BARÇA
INNOVATION HUB
Universitas

ASSESSING TRAINING AND TRAINING LOAD MANAGEMENT

ANALYSIS OF THE TRAINING TASK

Introduction

Today, the demands of training tasks are the subject of widespread study. These analyses have prompted the publication both of scientific research as well as books (Casamichana, San Román, Calleja & Castellano, 2016). This has brought about a wider understanding of players' acute response when performing in different training situations. As such, there is now specific literature about how an increase in the dimensions of the playing space could affect heart rate response, or how distance covered changes when moving from a task where the aim is to maintain possession of the ball to a task involving goals, rules, and goalkeepers, or what happens if wild cards are introduced into a previously proposed task, to name a few examples.

However, the methodological process is fundamentally importance for decision-making during the training process, when we seek to maximize performance by optimizing conditioning systems, with the always implicit focus on minimizing the likelihood of injuries.

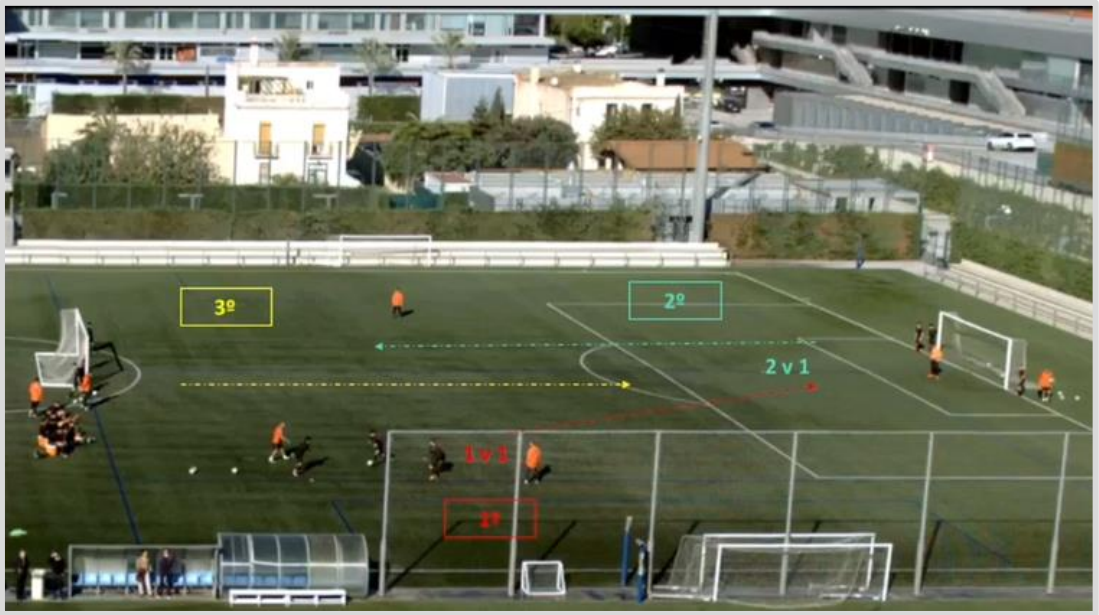
Description of the Demands of the Training Task

The description of the demands imposed on athletes during the performance of a training task is one of the classic uses of technology in the world of sport. Along these lines, the incorporation of GPS technology and its later developments and advances has allowed for the detailed study of every action performed by athletes in the execution of each task (and during each of the repetitions) assigned in training.

Let's take a look at an example of this process. To do this, we have chosen a task that is included in the training process. The task begins with a 1 vs. 1 situation, in which the attacking player enjoys positional advantage and has to try to score in the opposing goal. Once this action has been completed, the defensive player, along with a new teammate, begins to play as 2 vs. 1 in the opposing goal, finishing up with the defense from the 2 vs. 1 attacking the opposing goal along with a new teammate and against a new opponent. This is a training task in which players' efforts have a certain intermittent quality, since they have recovery periods once they have participated in the task. Furthermore, the duration of these active sequences exhibit a certain variability

in terms of their starting point and the way in which the action develops. It is worth mentioning that it is not necessary to have a specific understanding of the task given as an example in order to develop a methodological process for analyzing training tasks.

Figure 1: Photograph of the proposed training situation in action



Source: Prepared by the author.

Next, let's take a detailed look at the absolute load values that are produced in the execution of this training task, taking note of different variables. For example, we provide the mean value of different load variables in terms of the entire team, as well as more detailed values for two of the players participating in this task. This information describes to us the activity performed by the athletes and we understand that it is one of the first steps that should be taken when monitoring or assessing training load. However, we understand that training load management requires a methodological process that allows us to make decisions while managing training loads.

Table 1: Values for different load variables during the task illustrated in Figure 1 for the team's mean average and for two players participating in the task

	Distance (m)	Distance at high speed (m)	No. of sprints (n)	High intensity accelerations (n)	High intensity decelerations (n)
Team	1107.	207.	12.	13.	8.
Player 1	1094.	185.	10.	13.	8.
Player 2	913.	237.	12.	12.	5.

However, this information only gives us the load values, since they are values that accumulate during the total duration of the task. This would not allow us, therefore, to compare the intensity of the task with other training tasks of differing durations, or with the same task performed in another session, but having a different duration. Therefore, relating these demands to the minute played can make this process easier for us. At this point, let's remember that expressing load values relative to each minute played merely gives us the intensity values, and that, once we multiply them by the volume (duration in minutes) we will obtain the load values.

Table 2: Values for different intensity variables (relative to each minute) during the task illustrated in Figure 1 for the team (mean) average, and for two players participating in the task

	Distance ($m \cdot min^{-1}$)	Distance at high speed ($m \cdot min^{-1}$)	No. of sprints ($n \cdot min^{-1}$)	High-intensity accelerations ($n \cdot min^{-1}$)	High-intensity decelerations ($n \cdot min^{-1}$)
Player 1	109.4.	18.5.	1.	1.3.	0.8.
Player 2	91.3.	23.7.	1.2.	1.2.	0.5.
Team	110.7.	20.7.	1.2.	1.3.	0.8.

Source: Prepared by the author.

Intra-Subject Comparison

Intra-subject comparison allows for the comparison of an activity performed or a demand involved in carrying out a training task by a single player at different times. It is a process that is equally applicable for comparing different repetitions in a single training session, as well as comparisons of tasks performed (or repetitions of a task) in different training sessions.

Thus, returning to the previously-cited example, for player 1 we can express the changes produced in intensity by using the data derived from the performance of the same training task at two other times during the season.

Table 3: Values for different intensity variables (relative to each minute) during the task illustrated in Figure 1 for player 1 in different training sessions

	Distance ($m \cdot min^{-1}$)	Distance at high speed ($m \cdot min^{-1}$)	No. of sprints ($n \cdot min^{-1}$)	High-intensity accelerations ($n \cdot min^{-1}$)	High-intensity decelerations ($n \cdot min^{-1}$)
Session 1	109.4.	18.5.	1.	1.3.	0.8.
Session 2	115.3.	24.5.	2.	1.2.	0.5.
% change	5.4.	32.4.	100.0.	-7.7.	-37.5.

Source: Prepared by the author.

In the example offered, only the % change has been calculated, using the formula ((session 2 - session 1)/session 1)*100. We can observe how, when the value is positive (the first three variables), it indicates that the intensity has increased during session 2 with respect to session 1. On the other hand, when the value is negative (variables 4 and 5) the intensity of session 2 is lower than the values obtained during session 1.

Although this approach is no doubt interesting, from a mathematical perspective there is room for improvement, especially considering the variability shown by each measurement. Without wanting to go into too much detail, we can note that we should not consider a 10% change in a variable with a low level of variability (i.e. where the subject's values are always grouped closely or are stable) in the same way that we would consider the same percentage change (10%) in a variable with a high degree of variation or variability. In this specific case, the alert could probably appear for the first of

the variables, not for the second, since in the latter case this 10% change – in relation to the mean value – could be within normal percentages of change and, therefore, would have no detectable clinical significance.

The expression of change, taking into account deviations of the measurement, or using similar procedures (by establishing and utilizing a minimum detectable change or via the z-score), allow for better measurement of these intra-subject changes and, therefore, can be of help in improving the management of the workload imposed on an athlete.

Inter-Subject Comparison

If one of the objectives of the conditioning training is to optimize players' physical behavior during competition, the demands of competition should be used as a guide during the training process. Thus, we must ensure that the demands to which players are subjected during competition match up with the demands of the training tasks, and thus acknowledge the characteristics of the demands as being highly contextual.

The behavior, and as such, the physical demands required to play as a full back (wide defender) on a team in which full backs have a heightened responsibility during the offensive phase – for example, adding depth in midfield for those teams and joining frequently in the attack – are different from those of a full back with few offensive duties, to give one example.

Because of this, the demands of competition for different players are strongly influenced by the playing style developed by the team, by the position the player occupies on the field, by the player's role in the team's strategy, or by a player's individual characteristics, among other factors. Thus, we need to train our players for a specific and well-defined way of playing; accordingly, making reference to competition is no doubt essential.

Table 4: Mean values for different intensity variables (relative to each minute) during competitive matches for two different players that play different positions – player 1 is a central defender, while player 2 is an attacking central midfielder – and the mean values for the team.

	Distance ($m \cdot min^{-1}$)	Distance at high speed ($m \cdot min^{-1}$)	No. of sprints ($m \cdot min^{-1}$)	High-intensity accelerations ($n \cdot min^{-1}$)	High-intensity decelerations ($n \cdot min^{-1}$)
Player 1	101.3 ± 5.8	4.7 ± 1.2	1.1 ± 0.5	1.8 ± 0.2	1.7 ± 0.2
Player 2	113.9 ± 8.7	6.4 ± 2.1	0.9 ± 0.5	2.1 ± 0.4	2.1 ± 0.4
Team	105.4 ± 10.7	5.9 ± 2.1	1.2 ± 0.8	1.8 ± 0.5	1.8 ± 0.4

Source: Prepared by the author.

Knowing the mean competitive demands that are imposed on each player, we have a reference for individualizing demands during the training process and, of course, for developing training tasks as well. Thus, in order to facilitate the comparison between the demands imposed on different players and to assess the demands imposed on them, we will express the demands of the task as a percentage of the mean demands of the match.

Table 5: Physical demands of the task, represented using intensity variables relative to each minute played, expressed as a percentage of each player's competitive demands

	Distance (%)	Distance at high speed (%)	No. of sprints (%)	High-Intensity Accelerations (%)	High-Intensity Decelerations (%)
Player 1	108.0.	393,6	90.9.	72,2	47,1
Player 2	80.2.	370,3	133,3	57.1.	23,8
Average	**94.1.**	**382,0**	**112,1**	**64,7**	**35,4**

Source: Prepared by the author.

The values in the preceding table represent two different players who occupy different positions – player 1 is a central defender, while player 2 is an attacking central midfielder. In addition, the mean values for the team are given. These calculations have been carried out following the example in Table 3 (demands of the task) and in Table 4 (demands of competition).

The calculation made to determine the tasks' intensity demands, taking into consideration the individual competitive demands, has been carried out using the following formula:

= (Intensity during the task*100) / mean intensity of the competitive match.

We can observe, for example, how the task under-estimates high-intensity acceleration-deceleration actions and particularly over-estimates the distance covered at high speed. At this point, we should recall that the task used as an example gives priority to movement at high speed, so these results confirm to us that this objective has not been achieved. At this level, the demands of the task exceed the demands of competition (by over three times) in the two subjects studied.

Furthermore, one of the players exceeds the team mean, both for the total distance covered as well as the number of sprints performed variable (by over 100%), while the other player doesn't reach these values because the intensity of the task is lower than the mean intensity of competition. If we pay special attention the distance covered variable, we observe:

- In Table 2, we can see that the demand (intensity) of the task is lower for player 2 than for player 1.
- In Table 4, we see that the competitive demand (intensity) is greater for player 2 than for player 1.
- Thus, if we express the demands of the task (intensity) relative to the demands of the match, the demand for player 2 is lower than that for player 1.

By assessing the demands of these tasks, we can come closer to making correct decisions during the training process. For the example shown, it would be reasonable to consider increasing demands in terms of distance covered for player 2, since his demand during the task is lower than the competitive demand (113.9 $m \cdot min^{-1}$ in a match and 91.3 $m \cdot min^{-1}$ during the training task), which might lead to an inappropriate adaptation if this situation were to repeat over time.

Lastly, it is worth pointing out that the intensity of the different variables studied during the training tasks are being compared to the mean intensity

variables recorded during the match, in which there are often very long periods between activities. The duration of a competitive match is 90 minutes plus added time, while the training tasks are usually much shorter. Furthermore, during the 90-minute duration of a competitive match, there are many moments with little activity, which causes a decline in the mean demands for the match. It is also worth pointing that the actual playing time (i.e. the time in which the ball is on the playing field and available to a player and, therefore, free from rule-based interruptions) is close to half of the total match time, and has been falling in recent years.

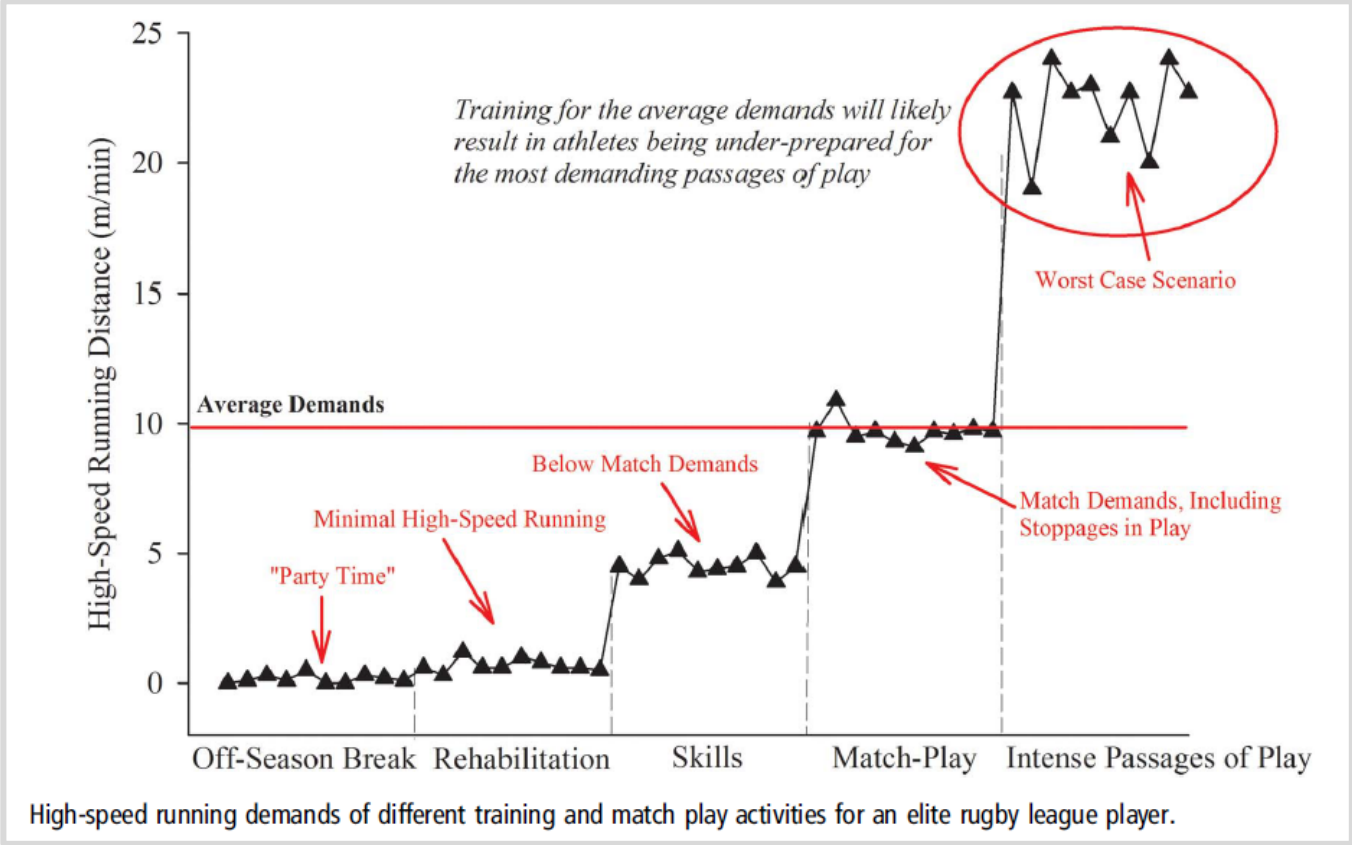
One step further in comparisons: assessments that take the maximum demand scenario as a reference

Training load, or intensity during the performance of a task can be expressed in absolute terms (for example, distance covered in m as a measure of load and in $m \cdot min^{-1}$ as an intensity variable), but also in comparison to the demands of competition. Thus, demand is a variable that can be represented relative to the % that a match represents or to some other reference value (season mean, mean for the last five matches, or mean for the matches having the most activity, for example). Thus, we would integrate the training needs of each athlete into the assessment, bearing in mind that individual references are used more often and references to playing position less often, since there is a certain variability between the demands imposed on players of the same position (Castellano and Blanco-Villaseñor, 2015).

Numerous studies have described the demands of competition in soccer (Castellano & Blanco-Villaseñor, 2015; Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009) and have been used as references in order to make comparisons with the demands of training (Stevens De Ruiter, Savelsbergh, & Beek, 2017), or tasks that are a part of training (Casamichana, Castellano, & Castagna, 2012; Dellal et al., 2012). However, within a match, as is reflected in Figure 2, there are periods in which demand can be reduced for all of the players on a team (such as, for example, periods with numerous rule-based stoppages, massive leads on the scoreboard, or relatively slow-paced matches) or for some specific players (i.e., the center of play is very far away due to increased action in a specific lane or sector of the field). Consequently, if our training sessions or training tasks prepare us to handle or tolerate the mean demands of the match,

then we would be underprepared for the more demanding phases within a match (Gabbett et al., 2016).

Figure 2: Distances covered at high speed per minute of participation in different training situations and competitions assessed



High-speed running demands of different training and match play activities for an elite rugby league player.

Source: Gabbet et al., 2016, p. 2.

Let's imagine a central defender during a phase of a match in which his team is attacking in the opponent's half, and in which his main role is to cover opposing players and provide support behind the line of the ball in order to facilitate ball circulation. It seems logical that this specific player would not experience any problems or difficulties in meeting the demands imposed on him by the match at those times. Thus, if – when comparing the demands imposed on the player during a training task – we include those moments from the match, the assessment might not fit with the player's training objectives.

In order to avoid this potential error during the assessment of the demands imposed on players during tasks, one interesting option is to compare the demands of the training task to worst-case scenarios, also known as maximum demand scenarios, to those that the player will face during competition, having durations similar to the repetitions performed during the training task (Gabbet et al., 2016). We should understand that determining potential worst-case scenarios for a player during competition is not a simple process, since it depends on the time period selected and the variables used to define that worst-case scenario (Lacome, Simpson, Cholley, Lambert, & Buchheit, 2017).

The most demanding moments or time periods within matches have been studied using different methodologies. A match broken up into predefined periods of play of 15 minutes (Carling, & Dupont, 2011), or of 5 minutes (Di Mascio, & Bradley, 2013), has shown higher peaks of activity in relation to the match mean, and the results increase as the duration of the studied period decreases. However, the match's worst-case scenario might not fall completely within these predefined blocks of time. Therefore, these methods underestimate the real worst-case scenario that is possible during competition (Varley Elias, & Aughey, 2012).

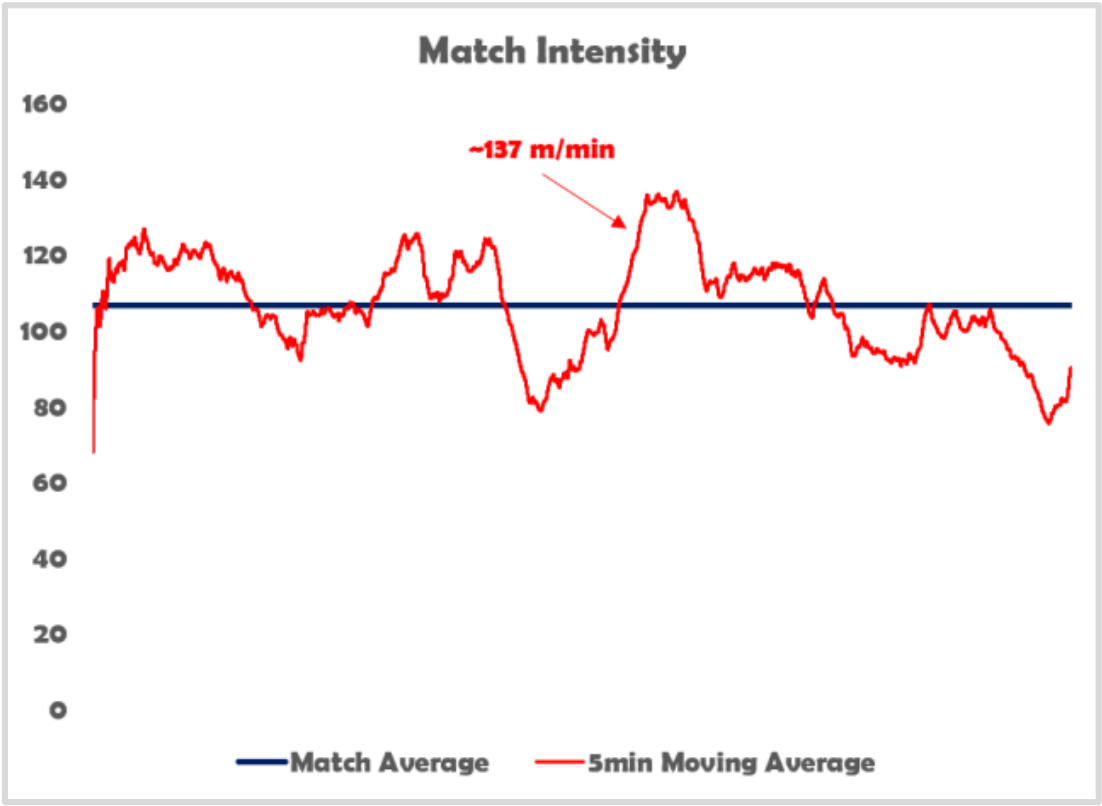
Alternatively, these worst-case scenarios may be established through the rolling method (using a moving average method) to ensure that players find themselves in the worst-case scenario. The procedure has been applied in Gaelic football (Malone, Solan, Hughes, & Collins, 2017), rugby (Delaney et al., 2016), Australian Rules football (Delaney, Thronton, Burgess, Dascombe, & Duthie, 2017) and soccer (Delaney et al., 2017; Lacome et al., 2017).

The concept of the *worst-case scenario* or the *maximum demand scenario* refers to those moments of the match in which the player or team are most active and can be continually calculated using different temporal intervals. Figure 3 shows that during the match there are moments in which the mean for the previous five minutes – the time period chosen in this example for the rolling method – far exceeds the mean values for the match. Thus, this analysis might be of much interest when:

- Designing training tasks that relate to maximum demand scenarios in competition.
- Assessing the demand imposed during training tasks on each player in relation to their maximum demand scenario for a length of time similar to that of the task.

In view of the example that appears in Figure 3, it is worth noting that, for tasks having a duration of close to 5 minutes, we should take into account that the assessed player registers periods of 5 minutes during the assessed match in which he reaches 137 $m \cdot min^{-1}$.

Figure 3: Distance covered ($m \cdot min^{-1}$) during a match



Source: Jace, 2018, https://goo.gl/355Ryj

Figure 3 shows the mean value for the match as well as values for periods of five minutes (the rolling mean of five minutes). This value takes as a reference the mean of the 5 minutes previous to the moment studied and thus is calculated continually.

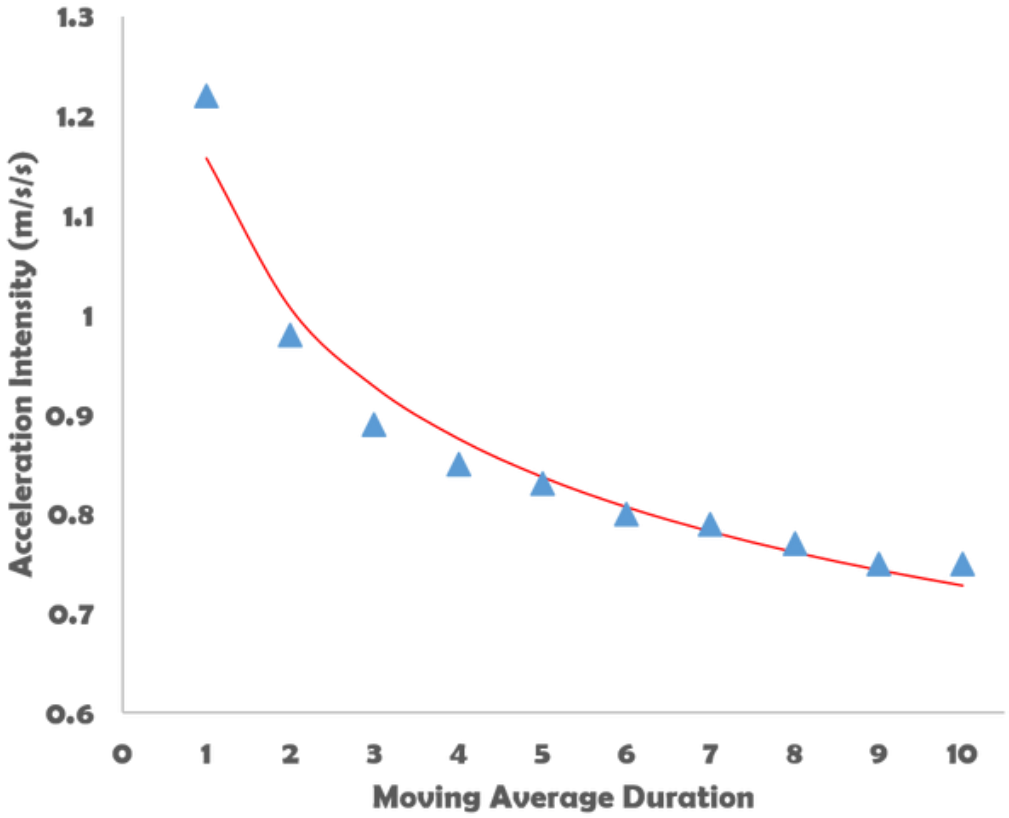
Table 6: Values for distance covered ($m \cdot min^{-1}$) and accelerations/decelerations ($m \cdot s^{-2}$) during different time periods

Duration	Speed ($m \cdot s^{-1}$)	Acceleration ($m \cdot s^{-2}$)
1	179 ± 15	1.22 ± 0.16
2	148 ± 13	0.98 ± 0.14
3	134 ± 11	0.89 ± 0.12
4	127 ± 10	0.85 ± 0.12
5	122 ± 9	0.83 ± 0.12
6	119 ± 9	0.80 ± 0.11
7	116 ± 10	0.79 ± 0.11
8	114 ± 9	0.77 ± 0.11
9	111 ± 8	0.75 ± 0.11
10	109 ± 8	0.75 ± 0.11

Source: Jace, 2018, https://goo.gl/355Ryj

Previously, in Figure 3, we saw the effect of rolling 5-minute periods on distance covered, while in Table 6, we see that mean values are time-dependent, such that the mean value diminishes as the time interval increases. For this reason, the values obtained in Figure 3 are of interest when we need to have references for comparing tasks whose repetitions last for approximately 5 minutes. However, for tasks with other durations, we would need to know the maximum demand scenario for competition.

Figure 4: Relationship between the intensity of acceleration ($m \cdot s^{-2}$) and the duration of rolling periods applied to the study of competitive demands



Source: Jace, 2018, https://goo.gl/355Ryj

The relationship between intensity and duration has been mathematically established through a simple formula that makes it possible to determine player intensity for any time period:

$$i = c*t^{n}$$

Where c is the intersection of the linear relationship between the two transformed logarithmic variables (intensity and duration); t is the duration of the exercise or period in question, and n is the slope of the model or the rate of

decrease of the performance intensity per unit of time (Delaney et al., 2017). This mathematical relationship seems to hold true for different sports and at different competitive levels, although the constants used to estimate the speed of play depend on the sport, the specific team's playing level and the manufacturer of the GPS devices used, among other factors.

In soccer, various studies have already proposed mathematical models that allow us to calculate intensity for any duration, although the ideal would be to study this relationship within our group of athletes.

Table 7: Values of the linear intersection of the two logarithmic variables, intensity and duration (intercept), and the rate of decline in the performance intensity per unit of time (slope) for the variables of distance covered ($m \cdot min^{-1}$) and mean accelerations/decelerations ($m \cdot s^{-2}$), as a function of the player's on-field playing position.

Code	Position	n	Relative Distance ($m \cdot min^{-1}$)		Average Acc/Dec ($m \cdot s^{-2}$)	
			Intercept	Slope	Intercept	Slope
Soccer	1. Centre Midfielders	49	196 ± 12[bf]	-0.17 ± 0.06	0.79 ± 0.05	-0.17 ± 0.03
	2. Central Defenders	78	173 ± 14	-0.17 ± 0.03	0.78 ± 0.06	-0.17 ± 0.03
	3. Strikers	33	193 ± 13[bf]	-0.18 ± 0.03	0.78 ± 0.06	-0.18 ± 0.03
	4. Wide Defenders	83	194 ± 17[bf]	-0.18 ± 0.04	0.86 ± 0.05[abcef]	-0.17 ± 0.03[f]
	5. Wide Midfielders	103	193 ± 14[bf]	-0.16 ± 0.03[df]	0.79 ± 0.06	-0.17 ± 0.03[f]
	6. Winger	88	184 ± 15[b]	-0.18 ± 0.04	0.82 ± 0.06[abce]	-0.18 ± 0.03

Source: Delaney et al., 2017, p. 13

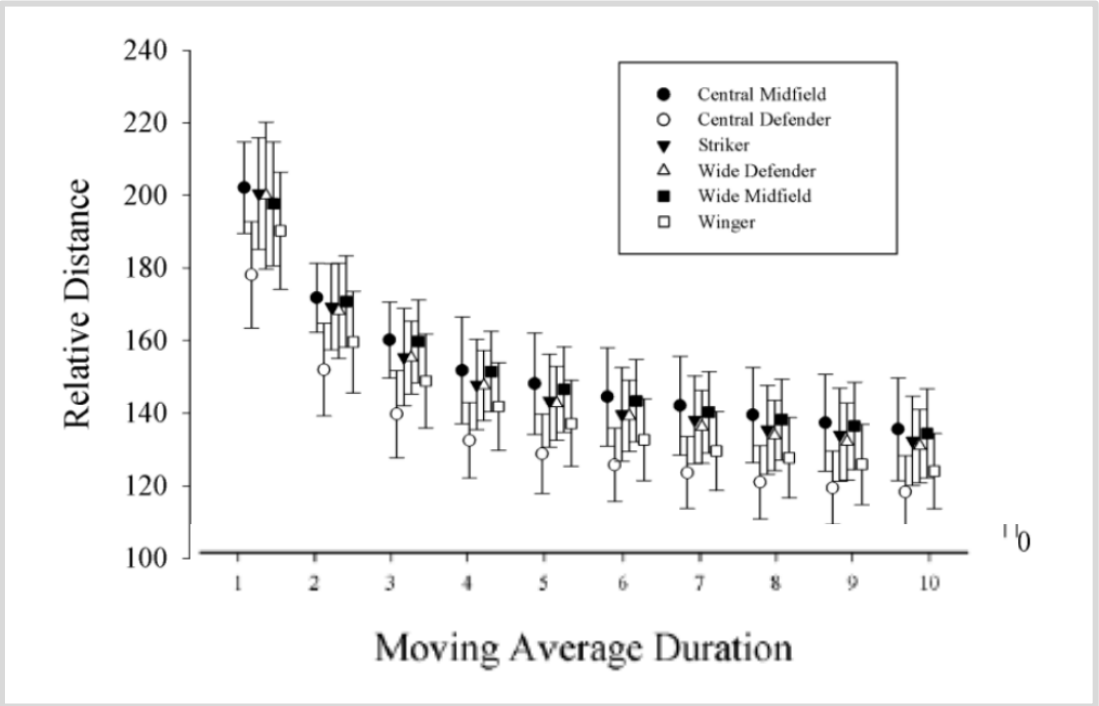
Based on these data points, maximum demand scenarios can be calculated for any duration. Thus, for example, strikers would show values for distance covered ($m \cdot min^{-1}$) in maximum demand scenarios having a duration of 3 minutes with:

$$\text{Intensity} = 193 \cdot 3^{-0.18}$$
$$\text{Intensity} = 158.4\ m \cdot min^{-1}$$

Thus, we would have established an estimate for the distance covered per minute for strikers during periods of maximum competitive demand of three minutes duration, a value that could serve as a reference when designing training tasks or quantifying the training demands to be imposed on players during tasks of similar duration.

In Figure 5, we can see the values obtained by Delaney et al. (2017) for soccer players as a function of their positions on the field, for maximum demand scenarios with durations between 1 and 10 minutes.

Figure 5: Distance covered (m·min^{-1}) during soccer matches as a function of player position, using the rolling method to study maximum demand scenarios of varying durations (1-10 minutes)

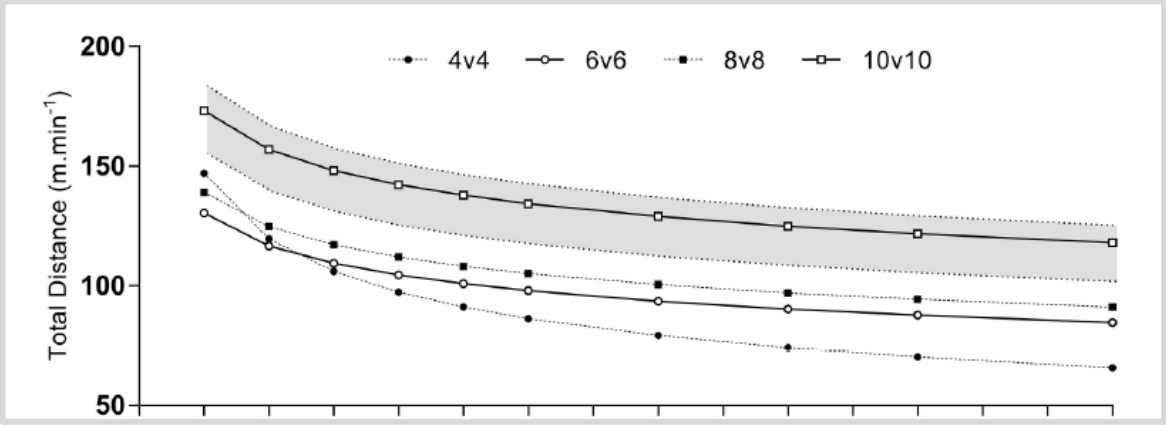


Source: Delaney et al., 2017, p. 12.

This information, therefore, has significant practical application when choosing between training activities, since it can serve as a reference when designing and assessing the demand of training tasks to be imposed on athletes. Accordingly, as of this date, only univariable analyses have been carried out when determining worst-case scenarios, utilizing total distance covered (Lacome et al., 2017) and distance covered at high speed, both expressed in m·min^{-1} (Lacome et al, 2017) in addition to mechanical load expressed in arbitrary units ·min^{-1} (Lacome et al., 2017).

In Figure 6, as shown by Lacome et al. (2017), using the search criteria for distance covered as a variable to apply the rolling method, in which the worst-case scenario has been applied both to matches and to small sided games (SSG) played during training, we can see that the worst-case scenario for 10 vs. 10 situations falls within the match values (the gray zone represents the match mean ± standard deviation). However, 4 vs. 4, 6 vs. 6 and 8 vs. 8 situations show lower values than those attained in matches, independent of the duration selected.

Figure 6: Distance covered (m·min^{-1}) in different durations (0-15 minutes) for different tasks included during the training process to which the rolling method has been applied in order to study maximum demand scenarios

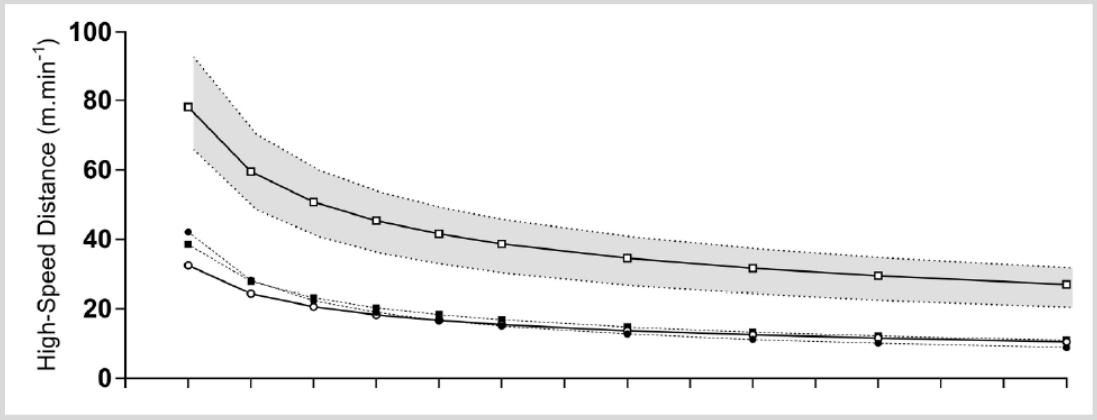


Source: Lacome et al., 2017, p. 19.

About Figure 6: rests between repetitions have been included in the study. The mean values ± standard deviation of the competitive match values appear in gray.

Similar results have been obtained when the criterion variable and the variable studied was distance covered at high speed (Figure 7). Therefore, worst-case scenarios that occur during SSG situations of 4 vs. 4, 6 vs. 6 and 8 vs. 8 are lower, and thus the players may be understimulated. As a result, players might exhibit low levels of performance or suffer injuries in these competitive scenarios if their typical training dynamic has not stimulated them.

Figure 7: Distance covered at high speed ($m \cdot min^{-1}$) in different durations (0-15 minutes) for different tasks included during the training process to which the rolling method has been applied in order to study maximum demand scenarios

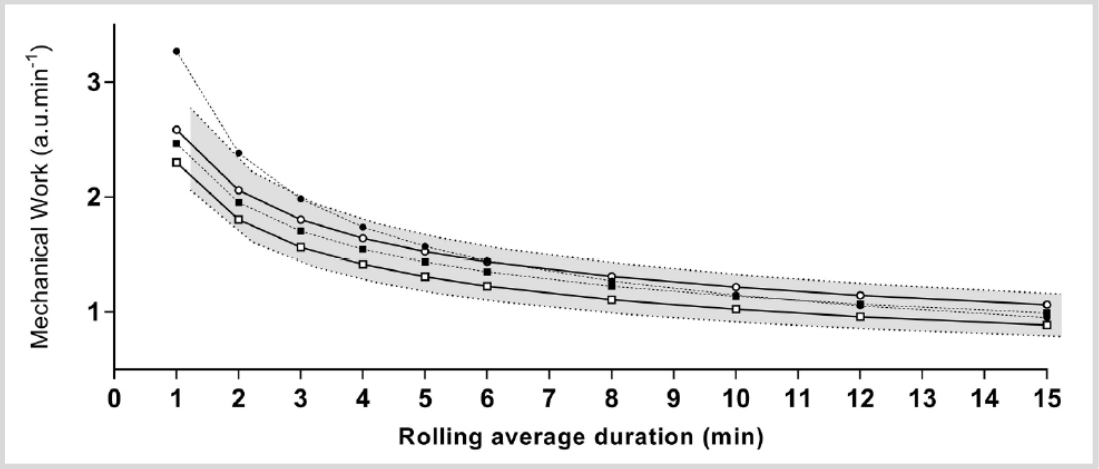


Source: Lacome et al., 2017, p. 19.

About Figure 7: rests between repetitions have been included in the study. The mean values ± standard deviation of the competitive match values appear in gray.

However, the mechanical load of the worst-case scenarios that occur during competition seems to be attained during small sided games (SSG), in addition to registering higher values in situations with fewer players, 4 vs. 4 and shorter duration. Accordingly, it is essential to understand that periods of rest between repetitions have been included in the analysis of worst-case scenarios for small sided games (SSG), which can account for the differences between 4 vs. 4 training situations and the match.

Figure 8: Mechanical load (arbitrary units·min^{-1}) in different durations (0-15 minutes) for different tasks included during the training process to which the rolling method has been applied in order to study maximum demand scenarios

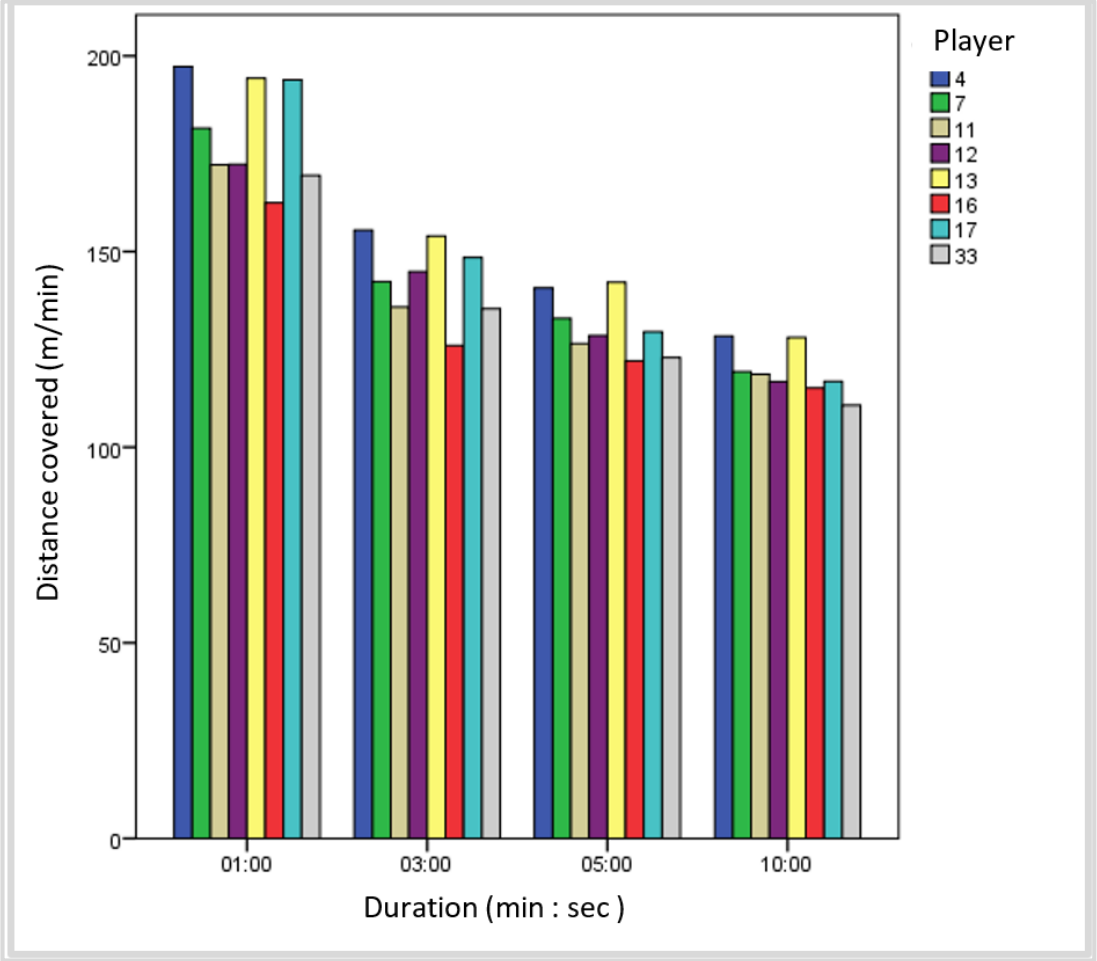


Source: Lacome et al., 2017, p. 19.

About Figure 8: rests between repetitions have been included in the study. The mean values ± standard deviation of the competitive match values appear in gray.

A specific example of this analysis is shown below. In Figure 9, we can observe how intensity decreases as the time window increases, with values differing in accordance with the variable utilized. These are the worst-case scenarios for players that completed a full league match.

Figure 9: Distance covered during maximum demand scenarios of 1, 3, 5 and 10-minute durations for different players



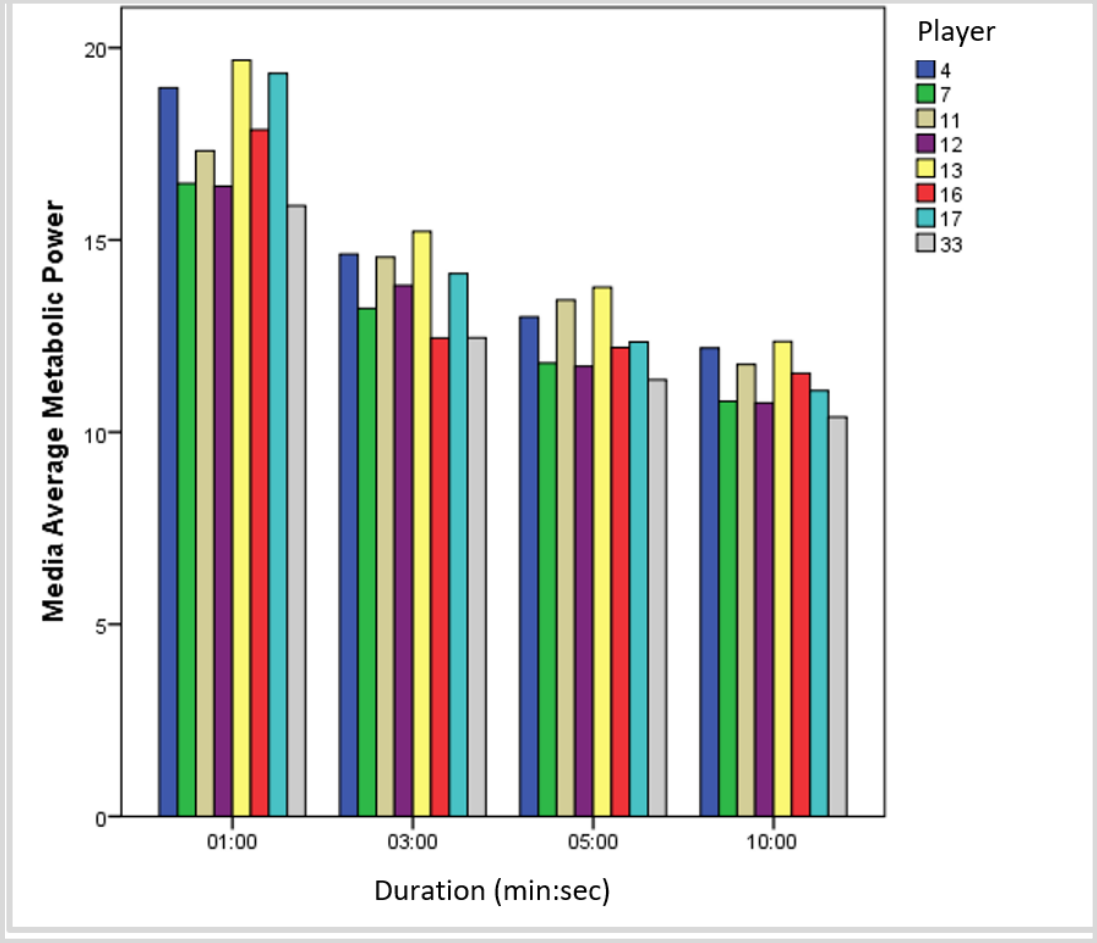
Source: Prepared by the author.

About Figure 9: a number has been assigned to identify each of these 8 specific players in a league match.

If we focus, for example, on player 13, we can see how, during the match in question, he attained values of close to 200 $m \cdot min^{-1}$ during the minute in which he covered the most distance; this intensity declines as we increase the duration, with values of under 150 $m \cdot min^{-1}$ for a duration of 10 minutes (Figure 9).

In Figure 10, average metabolic power (W·kg^{-1}) was used as a search criterion, with player 13 attaining values of close to 20 W·kg^{-1} for durations of 1 minute. Just as happened with distance, to the extent that duration increases, intensity declines, recording values of close to 15 W·kg^{-1} when the duration is increased to 3 minutes.

Figure 10: Average metabolic power (W·kg^{-1}) for different players during maximum demand scenarios of 1, 3, 5 and 10-minute durations



Source: Prepared by the author.

About Figure 10: a number has been assigned to identify each of these 8 specific players in a league match.

However, we should bear in mind that when playing soccer, athletes repeatedly perform actions of similar magnitude, duration, direction, frequency and density. For that very reason, it is difficult to determine a player's "most intense" moment of a match in a clear and precise way, since each variable may register different, and, in some cases, contradictory results. Thus, using criterion variables that incorporate different types of actions can help us to establish a more universal worst-case scenario.

To illustrate this idea, we can look at Table 8, which specifically refers to player 13 during the time period studied in the examples shown in figures 9 and 10, where the worst-case scenario during the match was established using the criterion of average metabolic power ($W \cdot kg^{-1}$). In other words, the maximum demand scenario was chosen by using the rolling method, searching for the 1, 3, 5, and 10-minute periods having the greatest value for this variable.

Table 8: Description of the maximum demand scenario of 1, 3, 5, and 10 minutes for player 13, utilizing the average metabolic power variable as the criterion variable for the selection of these periods

Duration (min:seconds)	1:00	3:00	5:00	10:00
Average metabolic power ($W \cdot kg^{-1}$)	19.68.	15.22.	13.77.	12.36.
Distance covered ($m \cdot min^{-1}$)	193.88.	153.97.	140.42.	128.
Distance covered at high speed ($m \cdot min^{-1}$)	33.11.	16.43.	10.08.	9.23.
Distance at sprint ($m \cdot min^{-1}$)	15.09.	8.75.	2.9.	3.97.
High-intensity accelerations ($n \cdot min^{-1}$)	4.5.	3.17.	3.1.	2.75.
High-intensity decelerations ($n \cdot min^{-1}$)	5.	4.17.	4.1.	3.4.
High metabolic load distance ($m \cdot min^{-1}$)	74.76.	43.88.	34.83.	29.63.

Source: Prepared by the author.

If we focus on the 3-minute duration, we can establish a maximum demand profile for this specific player, which can serve as a reference for comparing with training tasks. Thus, the three minutes with the greatest average metabolic

power values for the player studied are characterized by having attained values of 15 W·kg^{-1}, covering a distance of 154 m·min^{-1}, of which 16 m were covered at high speed and 9 at a sprint, with 3 high-intensity accelerations and 4 high-intensity decelerations performed, and a distance covered at high metabolic intensity of 44 m. We could use these values to relativize the demands of a specific task having a duration of close to 3 minutes in this case.

Thus, for example, the player utilized in this example (player 13) exhibits the following intensity during a repetition with a 3-minute duration in a 4 vs. 4 + 3 training situation in which the objective is to maintain ball possession in a space measuring 13 m x 17 m (Task column of Figure 9).

Table 9: Description of the demands of a 4 vs. 4 + 3 training task on player number 13

Duration (min:seconds)	3:00 match MDS	Task	% of the maximum demand scenario
Average metabolic power (W·kg^{-1})	15.22.	8.75.	57.5 %
Distance covered (m·min^{-1})	153.97.	81.55.	53.0 %
Distance covered at high speed (m·min^{-1})	16.43.	0.	0.0 %
Distance at sprint (m·min^{-1})	8.75.	0.	0.0 %
High-intensity accelerations (n·min^{-1})	3.17.	6.12.	193.1 %
High-intensity decelerations (n·min^{-1})	4.17.	3.67.	88.0 %
High metabolic load distance (m·min^{-1})	43.88.	12.82.	29.2 %

Source: Prepared by the author

About Table 9: the values for this task are expressed in distance covered or in number of actions performed per minute, but also in percentage values in relation to the maximum demand scenario during competition. Average metabolic power was used as a criterion variable when choosing this period. MDS stands for maximum demand scenario.

If we make these absolute values for the training task relative to the values obtained from the player's worst-case scenario during competition, we can to observe the following:

- A major under-estimation of actions performed a high movement speed and at a sprint, with values of 0% of the maximum demand scenario for the match.
- An under-estimation of distance covered and high metabolic load distance, which reaches values of 50% and 30% of the reference values obtained through the study of the maximum demand scenario in competition.
- An over-estimation of high-intensity accelerations, resulting in values almost double those obtained for the maximum demand scenario in competition. Accordingly, we must remember that the maximum demand scenario in competition has been determined using the metabolic power variable as the criterion variable. If we had searched for the maximum demand scenario for high-intensity accelerations during competition, the results for this variable would be much higher, which would result in a reduction of the over-estimation, were it to persist.
- We might take into consideration that the task reproduces the intensity of the maximum demand scenario utilized as a reference for the variable of high-intensity decelerations, given that its value comes close to 100%, which would indicate that the intensity exhibits the same values in the maximum demand scenario and in competition.

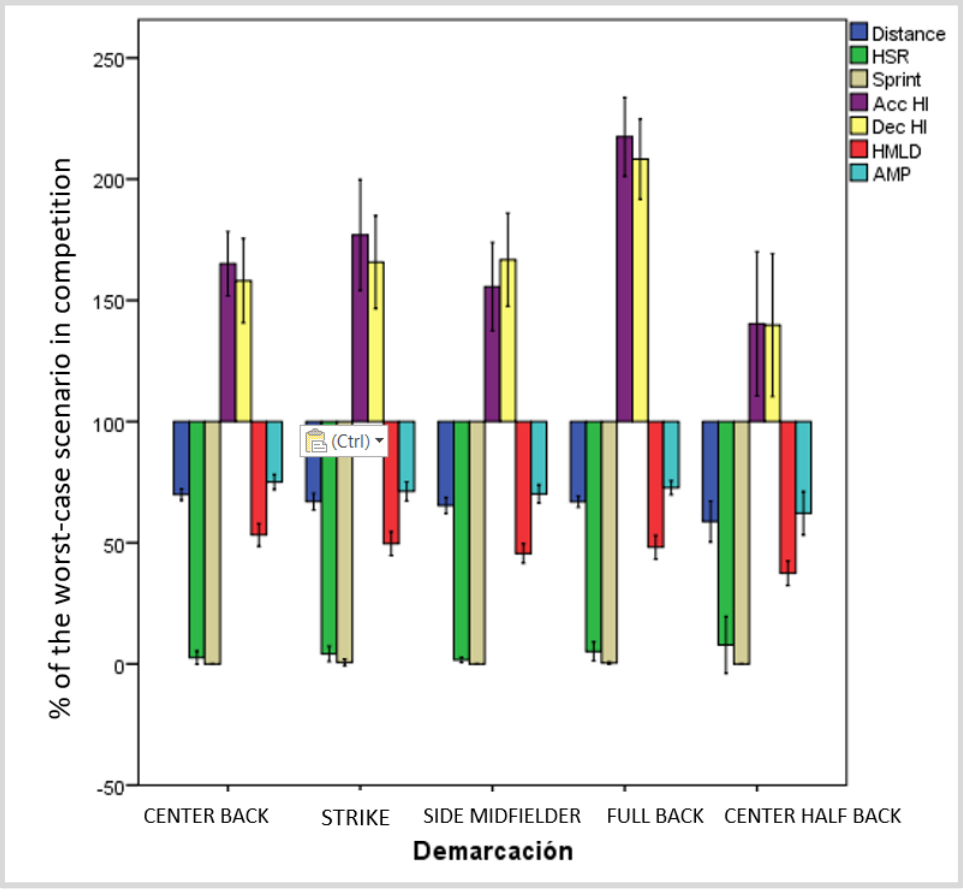
This estimate allows us to better adjust the demands of training tasks to those of competitions for each of our players and for each variable. This allows for an analysis of the training methodology or, at the very least, an analysis of the demands of tasks performed during the training process.

As has already been mentioned, the demands of tasks on players are heterogeneous, especially when we use open-ended tasks in the training process. This, along with existing differences between players in terms of competitive demands, justifies the need to carry out an individualized study on all players. However, and despite the fact that player-by-player profiles would increase the precision of this proposal, the use of position as a variable to categorize players is common in team sports. Thus, we can use references derived from competition (in this case, those referring to maximum demand

scenarios) for each of the positions as a reference with which to relativize the demands imposed during training tasks.

Figure 11 shows the demand imposed during different repetitions of a 5 vs. 5 + 3 task, in which the objective is to maintain possession of the ball, played within a space measuring 25 m x 30 m, which represents an area of 38.5 m^2 per participant. The intensity demands of the task have been analyzed as a function of the player's on-field position and relativized to maximum demand scenarios of a 3-minute duration, obtained by using average metabolic power as the criterion variable.

Figure 11: Description of the demands of a 5 vs. 5 + 3 training task for players belonging to the team, grouped by position



Source: Prepared by the author.

The variables represented in Figure 11 are: distance covered (distance), distance covered at high speed (HSR), number of high-intensity accelerations (HI ACC), number of high-intensity decelerations (HI DEC), average metabolic power (AMP) and high metabolic load distance (HMLD). Values have been expressed as a % of the demands of each position and of maximum demand scenarios in competition, utilizing the variable of average metabolic power as the criterion variable in the selection of this period.

As can be observed in Figure 11, more fine-tuning must be performed if – apart from studying the mean demands of the task – we concern ourselves with different groups of players on the team, bearing in mind that a maximum level of individualization is achieved when we study the demands imposed on each player.

In the example presented in Figure 11, we can note an over-estimation of high-intensity accelerations and decelerations during the task, but even so, the magnitude of the over-estimation is not the same for all players. Specifically, centers are the players with a lower degree of overstimulation in relation to their maximum demand scenarios, while the opposite occurs with full backs, who registered intensity values during the task that were more than double these same players' maximum demand scenarios.

We should not lose sight of the fact that we are relating two variables, which is why we should also assess the maximum demand scenario values – for each player as well as for the match. In the example presented, the overstimulation of the full backs could be attributed to the fact their maximum demand scenarios show lower values for these variables than those recorded by the rest of the players. It could be attributed to the fact that the demands imposed on them during the task (5 vs. 5 +3) are greater in these variables of high intensity acceleration and deceleration than those imposed on their teammates; or, both situations could exist to a greater or lesser degree (reduced maximum demand scenarios and elevated demands during the task). Thus, in order to fine-tune the assessment of the demands imposed on players, we must not forget to analyze both variables in isolation.

References

Carling, C., & Dupont, G. (2011). Are declines in physical performance associated with a reduction in skill-related performance during professional soccer match-play? J Sports Sci, 29(1), 63-71.

Casamichana, D., Castellano, J., & Castagna, C. (2012). Comparing the physical demands of friendly matches and small-sided games in semiprofessional soccer players. Journal of Strength and Conditioning Research, 26(3), 837-843.

Casamichana, D., San Román, J., Calleja, J., & Castellano, J. (2015). Los juegos reducidos en el entrenamiento del fútbol. Barcelona, SP: Fútbol De Libro.

Castellano, J., & Blanco-Villaseñor, A. (2015). Análisis de la variabilidad de desplazamiento de futbolistas de élite durante una temporada competitiva a partir de un modelo mixto multivariable. Cuadernos de Psicología del Deporte, 15(1), 161-168.

Delaney, J. A., Duthie, G. M., Thornton, H. R., Scott, T. J., Gay, D., & Dascombe, B. J. (2016). Acceleration-Based Running Intensities of Professional Rugby League Match Play. Int J Sports Physiol Perform, 11(6), 802-809.

Delaney, J. A., Thornton, H. R., Burgess, D. J., Dascombe, B. J., & Duthie, G. M. (2017). Duration-specific running intensities of Australian Football match-play. J Sports Sci Med, 20. (7), 689–694.

Delaney, J. A., Thornton, H. R., Rowell, A. E., Dascombe, B. J., Aughey, R. J., & Duthie, G. M. (2017). Modelling the decrement in running intensity within professional soccer players. Sci Med in Football, 1-7.

Delaney, J., Thornton, H. R., & Duthie, G. M. (2017). Modelling peak running intensity in football. Retrieved from http://sportperfex.com/wp-content/uploads/2018/02/Delaney-et-al.-2016-Modelling-peak-running-intensity-in-football.pdf

Dellal, A., Owen, A., Wong, D. P., Krustrup, P., Van Exsel, M., & Mallo, J. (2012). Technical and physical demands of small vs. large sided games in relation to playing position in elite soccer. Human Movement Science, 31(4), 957-69.

Di Mascio, M., & Bradley, P. S. (2013). Evaluation of the most intense high-intensity running period in English FA premier league soccer matches. J Strength Cond Res, 27(4), 909-915.

Di Salvo, W., Gregson, W., Atkinson, G., Tordoff, P., & Drust, B. (2009). Analysis of high intensity activity in premier league soccer. International Journal of Sports Medicine, 30(3), 205-212.

Gabbett, T. J., Kennelly, S., Sheehan, J., Hawkins, R., Milsom, J., King, E..., & Ekstrand, J. (2016). If overuse injury is a 'training load error', should undertraining be viewed the same way? Br J Sports Med, 50(17), 1017-1018.

Jace [User name]. (2018). How you should be using GPS (Part 1): GAME SPEED. Retrieved from http://sportperfexcom/2018/02/06/how-you-should-be-using-gps-part-1-game-speed/

Lacome, M., Simpson, B. M., Cholley, Y., Lambert, P., & Buchheit, M. (2017). Small-Sided Games in Elite Soccer: Does One Size Fits All? International Journal of Sports Physiology and Performance, 1-24.

Malone, S., Solan, B., Hughes, B., & Collins, K. (2017). Duration specific Running performance in Elite Gaelic Football. J Strength Cond Res, 4, doi: 10.1519/JSC.0000000000001972.

Stevens, T. G., De Ruiter, C. J., Twisk, J. W., Savelsbergh, G. J., & 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), 1-9.

Varley, M. C., Elias, G. P., & Aughey, R. J. (2012). Current match-analysis techniques' underestimation of intense periods of high-velocity running. Int J Sports Physiol Perform, 7(2), 183-5.