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Original research

Does the recent internal load and strain on players affect match outcome in elite Australian football?

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ABSTRACT

Objectives: To compare recent internal training load and strain of elite Australian football players for match outcome.
Design: Case study.
Methods: Load was quantified from session rating of perceived exertion (sRPE) for individual players from one team in 141 professional Australian football matches over six seasons, then averaged for players that competed for the team each week. Internal weekly-load and weekly-strain (load × monotony) was compared to recent-load and recent-strain (four-week rolling average) as a marker of training-stress balance for each player against the match outcome. Covariates for relative position of teams in the competition and days between matches were modelled. Differences were standardised (effect size; ES) and interpreted using magnitude based inferences.
Results: Weekly-load was *likely* higher for match wins (ES ± 90% confidence limits; 0.43 ± 0.27), and when days-break was used as a covariate (0.45 ± 0.27) but only *possibly* higher with relative ladder position covaried (RLP, 0.29 ± 0.33). There was a *possibly* greater positive training–stress balance for load in wins (0.31; ±0.38) with db (0.39; ±0.39) and RLP covaried (0.27; ±0.48). There were no clear differences for strain for wins and losses or with either covariate. There was a *likely* greater positive training-stress balance for strain in wins (0.51; ±0.41) with days-break (0.48; ±0.41) but not RLP covaried.
Conclusions: Weekly-load and a positive training-stress balance for strain were the best predictors of match success. The higher weekly-load and training-stress balance for strain highlight the conflict between maintaining the training stimulus and minimising fatigue in Australian football players between matches.

1. Introduction

There are many factors that affect the outcome of Australian football matches, including, but not limited to, the relative position of the two teams competing,[1] injuries to key athletes,[2] physical capacity,[3] and especially tactical and technical ability.[4] It is unknown how recent training load affects match outcomes.

The internal load on team-sport athletes can be determined from the session rating of perceived exertion method (session RPE)[5] that has been validated for use in team-sports[6] including Australian rules football.[7] Whilst a valid and reliable measure of internal load acutely, the dose response relationship between session RPE and training or fitness has not been established in this athletic cohort. Despite this gap in the knowledge, sport scientists allocate substantial resources to monitoring the internal load on athletes during a competitive season,[8] yet the influence of recent training load on subsequent match performance in elite footballers has not yet been investigated.

The likely effects of recent training load on performance can be considered through the prism of the effects of load on injury risk. One of the key risk factors for injury in athletes is transient fatigue induced through training load.[7,9,10] In at least one elite Australian football team, an increase in 1 or 2 week total load above a threshold of 2250 or 4000 arbitrary load units, respectively, increases injury risk by a factor of 2.58.[9] In another elite club, an increase in weekly load of >10% per week increased injury rates, although this study suffered from limited capacity to estimate small effects given the low incidence ($N = 5$) of injury occurrence during the data collection period.[10] Similarly, in elite cricket fast bowlers, a spike in acute workload relative to the previous four weeks' workload, termed training-stress balance, resulted in up to 3.3 times the injury risk.[11,12] In elite Australian football where there can be 6–13 days

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between matches, protecting players from large weekly increases in training load requires careful management, and must be considered within the context of the effect of training load on injury, physical performance and potentially match outcomes.

Acute load thresholds are useful, but fail to take into account the recent internal load of players. Training can be divided into smaller units, each with a specific goal, and these can be termed meso-cycles. Meso-cycle length varies, typically between 2 and 6 weeks duration.[13] Thus one definition of the recent load on athletes is the load accumulated in median of typical meso-cycle length, the previous 4-weeks of training and that will be used in this study. If the model where performance = fitness minus fatigue[8] applies, then athletes will more than likely experience periods of fatigue during acute high load phases. Thus the weekly load should be considered within the context of recent weeks of training. A spike in weekly training load relative to the recent weeks of training may decrease the performance of players, yet this approach has not yet been determined.

The strain on team-sport athletes (the product of how much load and how similar that stimulus is in any given week)[14] may also contribute to injury and sport match performance. In a group of primarily speed-skaters, strain was the best predictor of subsequent illness with a large[15] ($r = 0.60$) correlation.[16] The effect of varying strain on the performance of team-sport athletes has not yet been investigated.

Coaches strive to ensure players are at peak-physical capacity for matches. Team-sport athletes are required to focus on match-to-match wins, as each match in the regular season counts equally to the Premiership table and the ultimate success of the team. Thus, if additional training is considered to enhance the physical capacity of players "in-season"[17] the injury risk of players may be temporarily increased. Concomitantly, the match performance of players may be reduced acutely, yet the effect of changes in internal load on players has not yet been investigated. The aims of this study were, therefore, to determine: The effect of recent training load and strain of individual players on match outcome, defined as wins or losses; and if relative ladder position or days between matches mediated this effect.

2. Methods

Fifty-nine elite Australian footballers (age 24.7 ± 3.3 yrs; height 187.1 ± 7.6 cm; body mass 90.4 ± 8.2 kg) at the time of commencement involvement in the study, [Mean ± Standard Deviation (SD)] gave informed consent to participate in this study. The study was approved by the Victoria University Human Research Ethics committee. Participants were all registered players of one Australian Football League Club.

Internal load was quantified from the session rating of perceived exertion (sRPE) method[5] validated for use in Australian football[7] for elite individual players that competed in each week from one team in 141 professional Australian football matches (71 wins, 70 losses) over 6 seasons. Average weekly internal load (WL) from combined matches and training and strain (load × monotony or sameness of load;[5,14] WS) and WL and WS compared to average monthly load (four week rolling average, ML) and strain (four-week rolling average; MS) respectively for each player was compared against the match outcome, defined as wins or losses. Training stress was calculated by dividing the weekly workload by the four-week workload, as previously described.[11] The training-stress balance was deemed to be negative when the current week of training exceeded the four-week average of training load or strain; and therefore positive when current training was lower than the four-week average of load or strain, respectively.[11] Covariates for relative position of teams in the competition and days between matches were also modelled.

All data, including covariates were log-transformed prior to analysis to reduce bias arising from non-uniformity error. Differences between match wins and losses were standardised (effect size; ES) and interpreted using a magnitude based inference approach.[18] Threshold values were >0.2 (small), >0.6 (moderate) and >1.2 (large). Uncertainty in each effect was expressed as 90% confidence limits (CL) and as probabilities that the true effect was substantially positive or negative.[15] These probabilities were used to make a qualitative mechanistic inference about the true effect as previously described.[15]

3. Results

Weekly-load, training stress balance for load, weekly-strain, and training stress balance for strain for wins versus losses are presented in Fig. 1A–D. Data in text below are presented as a standardised effect with lower and upper confidence limits.

Mean weekly load on players was *likely* higher for match wins (0.43 [0.17;0.70], Fig. 2A), and when days break (db) was used as a covariate (0.45 [0.19;0.72], Fig. 2A) but only *possibly* higher with the covariate relative ladder position (0.29 [−0.04;0.62], Fig. 2A).

There were no clear differences for mean weekly strain for wins and losses or with wither covariate, Fig. 2B. The WL was *possibly* higher than ML for wins (0.31 [−0.07;0.70], Fig. 3A) when db was used as a covariate (0.39 [0.00;0.78], Fig. 3A) and for the covariate RLP (0.27 [−0.22;0.75], Fig. 3A). The WS was *likely* higher than MS for wins (0.51 [0.11;0.92], Fig. 3B) when db was used as a covariate (0.48 [0.06;0.89], Fig. 3B) but not for the covariate RLP (−0.02 [−0.53;0.49], Fig. 3B).

4. Discussion

The main findings of this study are that (1) in this elite Australian football team, weekly-load was higher preceding wins versus losses; (2) that outcome holds when the days break between matches are considered, but the effect is weakened by the relative ladder position of the teams; (3) For wins, there was a possible greater difference (i.e. greater positive training-stress balance), and this effect remained when days break, and relative ladder position were considered; and (4) the training stress balance for strain weekly and mean monthly strain was a strong discrimator of wins versus losses.

The weekly "in-season" training schedule for elite Australian football teams typically comprises recovery in the 24 h post-match that likely involves water immersion or pool-based mobility sessions.[9,19,20] The remainder of the training week typically involves up to two strength training, three skill training sessions[19] potentially with further water-based recovery sessions interspersed.[21] The internal load on athletes thus comes from varied sources. The number of days-break between matches has a large bearing on how much skills and strength training is performed, as a 6-d break leaves little room for training when it takes up to 72-h to recover from a match.[19]

When days break was taken into consideration, the weekly-load was still higher for wins than losses. One explanation for this effect remaining is that with little time between expected recovery from the previous match[19] to overlay a new training stimulus, it is relatively easy to program training. That is, there is little scope for training, so it is likely only one meaningful football training session can occur to allow sufficient time to recover for the upcoming match. It is somewhat counter-intuitive that with a short training week, internal load would still be higher for wins than losses. This outcome may highlight the need for a quality training stimulus to maintain the physical capacity of these athletes, such as the sprint interval training recently tested in sub-elite soccer players.[22] It is