number of injuries per 1000 h of tennis practice. Generalised estimating equations (GEE) examined the association between changes in the workload markers and injury risk on the subsequent week (Williamson, Bangdiwala, Marshall, & Waller, 1996). The GEE analysis was used as an approach for modelling longitudinal data in order to account for the correlation among outcomes for a given subject (repeated measures), and specifically as an application of injury to a binary outcome (injury: yes/no) (Karim & Zeger, 1988). Once collinearity was accounted for, clinical inference of statistically significant GEE predictors was derived from Exp(B) odds ratio, representing the risk estimate. Due to the unit of measurement of the workload markers (i.e. arbitrary units, AU), the variables were standardised through Z-scores so that one-unit change in the predictor corresponded to one standard deviation. Workload markers expressed as ratios (i.e. relative workload markers) do not suffer from scaling problems, reducing the need for standardised scores. Those workload markers that showed statistically significant associations with injuries following the GEE analysis were examined through receiver operating characteristics (ROC) analysis. ROC curves were computed to test the discriminant capacity of workload markers to classify players in two groups (with and without injury) by plotting the true positive rate (ie, sensitivity) against the false positive rate (ie, 1 – specificity; where specificity represents the true negative rate). Thereby, the area under the ROC curve (often referred to as simply the AUC) constitutes a measure of how well a parameter can distinguish between the two groups, with areas under the curve (AUCs) of 1.0 representing perfect discriminatory power and AUCs of 0.50 indicating no discriminatory power (Hanley & McNeil, 1982). AUCs > 0.70 and confidence intervals (CI) > 0.50 were considered as generic benchmarks for an acceptable level of discriminatory power (Menaspà, Sassi, & Impellizzeri, 2010). Additionally, the Youden's index (*J*), as a primary summary statistic of the ROC curves, was calculated ($J = \text{sensitivity} + \text{specificity} - 1$) to interpret the predictive ability. The maximum *J* index of 1 suggests perfect discriminatory ability, whereas a *J* index of 0 would reflect no diagnostic value (Youden, 1950).

Furthermore, workload markers that showed statistically significant associations with injuries were split into four categories based on the 15th, 50th and 85th percentiles and assessed for their sensitivity, specificity and positive predictive values to compare injury risk when considering different load zones (Parikh, Mathai, Parikh, Sekhar, & Thomas, 2008). The four categories were: very low (<15th percentile), moderately low (>15th to 50th percentile), moderately high (>50th to 85th percentile) and very high (>85th percentile) (McCall et al., 2018). Although binning data in bins of different sizes may introduce a bias, we used this approach because we were interested in investigating the diagnostic accuracy of very low/high (<15th percentile / >85th percentile, respectively) acute workloads.

GEE and ROC analyses were performed using SPSS (Version 21.0, IBM Corp., Armonk, NY, USA). Relative risk (RR) and predictive power diagnostic tests were computed using Medcalc (MedCalc Software, Ostend, Belgium) online free statistical calculators (available at www.medcalc.org). A *P* value ≤0.05 was considered to be statistically significant for all the analyses. The 95% confidence intervals (CI) were presented for all outcomes.

Results

Descriptive injury conditions

Descriptive statistics for injury distribution are presented in Table I. A total of 40 injuries were recorded for the 15 players in the study. The injury incidence rate was 3.5 injuries per 1000 h of tennis practice. Muscle injures represented half (50.0%) of the total injuries reported in this investigation, followed by ligament, tendon, and bone injuries. Most injuries (47.50%) were reported in the lower limbs, while a high proportion of injuries (45.0%) needed 8-to-28 days of recovery. The anatomical region with the highest percentage of injuries was the thigh (32.5%), followed by the lower back (lumbar region) and the shoulder. Lastly, 77.5% of the injuries were classified as new injuries.

Table I. Descriptive characteristics of the injuries by type, anatomical location, anatomical region, severity and recurrence of the 40 registered injuries.

Characteristics	*n*	%	Anatomical region / Recurrence	*n*	%
Type			**Region**		
Ligament	7	17.50	Shoulder	5	12.50
Muscle	20	50.00	Elbow	4	10.00
Tendon	5	12.50	Wrist	3	7.50
Bone	5	12.50	Hand, finger	0	0.00
Nerve	0	0.00	Cervical, dorsal, back	0	0.00
Others	3	7.50	Abdomen	1	2.50
Location			Lumbar	7	17.50
Upper limbs	13	32.50	Hip	3	7.50
Lower limbs	19	47.50	Thigh	13	32.50
Trunk	7	17.50	Knee	1	2.50
Head	1	2.50	Leg	1	2.50
Severity			Ankle, Achilles	1	2.50
1–3 days	9	22.50	Foot	0	0.00
4–7 days	8	20.00	Face	1	2.50
8–28 days	18	45.00	**Recurrence**	***n***	
28 days to 6 months	5	12.50	New	31	77.50
>6 months	0	0.00	Recurrent	9	22.50

Descriptive statistics of the different workload markers are shown in Table II. Mean acute and chronic workload AUs varied by only 2% across the investigated time windows.

Table II. Descriptive statistics for the different workload markers.

	Mean	Std. Dev.
Absolute workload markers (non-standardised)		
Acute workload (AU)	5029.60	1858.68
Chronic workload for 2-weeks (AU)	4974.44	1434.28
Chronic workload for 3-weeks (AU)	4943.57	1221.17
Chronic workload for 4-weeks (AU)	4930.40	1076.74
Relative workload markers		
ACWR for 2-weeks	0.99	0.27
ACWR for 3-weeks	0.99	0.31
ACWR for 4-weeks	1.00	0.32

AU: arbitrary units. ACWR: acute:chronic workload ratio.

Absolute workload markers

The GEE analysis results showed an association with injury for the acute workload (*P*=0.04), as injury risk increased by a factor of 1.62 (Exp (B) = 1.62; 95% CI: 1.01–2.62) times for every one-unit increase in workload Z-score in the most recent training week. In other words, a one-unit increase in the standardised acute workload (SD=1858.68) substantially increased injury risk of the given training week by 1.01–2.62 times. No associations with injury were found for chronic workload for 2-weeks, 3-weeks or 4-weeks (*P*=0.44, *P*=0.16 and *P*=0.21 respectively).

Table III shows injury risk comparisons based on the 15th, 50th and 85th workload percentiles for acute workload. Very high workload zones (>85th percentile) showed association with injury risk when compared to very low (<15th percentile) and moderately low (>15th to 50th percentile) workload zones (RR=2.12, 95% CI: 0.77–5.85; and RR=1.93; 95% CI: 0.90–4.15, respectively). The results also showed an association with injury risk when comparing the very high workload zone to the moderately high zone (RR=2.29; 95% CI: 1.03–5.07).

Table III. Injury risk comparisons for the acute workload when considering different load zones (<15th, 15-50th, 50-85th, >85th percentiles).

Load zone	Injuries (*n*)	Relative risk (95% CI)
<3330 (reference)	5	
3330–4994	13	1.10 (0.40–2.98)
4995–6844	11	0.93 (0.33–2.59)
>6844	11	2.12 (0.77–5.85)
3330–4994 (reference)	13	
4995–6844	11	0.85 (0.39–1.84)
>6844	11	1.93 (0.90–4.15)
4995–6844 (reference)	11	
>6844	11	2.29 (1.03–5.07)

The acute workload showed a poor predictive ability for injury (AUC=0.59; 95% CI: 0.49–0.69; J=0.21). The predictive power of injury, ROC curve analysis, sensitivity, specificity, and positive predictive values for acute workload are presented in Table IV. When assessing the diagnostic accuracy, the results showed low sensitivity figures for all the workload percentiles under analysis (sensitivity figures ranging from 12.50% to 32.50%, therefore missing 87.50% to 67.50% of injured players). Similarly, the positive predictive values analysis showed weak predictive power (ranging from 5.95% to 12.64%).

Table IV. Diagnostic accuracy assessment for the acute workload when considering different load zones (<15th, 15-50th, 50-85th, >85th percentiles).

Load zone	True positive (*n*)	False positive (*n*)	False negative (*n*)	True negative (*n*)	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)	Positive predictive value (%) (95% CI)
<3330	5	79	35	450	12.50 (4.19–26.80)	85.07 (81.74–88.00)	5.95 (2.65–12.84)
3330–4994	13	186	27	343	32.50 (18.57–49.13)	64.84 (60.60–68.91)	6.53 (4.22–9.98)
4995–6844	11	188	29	341	27.50 (14.60–43.89)	64.46 (60.22–68.54)	5.53 (3.37–8.93)
>6844	11	76	29	453	27.50 (14.60–43.89)	85.63 (82.35–88.51)	12.64 (7.75–19.97)

Relative workload markers

ACWR for 3-weeks showed substantial multicollinearity and was therefore excluded from the analysis. The results of the GEE analysis did not show associations to injury for ACWR for 2-weeks or ACWR for 4-weeks (P=0.22 and P=0.92 respectively).

Discussion

We examined if absolute and relative acute and chronic workload measures were associated with the risk of injury in young and high-performance tennis players. We revealed an association between injury and acute workload in the week before injury in this cohort of athletes but with no other association with chronic workload or ACWR for 2-weeks, 3-weeks or 4-weeks periods.

In the current study, the overall injury incidence was 3.5 injuries per 1000 h of tennis exposure. These results are consistent with previous reports of injury incidence in national-level junior tennis players (Gescheit et al., 2019). Significantly, three out of four injuries identified in this investigation were new injuries, likely due to our sample comprising high-performance junior tennis players that had not had many previous injuries.

In further agreement with other tennis studies, half of all reported injuries were muscle injuries (Maquirriain & Baglione, 2016; Moreno-Pérez et al., 2019). These muscle injuries were mainly located in the lower limbs (Moreno-Pérez et al., 2019; Pluim, Loeffen, Clarsen, Bahr, & Verhagen, 2016) especially the thigh (Maquirriain & Baglione, 2016; Moreno-Pérez et al., 2019). In the present study, a possible explanation of the high number of muscle injuries in the lower limbs may be the high number of hours of training (i.e. 35 h per week) induced by the augmented physical load. It is also important to note that most of the injuries reported in the current investigation required up to 28 days for a full recovery, which reinforces the negative impact they may have on tennis performance and the potential benefits of preventing injuries in high-level tennis.

Although there are obvious differences between the physical demands of tennis and football, the findings of the current study with high-performance junior tennis players are in line with the results reported by previous studies conducted with football players. For example, Malone et al. (2017) indicated that weekly workloads higher than 3200 AUs increased the risk of injury during the competitive season by 2.33. In these junior tennis players, a 2.12 higher risk of injury was found when the weekly workload surpassed 6884 AUs, which may be related to the comparatively higher training volumes of tennis players. These findings in tennis and football support the idea that acute, excessive and/or rapid increases in workloads may be responsible for a large proportion of injuries, rather than chronic exposure to higher workloads (Bowen, Gross, Gimpel, Bruce-Low, & Li, 2019; Gabbett, 2016). Our findings might explain the high number of injuries observed among high-level junior tennis players in programmes or academies (i.e. upon first entry into high-performance programmes/academies), where sudden increases in the volume and intensity of training are common (i.e. due to the inappropriate transition to a higher load) (Pluim et al., 2016).

In the present study, the predictive ability of acute workload markers for injury was poor. These results are similar to previous reports of poor predictive ability (i.e. AUC=0.54; 90% CI: 0.48–0.59) in football (Fanchini et al., 2018). So, in practice, our findings show that high values of absolute workload during a weekly period might predispose players to injury in tennis, but, in most cases, high values of absolute workload do not result in injury. Injury risk and causation are complex phenomena with many interacting factors involved (Colby et al., 2017). Thus, a multivariate approach to improve the predictive power of injury risk analysis is recommended for future investigations.

It has been shown that both low and high ACWRs are associated with increased injury risk in several sports, including basketball (Weiss, Allen S, McGuigan, & Whatman, 2017), rugby (Hulin, Gabbett, Lawson, Caputi, & Sampson, 2016), and football (Fanchini et al., 2018; Malone et al., 2017; McCall et al., 2018). In addition, in cricket players, excessive loads during a match led to a delayed increased risk of injury up 3–4 weeks after the acute overload (Orchard et al., 2009). A similar finding was reported by Myers et al. (2019), who found a significant association between ACWR for 4-weeks and injury risk in tennis players. They found that injured players had a mean ACWR of 1.57 in the week before the injury occurred. In contrast, the current study revealed no associations between injury and ACWR for 2-weeks, 3-weeks or 4-weeks, although injury was associated with acute workload in the week before the injury. These dichotomous findings may relate to differences in the characteristics of the respective samples. For example, Myers et al. (Myers et al., 2019) studied 14-year old players that played an average of three days per week in national or regional tournaments, while in the present study, players averaged 17.2 ± 1.1 years of age, trained approximately 35 h per week over six days and competed in international tournaments. Considering that our sample contained players dedicated exclusively to tennis, older, and with higher training experience, they may have had higher physical qualities to tolerate the demands of training, competition, and adaptations to training workload (Ulbricht, Fernandez-Fernandez, Mendez-Villanueva, & Ferrauti, 2016), which may reduce the risk of injury.

Previous studies in several sports have reported a significant association between ACWR and injury risk when players show low chronic workloads compared to high chronic workloads (Bowen et al., 2019; Colby et al., 2017). In this sense, high chronic workloads are considered protective. In contrast, low chronic workloads are proffered as insufficient to induce adaptations or result in detraining, potentially predisposing athletes to injuries when “spikes” of workload occur (Bowen et al., 2019). However, a recent study by Wang et al. (2020) has challenged the ACWR concept indicating the use of a ratio to represent changes in workload may not be the most meaningful measure to predict the relationship between activity and injury risk. In addition, Impellizzeri et al. (2020) suggest that manipulating ACWR in practical settings to change injury rates is still a conjecture and an over interpretation of the available data. As ACWR is not unidirectionally related to injury risk, the authors recommend implementing alternative methods to assess causality between changes in workload and injury risk in the future.

The present study has several limitations. Firstly, the current study had a small sample size, but recruiting many players with this level of expertise is challenging in tennis due to their extensive travel schedules. Future studies should endeavour to include more tennis players over multiple seasons. Secondly, we did not account for potential internal risk factors such as previous injury, age, or fitness (i.e. flexibility, strength). Further research is required to consider the potential influence of these confounds. Also, the present study analysed only internal load, so future work to benefit from the analysis of both internal and external loads. Finally, we did not consider the type of training performed even though the tennis and fitness load could be considered separately.

In conclusion, the present study is the first to examine the association and predictive ability of internal workload markers with injury risk in high-performance young tennis players. Our findings support the use of workload monitoring in tennis and, more specifically, justify the implementation of a monitoring strategy of workload using the s-RPE in high-level tennis players. Our results revealed an association between acute workload and injury risk in high-performance tennis players. Special attention must be paid to those weeks in which the players’ workloads increase, requiring more emphasis on adequate recovery strategies. However, this should not be confused with the ability of acute workload to predict injury at an individual player level, as in most weeks, an increase in absolute workload was not accompanied by an injury. To this regard, a high acute workload is only one of several factors associated with injury and has a low predictive ability for injury.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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