Indeed association does not equal prediction: the never-ending search for the perfect acute:chronic workload ratio

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LET'S GET SOMETHING STRAIGHT

We recently demonstrated *associations* between workload and injury.[1 2] Regrettably, in these manuscripts, we used the words '*predict*' and '*predictive*' within the titles. Although we clearly used more appropriate language throughout these manuscripts, the titles of our work have resulted in a misconception that we believe the acute:chronic workload ratio can predict injury with some certainty.[3 4] Our purpose for investigating workload–injury relationships in these studies was to identify workloads that practitioners could use (along with other information) to make informed decisions in regards to when injury *risk* may be increased or decreased—it was not our intention to imply that one variable could predict injury with crystal ball-like accuracy. We discussed at length that other variables will undoubtedly also have *associations* with injury,[1 2] and that good athlete monitoring involves consideration of factors in addition to workload.[5] However, we feel that these views may have been dismissed and, consequently, our purpose here is to provide novel perspectives and some clarity and context on the practical applications of the acute:chronic workload ratio.

AN ACUTE:CHRONIC WORKLOAD RATIO OF 1.5 IS NOT THE MAGICAL BOUNDARY WHERE ALL TRAINING SHOULD CEASE AND DESIST

The acute:chronic workload ratio should *never* be viewed in isolation. The size of an athlete's chronic workload is one of many other factors that should be monitored with equal importance. For example, figure 1 shows the proportion of rugby league players who are injured and remain injury free when subjected to acute:chronic workload ratios combined with low or high chronic workloads.[1] When players have a low chronic workload and are subjected to acute:chronic workload ratios of 1.4–2.2, 89–94% of these players remain injury free and 6%–11% sustain a time-loss injury. Conversely, when players are subjected to acute:chronic workload ratios >1.5 and have a high chronic workload, the proportion of injured players is increased to 29% (relative risk, 2.6–4.9), and 71% remain injury free.[1] Using these data, the acute:chronic workload ratio of 1.5 alone is almost worthless for providing the entire workload–injury relationship. A simple recommendation to avoid acute:chronic workload ratios of 1.5 does not provide coaches enough information to maximise the benefit of monitoring workloads for purposes of increasing performance and decreasing injury risk.

ACUTE AND CHRONIC WORKLOADS CAN BE USED FOR THE TEAM *AND* THE INDIVIDUAL

Planning the periodisation of a team should involve the comparison of acute and chronic workloads for the purpose of reducing the probability of players sustaining an injury—not for the purpose of 'predicting' whether injuries will definitely occur. Using our rugby league example, if a squad of players have high chronic workloads and coaching staff develop a training plan that will subject these players to acute:chronic workload ratios greater than 1.5, then nine players (29%) in a 30-man squad may sustain an injury (figure 1B). A sensitivity and specificity analysis of these data will no doubt highlight that these workload measures alone have poor accuracy for predicting injuries. However, losing 29% of a squad over a short period is likely to have a detrimental effect on team performance. The primary focus of monitoring workloads should not be 'predicting' injuries, but rather identifying the acceptable level of injury risk for a particular environment and reducing the probability of an unacceptable proportion of players sustaining an injury, which may provide teams the best possible chance of success.[6]

Using the same workload scenario with an individual athlete, a high chronic workload combined with an acute chronic workload ratio >1.5 would mean that there is a 71% likelihood that the player will not sustain an injury. This is hardly worth rushing to inform the coach that the athlete's training must cease. However, there is evidence that other factors will further influence this athlete's probability of injury.[7 8] As such, there are a few possible ways that a conversation with a coach may develop, two of which are:

1: "*Coach, we have noticed that Johno had a big week. However, he has good strength and aerobic capacity, no previous injury history and is not an older player.*

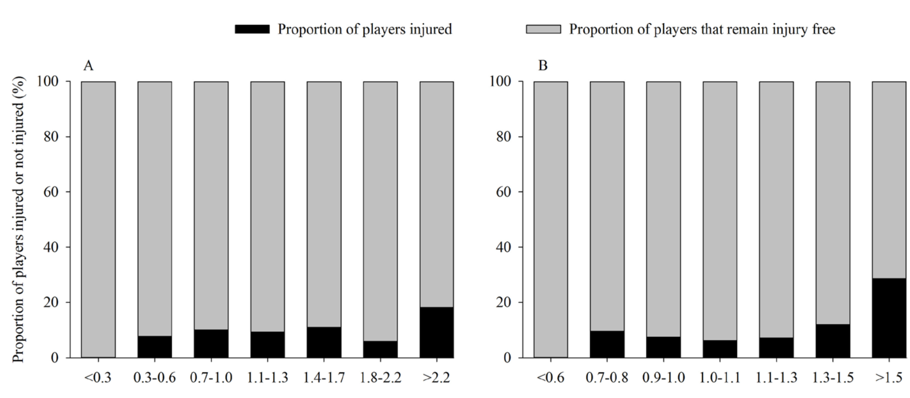

Figure 1 Proportion of rugby league players who are injured (black bars) and remain injury free (grey bars) when subjected to acute:chronic workload ratios combined with low chronic workload (<16.1 km (A)) and high chronic workload (>16.1 km (B)). Note: x-axis data have been categorised by z-scores. Data have been adapted from Hulin *et al*.[1] Readers are referred to previous work[1] for further details on these data.

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We will monitor his recovery and it is likely that he will be okay to continue training".

2: *"It was a big week for Macca. His strength and aerobic capacity are not great and he has a few previous injuries. We may need to modify his training pending how he recovers"* .

At no point do we need to alert the coach that there are 'red flags' and we should be highly concerned for this particular player. The coach has been given some information that we know is *associated* with increased injury risk—he/she can factor in their own opinion on the importance of that particular player to the training day and/or week and whether training modification will have an influence on the team's performance.

TRANSLATING RESEARCH TO PRACTICE WILL ALWAYS BE ABOUT CONSIDERING MULTIPLE VARIABLES AND OUTCOMES

No isolated study provides all the relevant information to allow practitioners to predict injuries, and we doubt one ever will. Challenges for practitioners are (1) reading and deciphering all of the literature relevant to their sport, (2) choosing which studies provide practical applications for their environment and (3) implementing evidence-based systems that minimise the risk of injury—predicting sport injuries will never be an exact science.

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