A better way to determine the acute:chronic workload ratio?

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We read with great interest the recent letter "Time to bin the term 'overuse' injury: Is 'training load error' a more accurate term?" [1], and in particular its associated PostScript correspondence, "Are rolling averages a good way to assess training load for injury prevention?" [2]. We are currently investigating the association between training loads and injury risk [3], and so we have also been considering the best way to model this relationship. We share Dr. Menaspà's concerns regarding the use of rolling averages for the calculation of 'acute' and 'chronic' loads. Namely, that they fail to account for the decaying nature of fitness and fatigue effects over time [4], and do not accurately represent variations in the manner in which loads are accumulated (as demonstrated in the example data presented by Dr Menaspà [2]). To mitigate some of these issues, we propose the use of 'exponentially-weighted moving averages (EWMA)' [5] for the calculation of acute and chronic loads, which assign a decreasing weighting for each older load value. Specifically, the EWMA for a given day is given by:

$$EWMA_{today} = Load_{today} * \lambda_a + ((1 - \lambda_a) * EWMA_{yesterday})$$

Where λ_a is a value between 0 and 1 that represents the degree of decay, with higher values discounting older observations at a faster rate. The λ_a is given by:

$$\lambda_a = 2/(N + 1)$$

Where *N* is the chosen time decay constant, typically 7 and 28 days for acute ('fatigue') and chronic ('fitness') loads, respectively. One and four week time-frames appear to align well with the periodisation strategies used in many team sports, although alternative time-constants may be more appropriate in different settings. Applying this method to the example data presented by Dr Menaspà [2] produces a different acute:chronic workload on day 28 for each of the three fictitious athletes (1.25, 1.41 and 1.55, respectively), whereas the use of rolling averages produces three identical values (1.43). Thus, in the case of athlete one, the two approaches differ with regards to whether the athlete is considered to be within or beyond the 'sweet spot' region of 0.8-1.3 [6]. Using athlete three as an illustrative example (Figure 1), in comparison to rolling averages the EWMA approach gives more weighting to the high loads undertaken towards the end of the 28 d period (when estimating 'fatigue') and so produces a higher (and we propose, more appropriate) acute:chronic workload ratio on day 28.

Thus, the EWMA approach may be better-suited to the modelling of training loads than rolling averages, and so we believe this method warrants consideration in future research and practice.

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Figure legend

Figure 1. A demonstration of the differing acute:chronic workload ratio values produced when using the EWMA and rolling average methods. EWMA values were initialised with the load value for Day 1, and used time-decay constants of 7 and 28 days for acute and chronic loads, respectively.