BARÇA
INNOVATION HUB
Universitas

ASSESSING TRAINING AND TRAINING LOAD MANAGEMENT

MICROCYCLE ANALYSIS

3.1 Introduction

For many authors, the week of training, or microcycle, is the operative planning unit in team sports, meaning that the proper distribution and management of the training load (training and match) is of great importance. This analysis is fundamental in order to optimize the athlete's conditional state, detect possible over- or under-stimulation and try to reduce athlete's injury incidence.

3.2 The Weekly Workload (total)

Literature provides many works that describe the weekly load accumulated by teams in different contexts. Akenhead (2014), with a Premier League team, provides values with 300 minutes of training, a total distance of 20 km traveled, running 400 meters at high speed and close to 100 meters sprinting.

Table 1: Description of the training week for professional soccer players

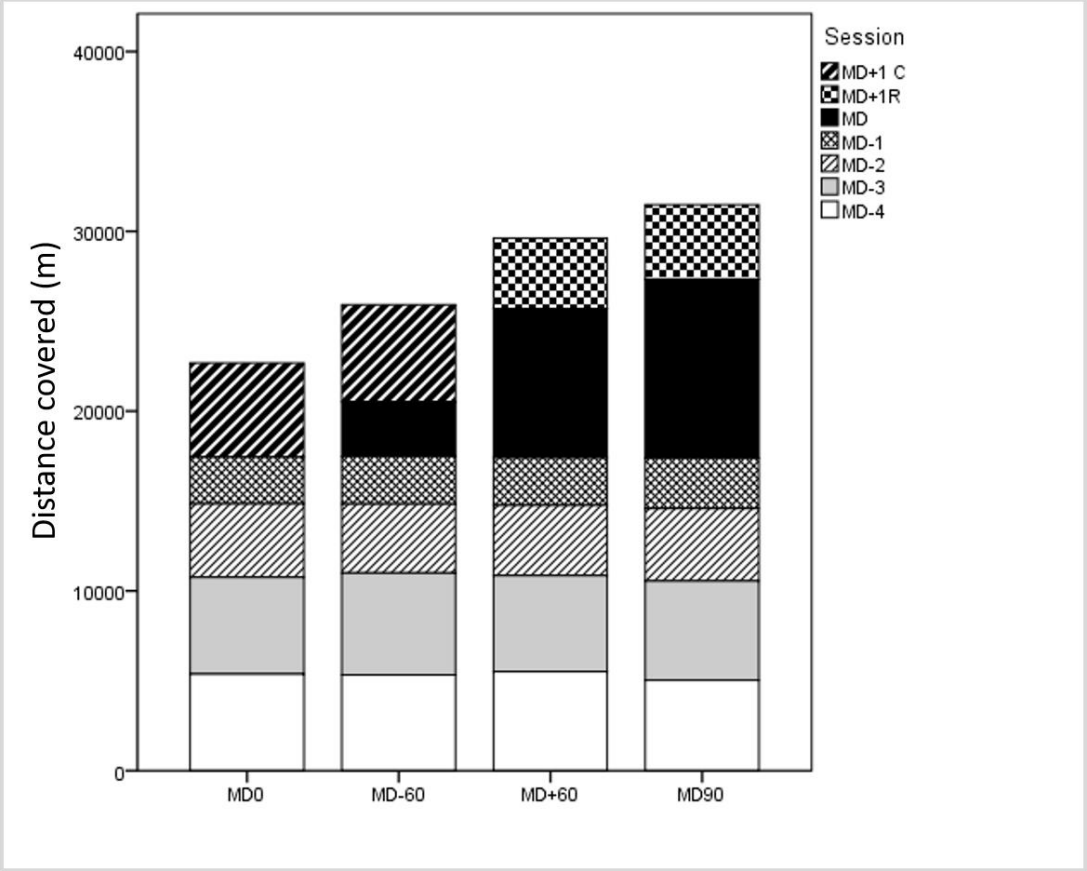
Variables	Weekly Total
Duration (min)	304
Total distance covered (m)	19939
Distance covered at high speed (m)	398
Number of actions performed at high speed (n)	39
Distance Covered at Sprint (m)	87
Number of actions at sprint (n)	6
Number of Accelerations (n)	816
Number of Decelerations (n)	790
Time at >90% $_{max}$HR (min)	21
Load on the player (session-RPE (Rating of Perceived Exertion); AU)	2093

Source: Prepared by the author based on Akenhead, 2014.

However, as previously mentioned, simply describing the weekly demands may not be sufficient to be able to make the right decisions when it comes to managing the total workload (total of the training process and competition). This analysis can certainly be carried out in order to obtain the average for the team, providing us with information about the demands placed on the team, which can in turn assist us in the management of training loads. From there, the analysis may be carried out according to different groups of players, down to an individual analysis, player by player, which we understand to be the proposal that, in the field of performance, enables the most finely-tuned management of training loads.

In the example shown in Figure 1, the distance covered is shown for 4 groups of players, depending on the minutes of competition accumulated in the previous match. This shows how the distance covered is less among the group that did not play a single minute of the previous match and that this weekly value increases as the number of minutes played during the previous match increases. This chart also shows the sessions during which the data was gathered. As we can see, the group that played the entire match (match day; MD90) accumulated the greatest distance covered, but this also occurs in the group of players who played for more than 60 minutes during the match (MD+60). Figure 1 also shows that there are few differences between the load accumulated over sessions MD-4, MD-3, MD-2 and MD-1 in the different groups of players. Lastly, we can see how session MD+1 (the session held the day after the match) presents a clear difference with session MD+1R for the players who accumulated the most time during the match (MD+60 and MD90), while the players who had accumulated the least minutes had a compensatory session (MD+1C for the MD0 and MD<60).

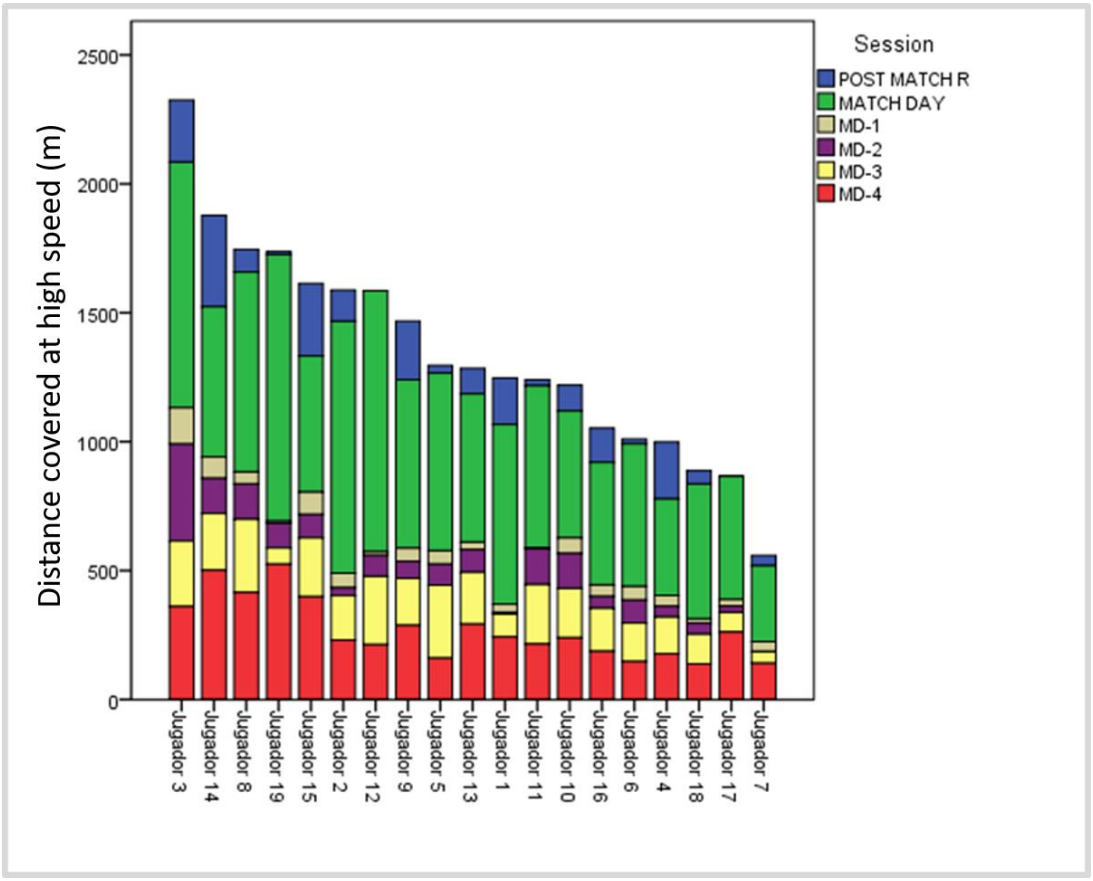
Figure 1: Cumulative distance covered (m) during weeks with 6 days between matches in which 5 training sessions are held with one day off and one day of competition



Source: Prepared by the author.

About Figure 1: The groups have been analyzed based on the number of minutes accumulated in the previous match. MD0 means that the player did not play for even one minute during the previous match; MD-60 means that the player played for less than 60 minutes during the match the previous week; MD+60 means that the player played for over 60 minutes during the match the previous week; and MD90 means that the player played the entire match.
Lastly, as already mentioned, weekly load can be expressed as follows:

Figure 2: Distance covered at high speed (m) accumulated over different training sessions for each player



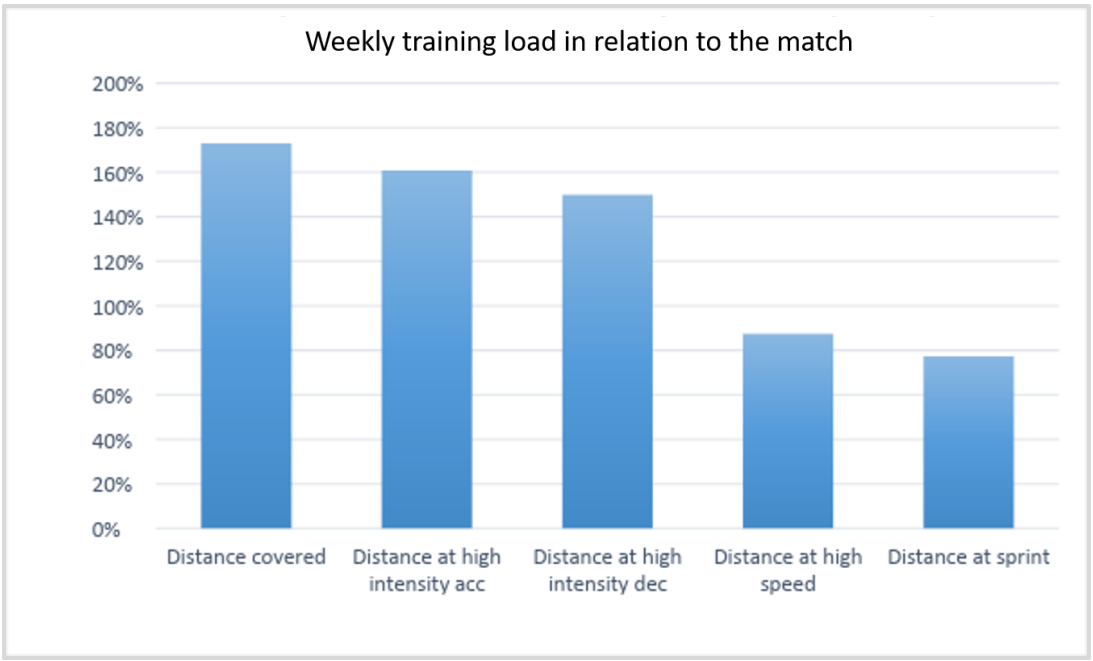
Source: Prepared by the author.

About Figure 2: this figure refers to the distance of the different training sessions held during the week of training and during the match. The values have been put in descending order according to the accumulated weekly distance.
However, this analysis does not consider the competition demands for which the players must prepare themselves. In this sense, expressing weekly demand according to competition demand, as previously explained in the training session analysis, would make it possible to compare the load placed on each athlete compared to their training needs.

3.3 Training Load on % of Match Demands

However, just as was the case when we studied the training sessions, when it comes to comparing players, this is particularly interesting if we analyze it in accordance with the match demand. The values given in Figure 3 refer to unpublished data for a player from a semi-professional soccer team in weeks with 6 days between matches. Only training values have been included, so the demands of the competitive match are excluded. We can observe how the training week exceeds the match demand in the variables of total distance covered and distance covered accelerating and decelerating at high intensity, while the values obtained during a match for the variables of distance covered at high speed and distance covered sprinting were not reached.

Figure 3: Weekly training load corresponding to the match demand on a specific player

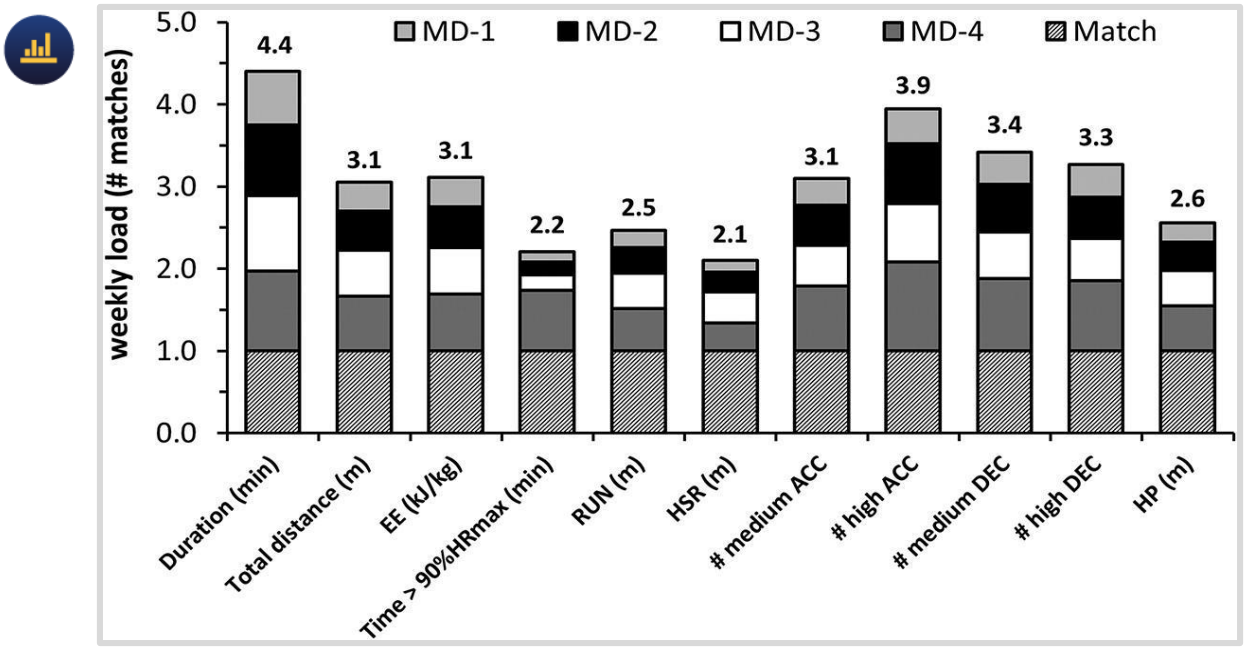


Source: Prepared by the author.

About Figure 3: the match demand has been excluded from the analysis.

However, the competitive load is hugely important given its magnitude and it is of vital importance that it be monitored and included in the weekly workload analysis. Stevens, De Ruiter, Twisk, Savelsbergh and Beek (2017) recently reported on the load placed on athletes during different types of weeks compared to the competitive demand. Figure 4 shows how the duration in minutes and the number of high intensity accelerations reach values similar to the 4 matches while the distance covered at high speed reaches the values of a little more than two matches.

Figure 4: Weekly load in different match-related variables



Source: Stevens et al., 2017, p. 4.

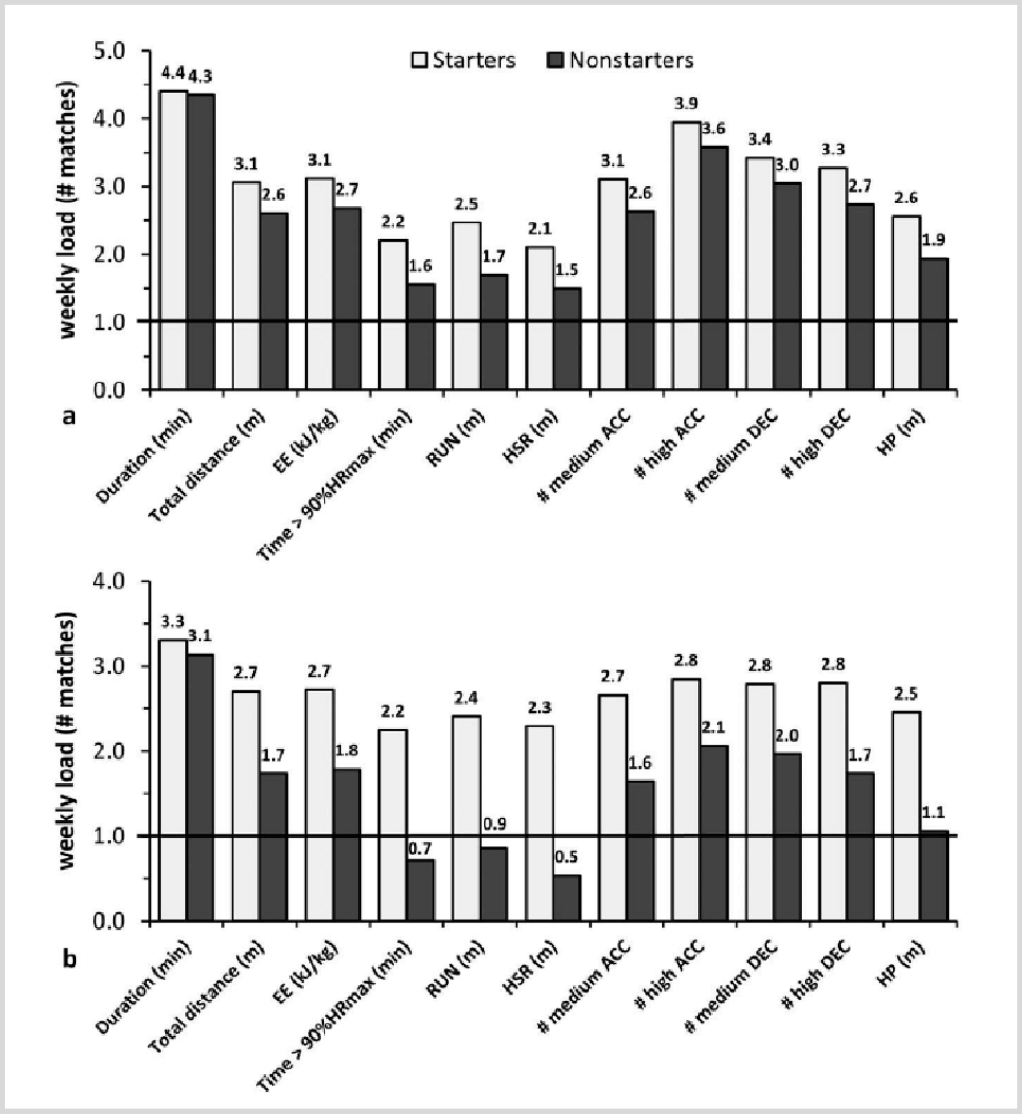
About Figure 4: The match demand has been included in the analysis. Session MD-4 refers to a training session held 4 days before the match, and so on for M-3, MD-2 and MD-1.

This same group of authors provides the starters' values in relation to the non-starters, in weeks with one match and in weeks with two matches (Figure 5). From the results of these works, we can draw a number of interesting conclusions.

- If we consider the starters, almost all the variables reach lower levels when there are two matches per week, except for distance covered at high speed, which is higher when there are two matches per week.
- If we consider the non-starters, there is a significant decrease in the load level when there are two matches per week compared to when there is only one match per week.

- All of the variables reach higher levels than those corresponding to a match, except for weeks with two matches and among non-starters, the time spent at >90% of $_{max}$HR, the distance covered sprinting and the distance covered at high speed.
- The difference in the load placed on non-starters compared to starters is greater when there are two matches during the same week, and the distance covered at high speed is the variable that differs the most.

Figure 5: Weekly load in different variables regarding the match for starters and non-starters



Source: Stevens et al., 2017, p. 6

About Figure 5: The match demand has been included in the analysis. The top image is for a week with one match while the bottom image is for a week with two matches.

3.4 Relationship Between Weekly Training Load and Probability of Injury

With regard to the relationship between the weekly load and the probability of injury, there are works published on other team sports that may be of interest. However, the findings should be interpreted with caution given the differences between the sports. In rugby, Hulin, Gabbett, Lawson, Caputi and Sampson (2015) find that the probability of injury is significantly lower when the weekly load is very low and significantly higher when the weekly load is very high, with players being 18 times more likely to suffer an injury. The practical application that we can take away from these findings has to do with:

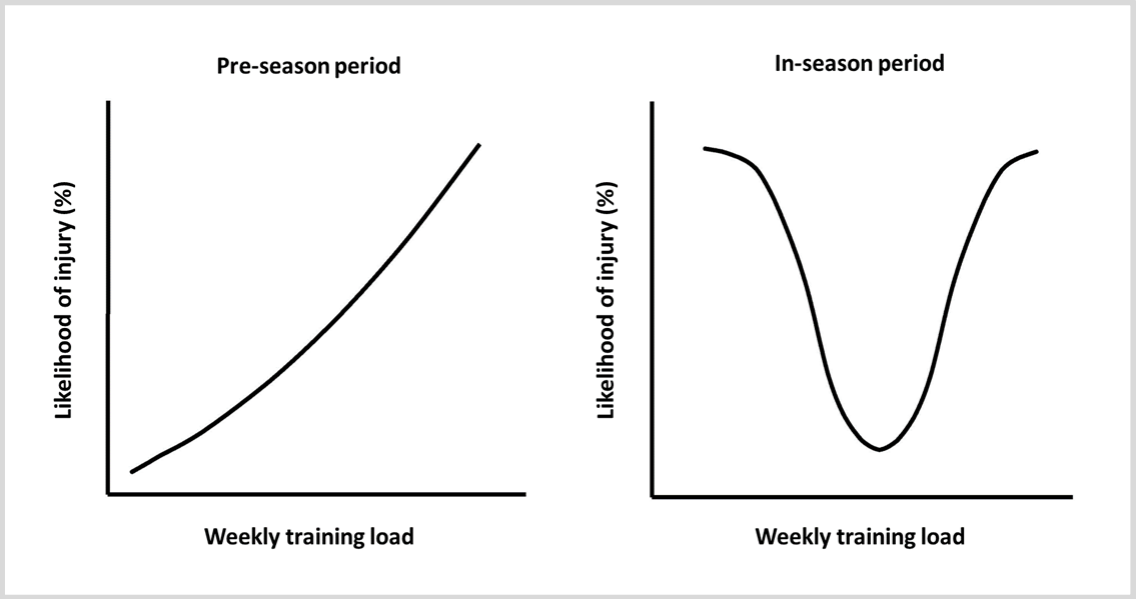
a) Using very low weekly loads when training the athletes;
b) Avoiding very high weekly loads.

However, and as we will see below, moderately high loads can have a protective effect on athletes and therefore reduce the probability of injury. Additionally, very low loads, especially if they are repeated over time, can lead to decreased physical fitness in the athlete, which increases their probability of injury.

Specifically in the field of soccer, recent research has provided knowledge that is very applicable in the management of training loads and that, given its specificity, should be taken into consideration when it comes to establishing a methodology for training and competition load management. Malone et al. (2017), in their study carried out with two top tier European teams, find a significant increase in the probability of injury as the level of load increases during pre-season, meaning that the probability of injury is tripled when the weekly load exceeds a value of 3200 arbitrary units (AU, obtained using the subjective perception of the effort method) in comparison to when the weekly load is less than 1500 AU. Notwithstanding, during competition season, the relationship between load and probability of injury is U-shaped, with less

probability when loads are moderately high (between 2120-3200 AU), increasing significantly when the load is greater than 3200 AU. However, in the case of high loads (>3200 AU) the probability of injury increases during pre-season in relation to competitive season (Figure 6).

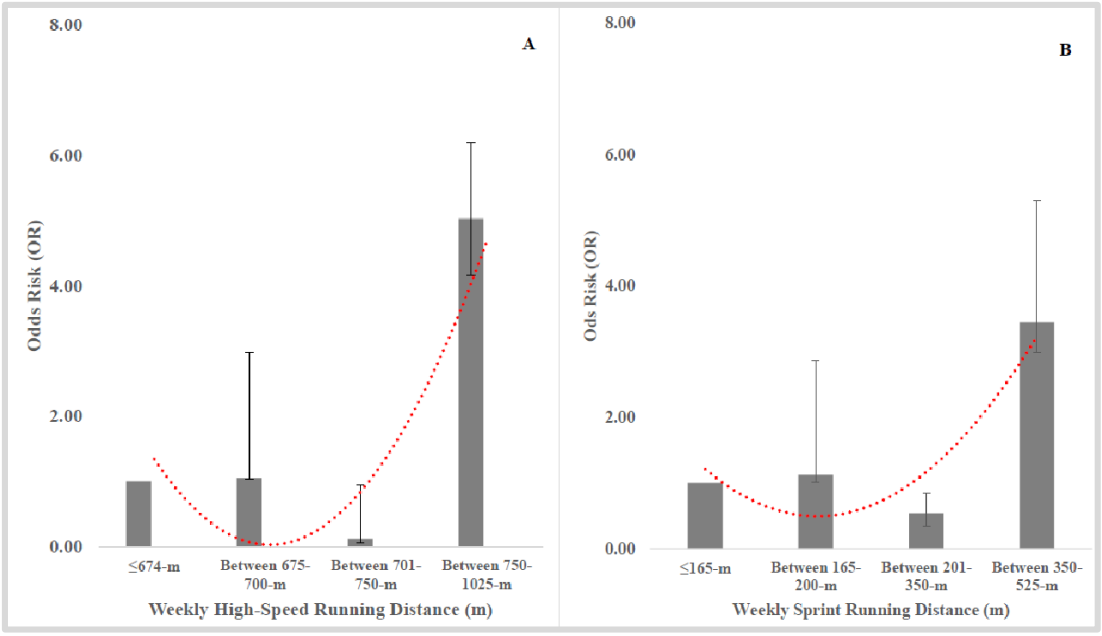
Figure 6: Relationship between the level of weekly training load and the probability of injury during pre-season and competitive season



Source: Malone et al., 2017.

The relationship between weekly external load and probability of injury has recently been studied. Initially, the relationship with the total distance covered was studied, and then the relationship between certain types of specific movements (e.g. distance covered at high speed) and specific pathologies was studied in greater depth. Malone et al. (2018), in Portuguese soccer players, they found that a moderate weekly load (701-750 m) of distance covered at high speed (>14.4 km-h-1) and sprints (>19.8 km-h-1; 201-350 m) decreases the chance of injury (OR = 0.12 and 0.54, respectively), while the probability of injury increases significantly if the distance covered at high speed is between 750-1025 m (OR = 5.02) and the sprint distance between 350-525 m (OR = 3.44).

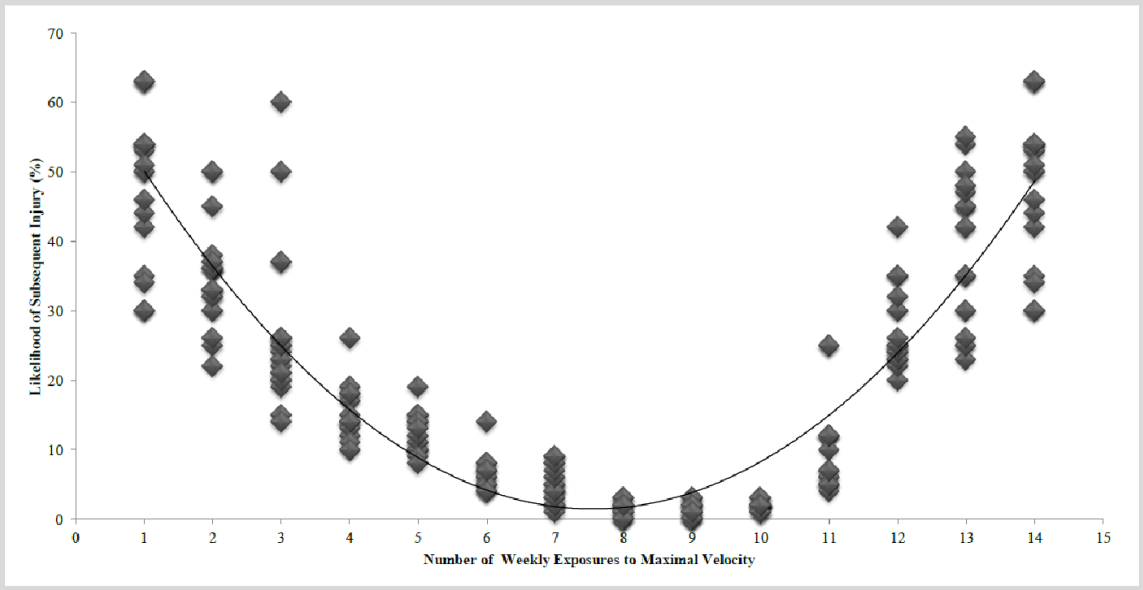
Figure 7: Relationship between the weekly distance covered at high speed (A) and the weekly distance covered sprinting (B) and the probability of lower limb injury in professional soccer players



Source: Malone et al., 2018.

As such, it would appear that, when it comes to actions performed at high speed, there is a certain workload that has a protective effect, as may be observed in Figure 8, when we link the probability of injury to the number of exposures to actions categorized as maximum speed per week.

Figure 8: Relationship between weekly exposure to maximum speed actions (in number of actions) and probability of injury the following week



Source: Malone et al., 2018.

In fact, these same authors find a relationship between the top speed reached by the player during the week and the injury rate (Table 2). This is why it would appear that having our athletes perform activities close to their maximum speed (100% of the individual maximum speed) has a certain protective effect compared to when the highest value recorded by the player during the week is below 85% of their individual maximum speed.

Table 2: Relative maximum speed (%) as an injury risk factor in Gaelic soccer players

Relative Maximum Speed (%)	Probability of Injury (OR)
< 85% maximum speed (reference)	1.00
85%-90% of maximum speed	0.72
90-95% of maximum speed	0.22
>95% of maximum speed	0.12

Source: Prepared by the author based on Malone et al., 2017.

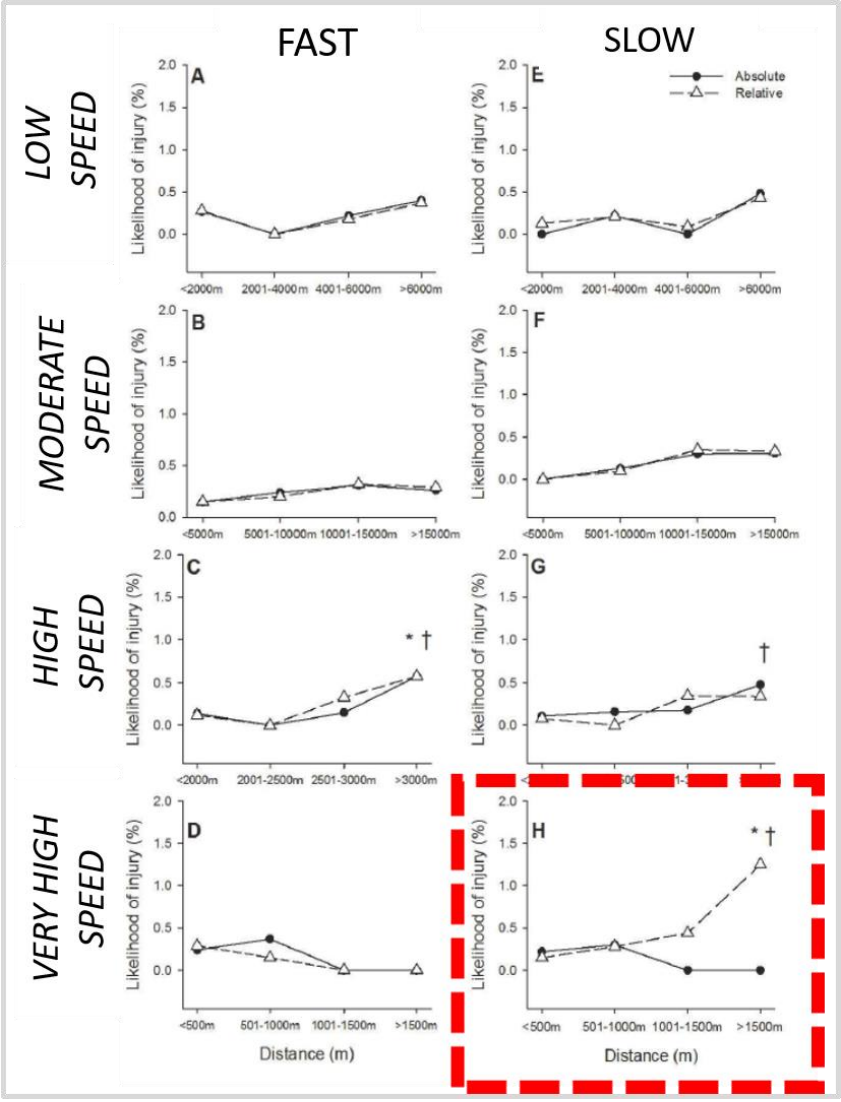
About Table 2: the OR data is compared to the cited group.

Jaspers et al. (2017) perform a study on external and internal load levels in soccer players with injuries due to overuse. In this sense, injures were categorized as being due to overuse when they were caused by repeated trauma, without a specific event being identified as having caused the injury. The load values for each variable were put into three groups based on the percentiles obtained: low load, intermediate load and high load. The results obtained over two seasons show that, when the weekly load in terms of distance covered was high (>31.161 m), the probability of injury increased in relation to when the weekly load was low (<23.554 m; OR: 1.4290 % 0.92–2.21). However, the response to distance covered at high speed (>20.9 km·h-1) was different, with the probability of injury increasing under the intermediate load (634-1028 m; OR: 1.56, 90 % CI: 0.99–2.46), and no differences were found when the load was low (<634 m) or high (>1028 m). Meanwhile, differences in weekly load, in the number of accelerations and decelerations and subjective perception of the effort do not show any variation in the probability of injury.

Recently, different relationships have been found between the weekly training load and the probability of injury based on the subjects' maximum speed (Figure 9). Thus, they were categorized into slow or fast. It has been observed that the athletes categorized as slow, when they perform a large weekly load of distance covered at very high relative speed (depending on individual maximum speed), they have a greater risk of injury than when the distance covered at very high speed is shorter. In this sense, it appears that it is necessary to monitor those athletes classified as slow using individual speed ranges. Specifically, the distance covered at high speed by those classified as

slow is underestimated by absolute values and, when using absolute speed categories, an increase in weekly load does not increase the probability of injury. However, when individual speed ranges are used and the distance covered at very high-speed is greater than 1500 m, the probability of injury is 8 times greater than when this group of athletes travel <500 m within their individual speed range (Murray, Gabbett, & Townshend, 2017).

Figure 9: Probability of injury under different weekly loads in different speed categories for the group of athletes categorized as slow and the other group categorized as fast



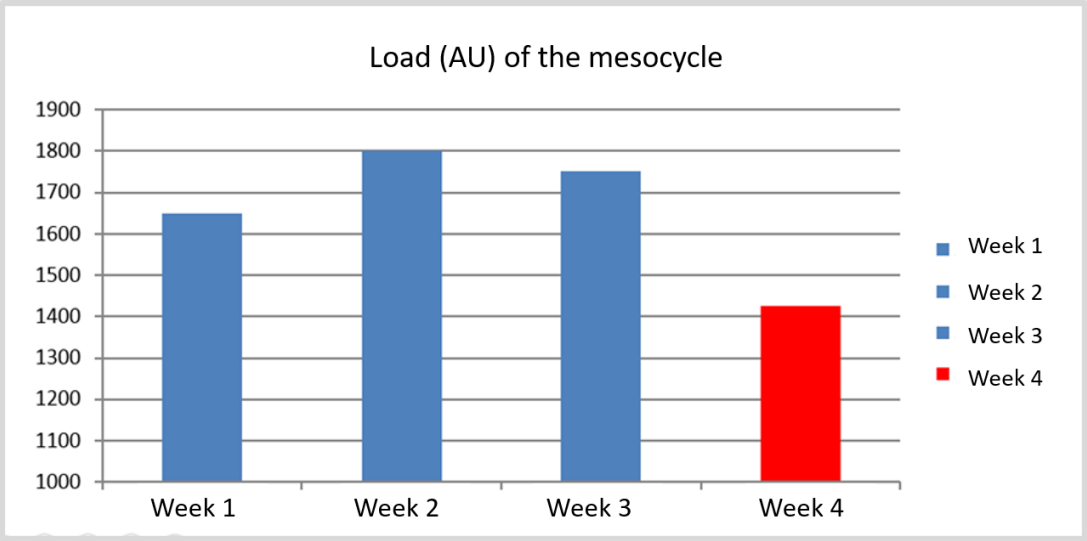
Source: Murray et al., 2017, p. 21.

3.5 Relationship Between Weekly Training Load and Performance

Lastly, very little research has delved into the relationship between weekly load and performance. On one hand, the difficulty of establishing athletic performance in team sports makes establishing the aforementioned relationship problematic. The activity performed by the athlete during competition (total distance traveled at high speed or sprinting) is considered a demand rather than performance, as it is heavily conditioned by contextual variables (Castellano et al., 2011).

However, some works have focused on the study of the relationships between the weekly training load and the activity of the player during the match. Although the analysis should be performed taking into account not only the activity performed during the previous week, but also the activity performed during all previous weeks, in the work of Fessi at al. (2016) the authors find that in match activity during week 4 in which tapering is used (a decrease in training load) is 15% higher than match activity in other weeks.

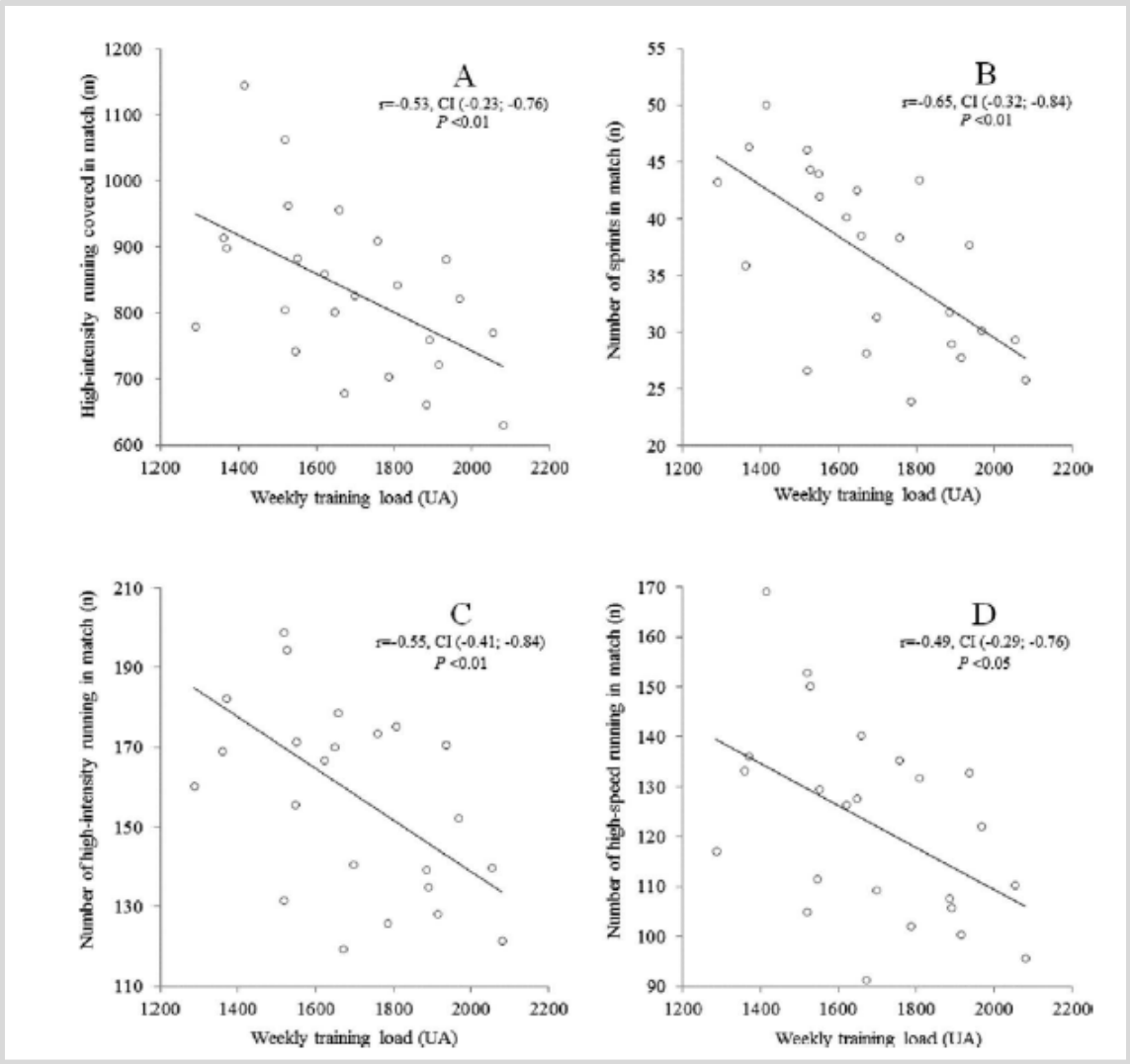
Figure 10: Training load over 4 weeks



Source: Fessi et al., 2016.

Furthermore, there is an inverse relationship between the weekly training load and the player activity during the match. For example, the number of sprints is lower when the training load is higher. The hypothesis is that the fatigue generated during the week of training could reduce the activity performed by the player during competition (Fessi et al., 2016). Therefore, although more scientific research is still needed on the matter, in the aforementioned study, a decrease of 25% in the weekly training load, which was not at the expense of the average perceived exertion of the training, led to a 15% increase in the distance covered at high intensity at the league game during that microcycle. This is a very interesting line of study.

Figure 10: Weekly training load and activity performed during match

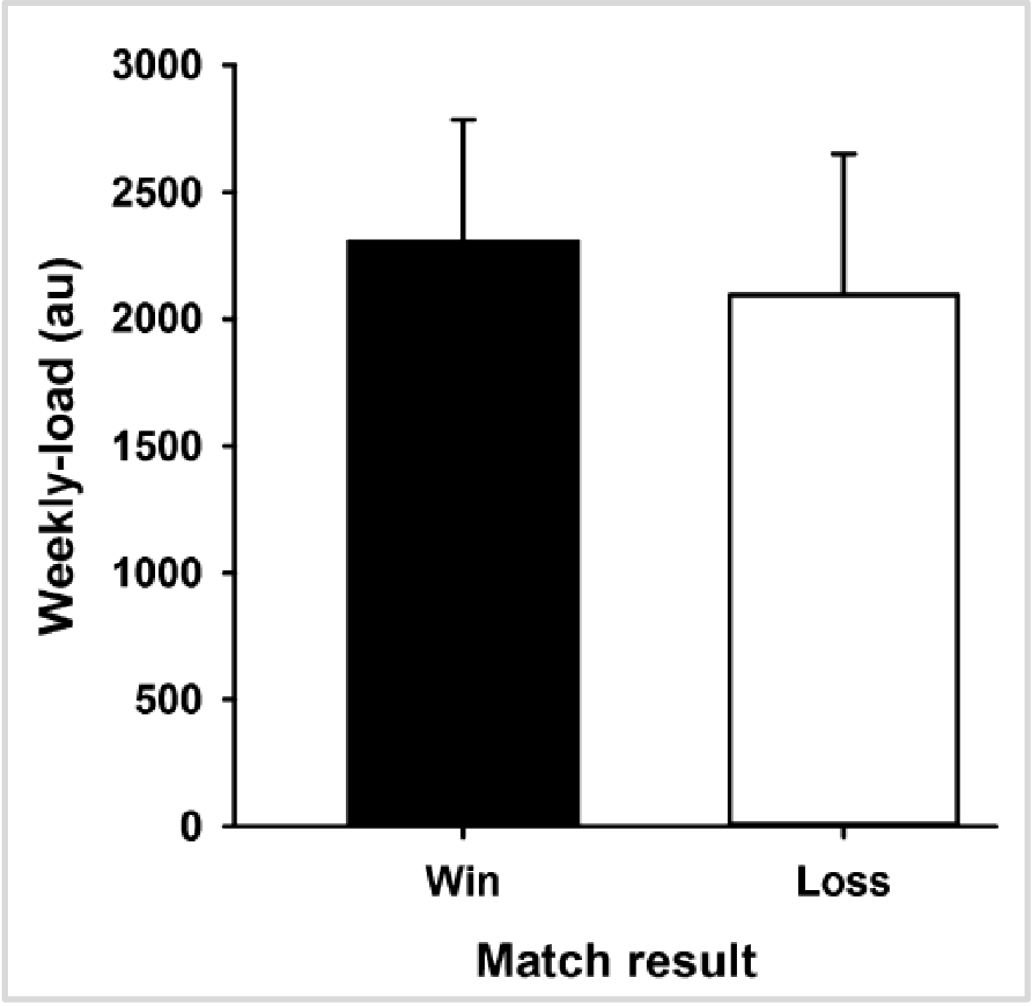


Source: Fessi et al., 2016, p. 4.

Meanwhile, although we see little justification in establishing a relationship between the management of the training load and the outcome of the match, instead of being more in favor of studying its relationship with performance rather than outcome, some research has been carried out on this relationship. This shows us that there is little validity in establishing the relationship between winning or losing a match and the weekly load placed on the athlete. However, in this sense, Aughey, Elias, Esmaeili, Lazarus and Stewart (2016) compared

training load during weeks in which teams won with that of weeks in which teams lost, and they found no significant difference between the load placed on the athletes during weeks in which they won compared to the weeks in which they lost.

Figure 11: Training load during weeks in which the team wins and loses



Source: Aughey et al., 2016, p. 16.

It would appear that winning or losing does not have much to do with the load imposed on athletes during the training week, at least if this variable is analyzed independently. Later on, we will show how including the weekly load,

taking into consideration the activity performed during previous weeks, is related to the activity performed during competition. Future research needs to take a more in depth look at this relationship between weekly load and performance, perhaps using the athlete's state of readiness for competition, measured using subjective questionnaires or an objective measure of performance or fatigue prior to competition (Thorpe et al., 2017).

References

Akenhead, R. (2014). *An examination of the training loads within elite professional football* (Doctoral Thesis). Newcastle: Northumbria University.

Aughey, R. J., Elias, G. P., Esmaeili, A., Lazarus, B., & Stewart, A. M. (2016). Does the recent internal load and strain on players affect match outcome in elite Australian football? *J Sci Med Sport*, *19*(2), 182-186.

Castellano, J., Blanco-Villaseñor, A., & Alvarez, D. (2011). Contextual variables and time-motion analysis in soccer. *Int J Sports Med*, *32*(6), 415-421.

Fessi, M. S., Zarrouk, N., Di Salvo, V., Filetti, C., Barker, A. R., & Moalla, W. (2016). Effects of tapering on physical match activities in professional soccer players. *Journal of Sports Sciences*. doi: 10.1080/02640414.2016.1171891.

Hulin, B. T., Gabbett, T. J., Lawson, D. W., Caputi, P., y Sampson, J. A. (2015). The acute:chronic workload ratio predicts injury: high chronic workload may decrease injury risk in elite rugby league players. *Br J Sports Med*, *50*(4), 231-236.

Jaspers, A., Kuyvenhoven, J. P., Staes, F., Frencken, W. G. P., Helsen, W. F., & Brink, M. S. (2017). Examination of the external and internal load indicators' association with overuse injuries in professional soccer players. Journal of science and medicine in sport. DOI: 10.1016/j.jsams.2017.10.005

Malone, S., Owen, A., Mendes, B., Hughes, B., Collins, K., & Gabbett, T. J. (2018). High-speed running and sprinting as an injury risk factor in soccer: Can well-developed physical qualities reduce the risk? *J Sci Med Sport*, *21*(3), 257-262.

Malone, S., Owen, A., Newton, M., Mendes, B., Collins, K. D., & Gabbett, T. J. (2017). The acute:chronic workload ratio in relation to injury risk in professional soccer. *J Sci Med Sport*, *20*(6), 561-565.

Malone, S., Roe, M., Doran, D. A., Gabbett, T. J., & Collins, K. (2017). High chronic training loads and exposure to bouts of maximal velocity running reduce injury risk in elite Gaelic football. *J Sci Med Sport*, *20*(3), 250-254.

Murray, N. B., Gabbett, T. J., & Townshend, A. D. (2017). The use of relative speed zones in Australian Football: are we really measuring what we think we are? *Int J Sports Physiol Perform*, *5*(1), 1-25.

Stevens, T. G. A., De Ruiter, C. J., Twisk, J. W. R., Savelsbergh, G. J. P., & Beek, P. J. (2017). Quantification of in-season training load relative to match load in professional Dutch Eredivisie football players. *Science and Medicine in Football*, *1*(2), 117-125.

Thorpe, R. T., Strudwick, A. J., Buchheit, M., Atkinson, G., Drust, B., & Gregson, W. (2017). The Influence of Changes in Acute Training Load on Daily Sensitivity of Morning-Measured Fatigue Variables in Elite Soccer Players. *Int J Sports Physiol*, *vol.*(0).