The acute-chronic workload ratio-injury figure and its ‘sweet spot’ are flawed

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This is a preprint of the request of retraction or errata submitted to British Journal of Sports Medicine as a revised letter (R2) the 31st May 2019 (first submission, 28th February 2019) and currently under review.

Dear Editor,

Immediately following the publication of two studies^{1,2} that described the relationship between ACWR and injury risk, the BJSM published an editorial including a figure demonstrating ACWR – injury risk relationship (Figure 1A)³. This figure was re-published soon after (with some aesthetic modifications) in another editorial in this journal⁴ (Figure 1B). This relation used likelihoods of injury (LI) and injury risks corresponding to different training load constructs (internal and external), taken from uniquely different sports (cricket, rugby and Australian football), and combined published¹ with unpublished data.

In their editorial, the authors described how the figure was created: *“For our purposes, we have taken either: (1) The midpoint of the acute:chronic workload ratio range (i.e., 0.5 – 1.0 becomes 0.75, as our acute:chronic workload ratio score). Or (2) In the case of the end-point ranges, that is, 0.0 – 0.5 or >2.0, the acute:chronic workload ratio has been entered as 0.5 or 2.0.”*

Although we have several other conceptual and methodological concerns (that we will discuss elsewhere), the particular concern we raise in this communication is the manner in which these data have been combined and adjusted to show the ACWR-injury risk relationship. These adjustments make the ACWR figure unreliable. In the two original studies used to develop this figure^{1,2} the ACWR values were combined into discrete specific categories and the LI and risk of injury were calculated relative to each category, which assumes the risk of injury within the category is equal.⁵ To create the ACWR-figure in the editorials, these data points^{1,2} were merged with unpublished data. For the published data, the authors attributed the LI corresponding to a range of ACWR values to its midpoint and for the open ranges to the starting-points. After this, they transposed these points (originally corresponding to discrete categories) on an x-axis treating them as continuous variables. Through this the authors have moved the individual data points (corresponding to the extreme categories) to the right/left placing them closer to the center of the graph. Additionally, in the ACWR figure, the authors have also attributed some LI values to different categories than they were originally calculated. For example, the LI calculated for ACWR<0.3 in one of the original studies² was assigned to another category because there are no points corresponding to 0.3 in the figure but only at 0.5. Whilst this was not explained in the editorial, the only

alternative explanation is that this value was excluded, which is even more serious. The same was approach was taken with the injury risk data point corresponding to an ACWR >2.11 since the original value reported in table 4² (central column) was 11.8 but this point is not in the figure: i.e. it was attributed to a different category or omitted. With an x-axis representing categorical variables, it would still not be possible to combine the LI values given the two original studies used different ACWR categories.^{1,2} In addition, it is inappropriate to combine LI values calculated from the exposure to different measures of training load (agent), since these are not interchangeable (distance, perceived load, counts of ball bowled). Lastly, the LI reported in the original studies have been calculated as the number of injuries sustained relative to the number of exposures to each workload classification, which is not an LI or injury risk but actually an injury rate. In light of all these methodological errors, fitting the polynomial after this data manipulation is clearly inappropriate and the resulting curve flawed other than not interpretable.

Finally, a coloured version of the figure was later published with the addition of the ACWR “sweet spot”⁴ where the LI is claimed to be lower. Unfortunately, this sweet spot was not apparent in the two original studies. It only appeared after visual inspection of the new figure, which has been developed with the aforementioned methodological problems and included unpublished data that shaped this relation.

This figure was presented with the intent to be “illustrative only” and “just a guide”. However, even if only provided for such purposes, this figure has since been republished 5 times in the BJSM and to our knowledge at least 7 times in total, including two consensus one of which (the IOC consensus) presented this flawed relation as validated.^{6,7} This has increased the reader’s trust, providing credibility to potentially misleading information and favoring its spread over social media and practitioners. Last but not least, several researchers have used this quadratic relation as a reference model to fit their data instead of examining the best model. The resultant problems created among practitioners and the scientific community are quite evident.

Since the ACWR figure is unreliable, we request a retraction of the original editorials or an errata corrigé acknowledging and advising the reader that initial ACWR figures are flawed and therefore misleading.

Competing interest None

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FIGURE LEGEND

Figure 1. Original “illustrative” figures by Blanch et al.³ (A) and Gabbett⁴ (B) showing the relation between Acute:Chronic Workload Ratio and likelihood of subsequent injury published in 2016 on the *British Journal of Sports Medicine*.

A

Figure 2 The acute:chronic workload ratio and subsequent injury likelihood from studies of three different sports. The fitted polynomial line ($\pm 95\%$ CIs) has an $R^2=0.53$ and the equation: likelihood of subsequent injury = $9.98 \text{ acute:chronic workload ratio}^2 - 18.42 \text{ acute:chronic workload ratio} + 11.73$. This equation can allow us to approximate the injury likelihood for any given acute:chronic workload ratio.

B

Figure 6 Guide to interpreting and applying acute:chronic workload ratio data. The green-shaded area ('sweet spot') represents acute:chronic workload ratios where injury risk is low. The red-shaded area ('danger zone') represents acute:chronic workload ratios where injury risk is high. To minimise injury risk, practitioners should aim to maintain the acute:chronic workload ratio within a range of approximately 0.8–1.3. Redrawn from Blanch and Gabbett.⁴