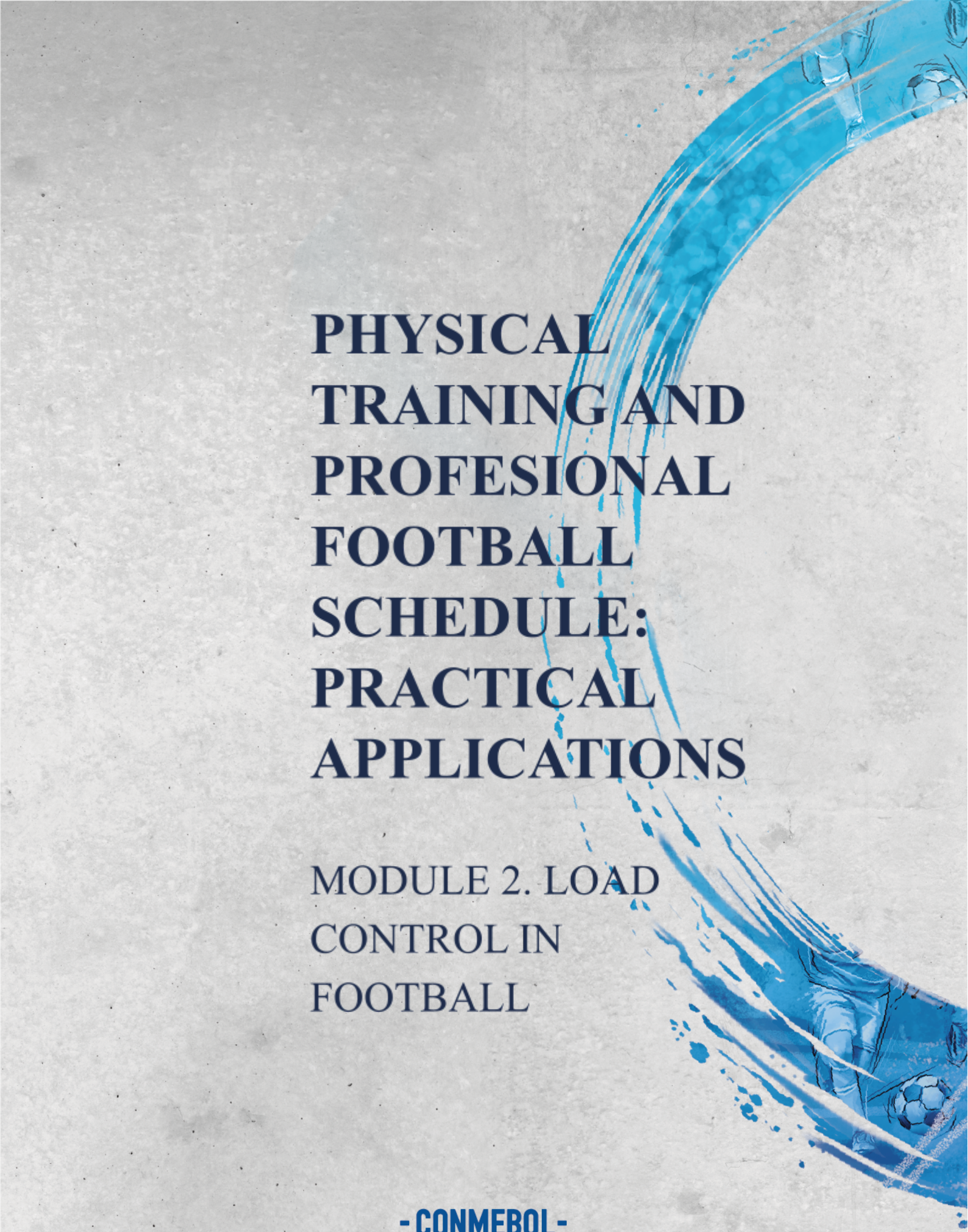
PHYSICAL TRAINING AND PROFESIONAL FOOTBALL SCHEDULE: PRACTICAL APPLICATIONS

MODULE 2. LOAD CONTROL IN FOOTBALL



- CONMEBOL -
EVOLUCIÓN

Presentation

We come to the second module of the course, in which we will deal with load control in football. Since the emergence of new technologies for monitoring athletes, this topic has been present in scientific studies and in the routines of the great teams of world football.

Just planning and applying training sessions throughout the season is not enough to develop the team and the athletes. It is essential to follow the responses to the stimuli of the training sessions, mapping and monitoring daily each step of the athlete, in pursuit of the two main objectives of physical preparation: optimizing performance and minimizing the risk of injury.

To increase the probability of success on the field, we cannot work with "it seems to me" references. Increasingly, the combination of relevant information on load control in football must guide the coaching staff's decisions.

Therefore, the topics presented here will be: external load and internal load, training monitoring, constraints to manage loads, and how to construct training in the face of all load control factors.

Unit 2.1 Load control

External and internal load

Before delving into load control itself, we must conceptualize two terms widely used in football science: external load and internal load.

External load is any stimulus imposed on the athlete's body, i.e., everything that consists of training prescription. It can be represented by the duration, number of sets and repetitions, overload lifted in the strength exercise, total distance covered, number of sprints, number of jumps and others.

Internal load is the physiological stress in response to external load. It may be represented by oxygen consumption, heart rate, biochemical markers, psychophysiological stress, etc.

In the sports technology market there are several equipments that measure the external and internal loads of the football athlete, in order to provide the maximum information regarding the performance in the field.

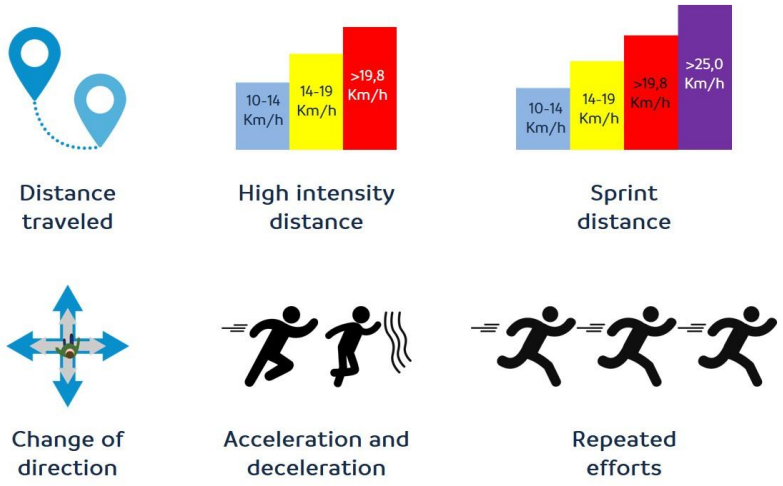
One of the most widely used technologies worldwide is GPS Tracking (Global Positioning System) which allows tracking the athlete's movement on the field, recording the distance traveled in different speed ranges (Di Mascio; Ade; Bradley, 2015; Buchheit et al. 2014;

Bradley et al., 2009; Bangsbo; Norregaard; Thorso, 1991; Reilly T, Thomas; 1976), as well as accurately mapping the location in space (known as heat mapping).

Moreover, the most advanced monitoring systems offer additional solutions such as **accelerometer, gyroscope and magnetometer that measure body position, changes in planes of motion and inertial movements** (Osgnach et al., 2010). What is most impressive is that all these variables are collected in real time, generating information for decision making in the field.

At this point, we will pay attention to the most common external load metrics for monitoring during football training and matches. It should be noted that the amount of data generated by these teams is enormous and should be selected those information that best fit the specificity of the sport and that make sense in the analysis of that particular situation.

Figure 1: Athlete tracking



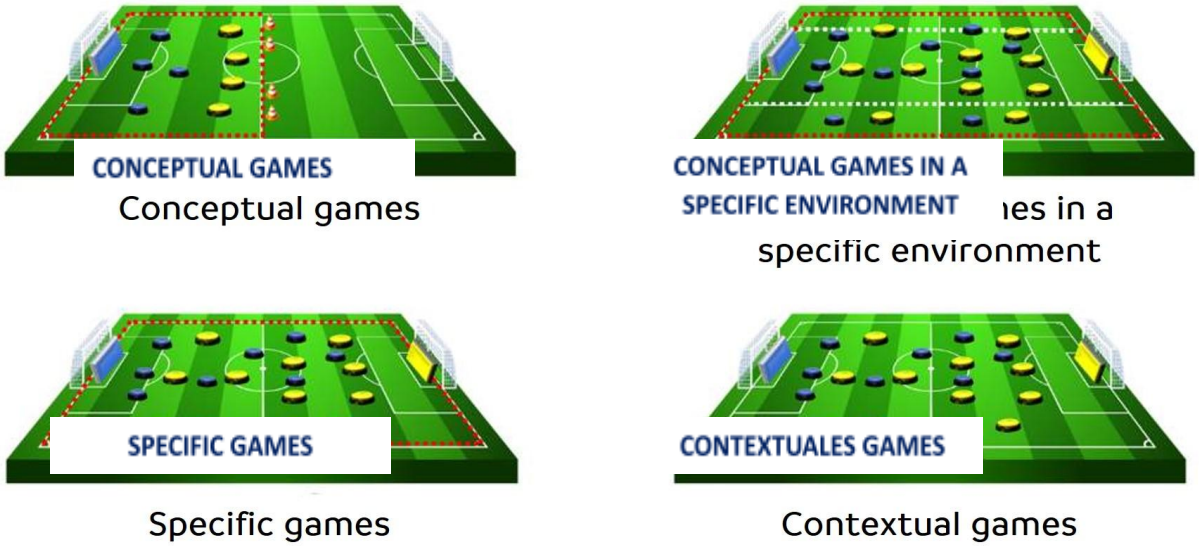
	Distance traveled per series, exercise, training session and game E.g.: Activities performed in large areas such as ¾ of the official field tend to have high numbers of distance traveled (may vary depending on the duration of the stimulus).		**Change of direction per series, exercise, training session and game.** E.g.: rounds, small games 3v3 / 4v4/ 5v5. 1v1 / 2v1 / 2v2 / 3v2 face-offs.
	Distance at high intensity (>19.8 km/h) per set, exercise, training session and game. E.g.: Offensive and defensive transition games, in addition to official games. Drills such as offensive combinations (standard passing + centering + definition).		**Acceleration and deceleration by series, exercise, training session and game.** E.g.: rounds, small games 3v3 / 4v4 / 5v5. 1v1 / 2v1 / 2v2 / 3v2 face-offs.
	Sprint distance (25 km/h) per series, exercise, training session and game. E.g.: Offensive and defensive transition games, in addition to official games. Exercises such as openings (long accelerations).		**Repeat efforts per set, exercise training session and game.** E.g.: offensive and defensive transition games, official games, small games 3v3 / 4v4 / 5v5.

Source: own elaboration.

Unit 2.2 Training monitoring

Initially, four types widely used in routine training should be highlighted: conceptual games, conceptual games in a specific environment, specific games and contextual games (Scaglia et al., 2013).

Figure 2: Different types of games



Source: own elaboration.

Conceptual games are games whose structural references (ball, targets and field size, among other invariants) and functional references (operating principles and rules of action) do not faithfully respect the logic of the intended collective sports game.

Conceptual games in a specific environment are games whose structural references obey those of the intended collective sports game (size of the field, presence of goals for attacking and defending, and ball in play). In these games, the concepts developed in conceptual games will be placed in a formal environment, with the purpose of their application within a spatial structure that resembles the game.

In turn, specific games are games whose structural and functional references (game logic) are kept intact. Thus, they resemble formal games (official rules) whose developed concepts are part of a previously defined game model (involving game platform and tactical means, among others).

Finally, contextual games are specific games that are directly related to the formal competition. That is, they must maintain the structural references required by the

competition, such as, for example, time duration of the game, size of the field, number of players, replacements, etc. Thus, friendly matches and official matches are all contextual games (Scaglia et al., 2013, https://bit.ly/3ANU9DI).

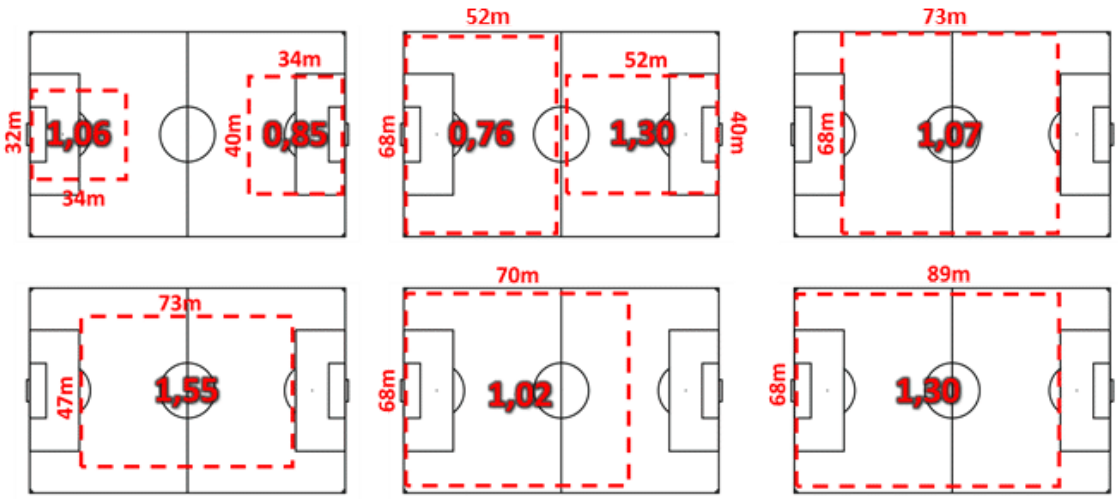
For each type of training, there are game constraints that can be manipulated in order to generate physical, physiological, cognitive and behavioral adaptations of the athlete. Among them, we can mention:

Figure 3: Types of constraints in the game

Source: own elaboration.

At this point, let's focus on the dimensional characteristics that can be easily manipulated in the training prescription: field proportion and area per player. Given that the ratio of the official football field is 1.54 (Length = 105 m; Width = 68 m; L ÷ A = 1.54), what dimensions of the field below would most closely represent the official playing field?

Figure 4: Different possible dimensions of the playing field

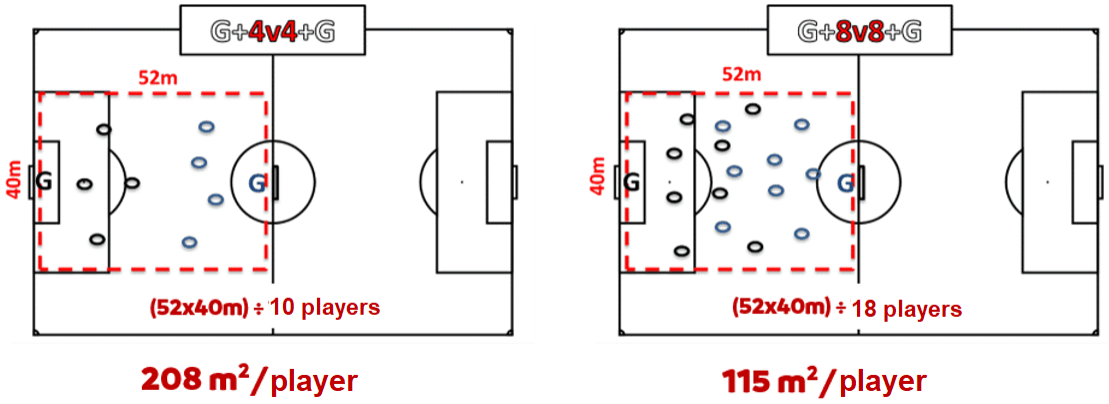


Source: own elaboration

Fields that are wider than they are long, i.e. with a smaller proportion, what types of individual and collective behaviors do they generate? What are the coach's objectives in that training and/or exercise? Playing in width or depth? What can this field proportion characteristic generate in terms of workload for the different functions? Too much distance covered at high intensity by the wingers? Low total distance covered by the defenders? Think about it.

What about the area per player? Considering the 22 players inside an official football field, the area is 324 m.2 for each player ([LxA] ÷ 22 = 324). And what does it mean that the game has, for the same field size, different numbers of athletes? More or less space to move around? More or less time to think and decide? More or less workload? Consider the following example and reflect.

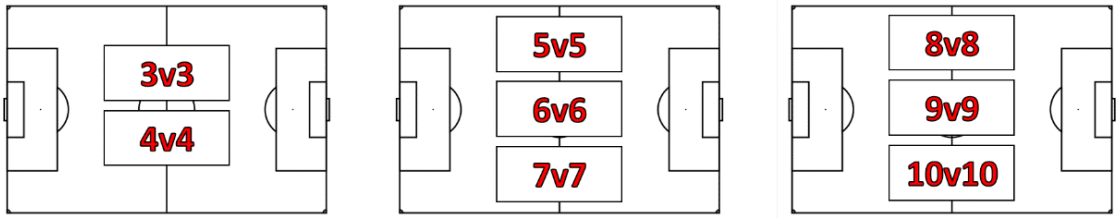
Figure 5: Proportion of field and area per player



Source: own elaboration

The number of players on the field can also change individual and collective responses, both from a physical and physiological perspective, as well as from a behavioral and tactical perspective. In general, reduced games can be planned by determining individual, group, sectorial, intersectorial and collective tactical action objectives, which involve manipulating this numerical variable that generates specific training loads.

Figure 6: Variation in the number of players



Source: own elaboration.

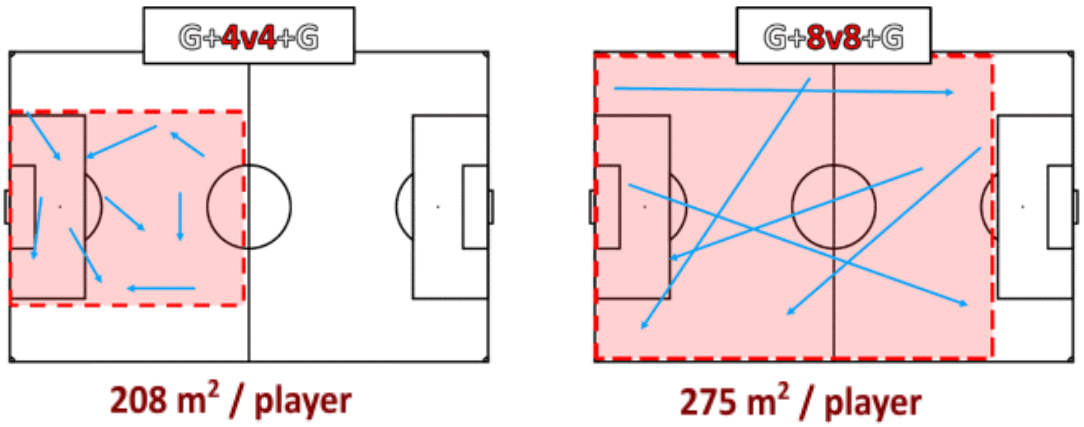
Overview

And for all this to make sense, it is not enough to plan and apply the different types of training. it is necessary to monitor and follow up each session, using the metrics that will provide the information of interest. We will talk more about this topic below.

For a better understanding of monitoring in training and matches, we present here exactly what the big football teams select from the most important information, within a scenario of thousands of data generated by the monitoring system.

The metrics generally analyzed reflect the specificity of football and the real demands of each athlete in his position and of the team as a whole. For ease of understanding, here is a summary table of the main characteristics of small-sided and big-sided games:

Figure 7: Demands of each player at his position



Source: own elaboration.

Small group games such as 3v3-4v4 are usually played on small fields, respecting the concepts of field proportion, area per player and training objectives. However, complementary to all this, small group games encourage different physical and physiological responses than those presented in medium and large group games. Imagine the following situation:

Figure 8: Comparison of the physical demands of two players in two different game models.

	3v3 – 4v4	8v8-10v10
Distance traveled	✓	✓
High intensity distance / sprint	✓	✓
Change of direction	✓	✓
Acceleration / deceleration	✓	✓
Repeated efforts	✓	✓

Source: own elaboration.

The G+4v4+G game, in this field size, has an area per player of 208 m.2 and with that, very specific actions will occur more frequently, such as accelerations and decelerations, sudden changes of direction, confrontations, dribbles, overcoming and definitions. Note the size of the arrows on the field, which represent the types of short and common actions in this type of activity.

The G+8v8+G game, on the other hand, even with more players on the field, has a wider area per player and spaces to generate other actions such as high intensity runs (> 20 km/h), piques (> 25 km/h), top speed, high volume of total distance covered, transitions, infiltrations, space balls, among others. The larger arrows represent the types of long and intense actions of this activity.

Next, we will discuss the last highlighted constraint that is extremely important for load monitoring: training rules and objectives.

Figure 9: Training rules and objectives

Source: own elaboration.

The manipulation of rules and training objectives such as number of ball touches, numerical superiority or inferiority, goalkeeper presence, fast ball launching, advanced position and coach participation create different scenarios and responses of physical, physiological, cognitive and tactical aspects within small-sided games.

Number of touches to the ball

A restricted number of touches to the ball can increase the players' participation in the moments of the game, considering the need to create passing lines and support the ball carrier, for example. As a result, the physical demand becomes evident to the extent that the actions of unmarking, feinting, dribbling and overcoming increase the demand on each player.

Figure 10: Number of touches to the ball.

Source: own elaboration

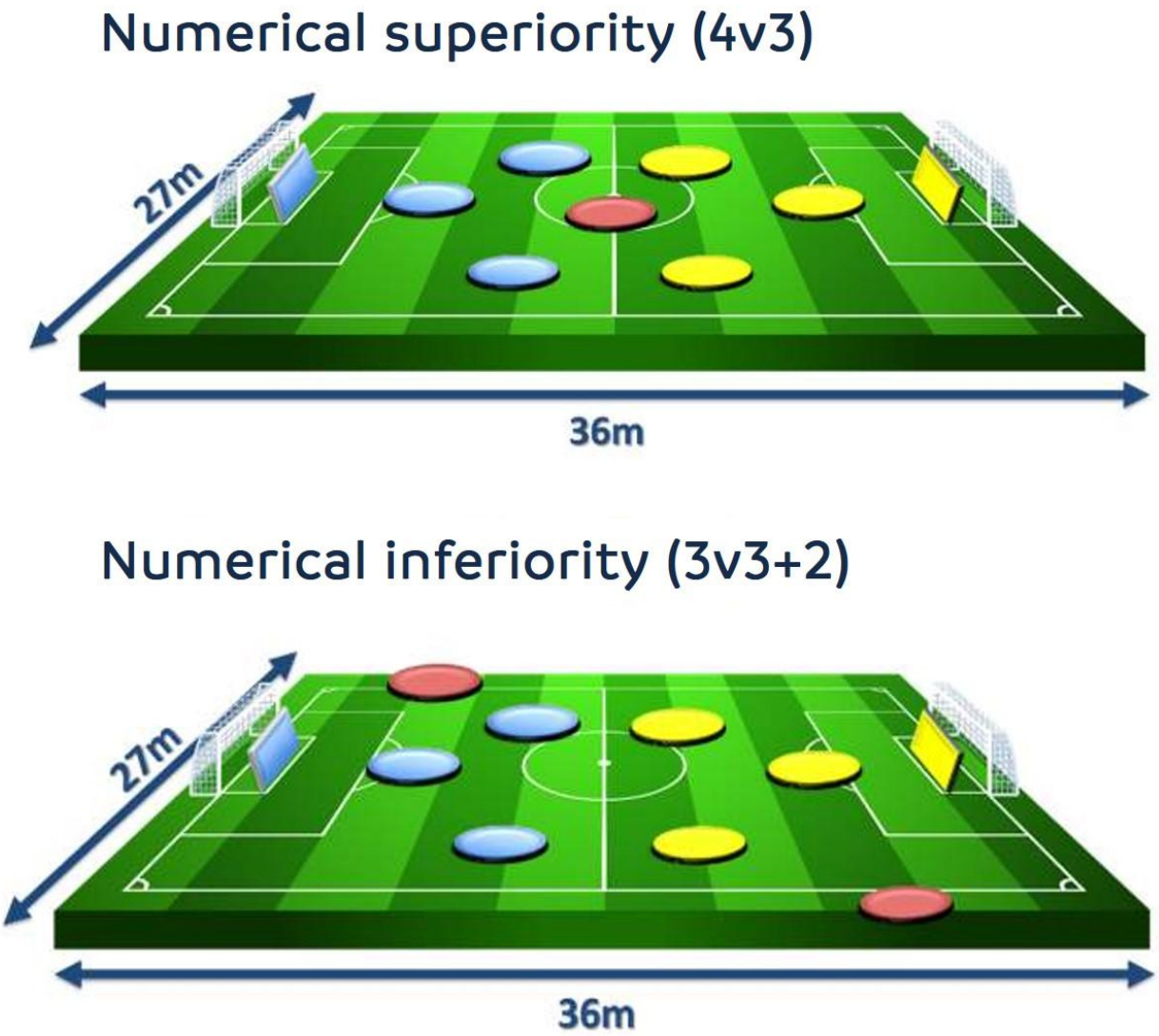
To exemplify this physical demand, it was reported in two studies by Casamicana et al. (2013) and Dellal et al. (2011) that, in reduced games with restriction to 2 touches of the ball, athletes performed more inertial actions (accelerations and decelerations) and, with restriction to one touch of the ball, athletes run more total distances and at high intensity (> 20 km/H).

Numerical superiority or inferiority

Reduced games with difference in the number of athletes between teams is a strategy that, in addition to creating tactical behaviors for specific game circumstances, can also generate different physical demands. Games with numerical superiority such as those presented in the study by Praça, Custódio and Greco (2015) demonstrate that:

Game number G+4v3+G (36mx27m), athletes who were on the team in superiority covered a shorter total distance and a shorter distance at high intensity (> 20 km/h);

Figure 11: numerical superiority in small-sided games



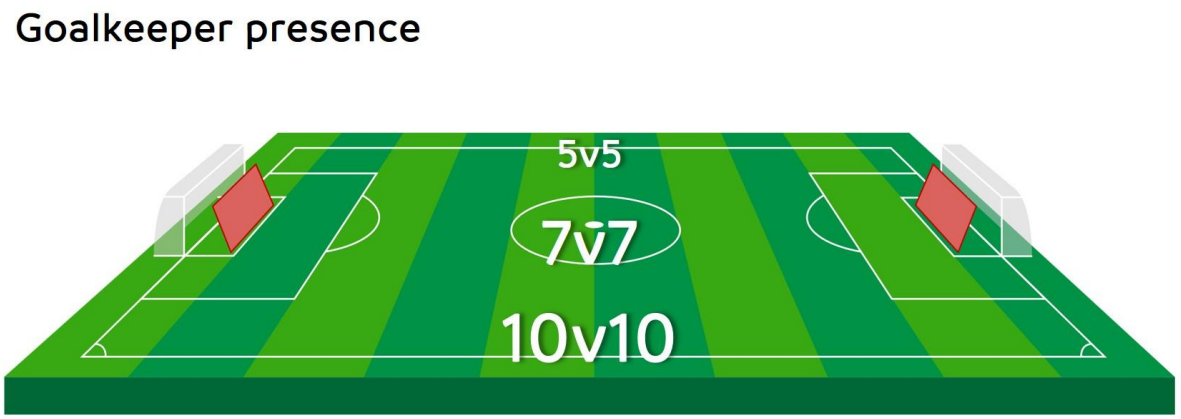
Source: own elaboration.

In a G+3v3(+2)+G game (36mx27m), athletes who were on the team in superiority, using athletes as support on the side of the field, also traveled a shorter total distance and shorter distance at high intensity (> 20 km/h).

Goalkeeper presence

Planning training sessions with reduced games using different objectives such as, for example, keeping possession of the ball or shooting at the opposing goal is part of the content to be applied throughout the development of a team. For some, the game must always respect the guidelines of the formal game, i.e., the final objective is only and exclusively to score goals.

Figure 12: Presence of goalkeepers in small-sided games



Source: own elaboration.

It is important to note that the physical demand of games with and without the presence of the goalkeeper may be different. According to the study by Gaudino, Alberti and Iaia (2014), when comparing ball possession games with games aimed at definition (with goalkeeper), in 5v5, 7v7 and 10v10 formats, the metrics total distance covered, distance at high intensity (> 20km / h) and inertial movements (accelerations and decelerations) were significantly higher in games with the presence of the goalkeeper.

I think you can already imagine that this type of game generates more motivation for athletes, right?

Other rules and objectives

Quick ball replacement, both on the baseline and on the sidelines, generates the dynamism of a high-intensity and concentrated training, avoiding long pauses that interfere with the total workload (we will talk about complete and incomplete recovery later on).

Having or not having forward position as a rule of the game also interferes with the tactical behavior of athletes (Praça et al., 2020) and, consequently, with the physical and physiological demand. Imagine how much the positioning, behavior and choice of players on defense in a game can change without the offside position rule? Does it make sense to eliminate a fundamental rule of the formal game? But this is a discussion for another time.

And finally, the involvement of the coach (understood here as the coaching staff) demanding the maximum from the athletes as an external motivation, seems to directly influence the physical and physiological indicators (Rampinini et al., 2007; Hoff et al., 2002). Encouraging the athlete to reach a state of maximum concentration and high intensity in the actions is a strategy that should always be applied.

Contextualization of monitoring data to the game of football

For the information generated by monitoring the load of athletes to become relevant, usable and more than that, applicable to the routine within the football club, the data must be contextualized to the game. The data itself is just a "cold" number that must have meaning in relation to the circumstance to which it relates.

To facilitate understanding, observe the following example:

Figure 13: Kilometers traveled by the player

Source: own elaboration

How can we analyze this situation? What conclusions can we draw from reading this single piece of information?

Very little, right?

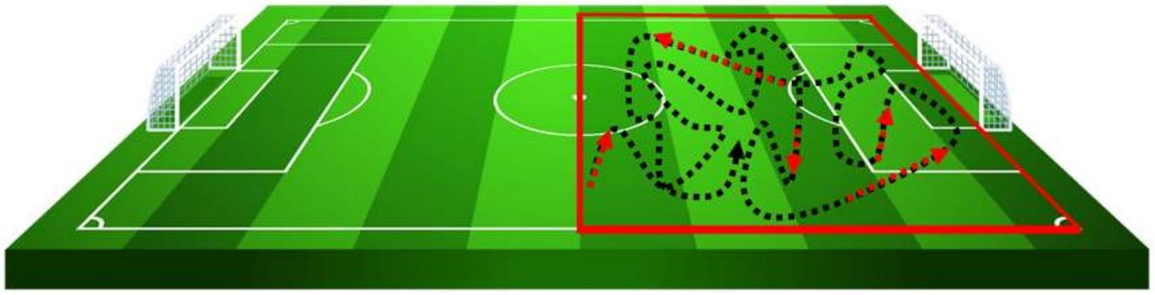
Now analyze again, with this additional information:

Figure 14: Distance traveled by the player in attack (in km)

Source: own elaboration

A game fact was added to the information, but it still doesn't say much. How were these 6 km run?

Figure 15: Specific measurement of the athlete's pathway in the offensive field



Athlete X Traveled 6km in the offensive field, being 200 over 18km/h.

Source: own elaboration

From that point on, the data starts to make sense for a more realistic analysis of what the game was. However, another fundamental piece of information is still missing.

Figure 16: Analysis of the mode, speed and place traveled by the player.

Athlete X Traveled 6km in the offensive field, being 200 over 18km/h, performing post loss.

Source: own elaboration

Finally, we have information that is applicable and, above all, contextualized to the tactical actions of the game. This is how all monitoring and load control data should be analyzed. This is a responsibility of the entire technical staff, including the coach.

Thus, having a broader and more systemic vision of what the whole game of football consists of is a premise for more concrete analysis and more assertive decisions in training, matches and seasons. As an easy analogy to understand, we must observe the film in motion and not just the snapshot.

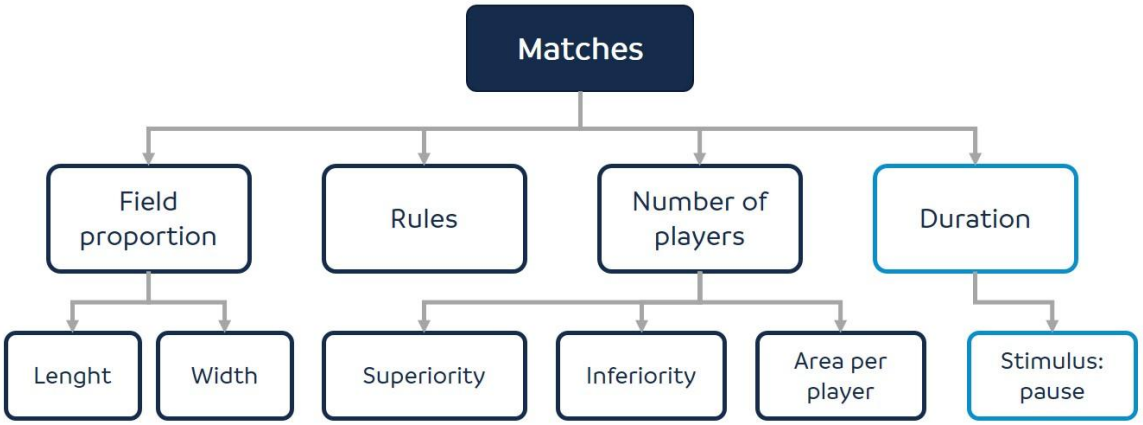
Figure 17: Analogy between football and photography

Source: own elaboration

Unit 2.3 Training planning

Based on this information, the planning of the training session is facilitated, respecting the monitoring concepts, preserving the athlete's health and, mainly, maximizing his performance.

Figure 18: Aspects to be taken into account in training planning



Source: own elaboration

Therefore, the coaching staff must have sufficient knowledge to manipulate the different characteristics that make up a game and manage the responses of their athletes, as well as to use load monitoring metrics.

Who defines the space of the games in training? Do you guide the trainer on the different dimensions and their consequences on physiological adaptations?

Think about it.

In the following, we will discuss two determining elements for the complete prescription of a training session (highlighted in the figure above).

The training variables duration and stimulus: pause relationship must be very clear, because they give meaning to the type of conditioning that is intended to be developed in the athlete.

Firstly, the concept of duration can be understood as the elapsed time of each exercise, set, recovery interval or even of the training session. And, secondly, the stimulus: pause ratio (E: P) means to what extent the duration of the stimulus (action) is connected with the duration of the pause (recovery). For example:

1) A reduced set G+4v4+G of 3 sets of 4min and 2min pauses between them, presenting a stimulus-pause ratio of 2:1;

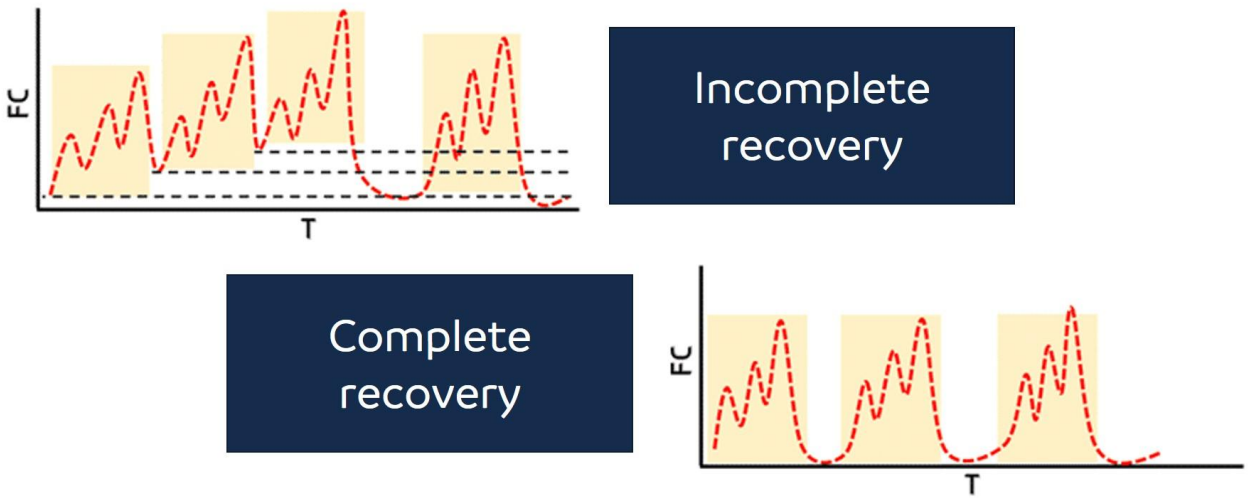
2) A reduced set G+4v4+G of 3 sets of 4min and pauses of 1min between them, on the other hand, presents a ratio of 4:1.

Let's analyze it calmly. In example 1, there is more recovery time between sets which, in principle, allows more time for the athletes to rest in the pause intervals. And this, while characterizing an incomplete recovery between sets, generates a different workload from example 2.

But what does this term incomplete recovery mean?

To facilitate your understanding, analyze the following figure.

Figure 19: Analysis and differences between complete and incomplete recovery



Source:own elaboration

Incomplete recovery means that the athlete does not have enough time to recover from an action, considering a pause interval shorter than that action. Consequently, at each start of a new action, the athlete starts from a state of increased fatigue (represented by the heart rate - HR in the figure above).

Examples: E:P of 2:1; 2:0.5; 2:0.25.

Full recovery, on the other hand, means that the athlete's action has a duration equal to or shorter than the pause interval, allowing a greater recovery that can reach close to the initial levels of the athlete's state.

Examples: E:P of 1:1; 1:2; 1:3.

Well, considering that the game of football presents a characteristic of intermittency with high intensity actions, interspersed with incomplete recoveries, should we always train in incomplete recovery to reproduce the demands of a match?

It is relative. Reflect on the points presented below:

1) In the preseason, a period in which athletes come after a long vacation, is it wise to use only incomplete recovery in the first week of training, knowing that the athletes are detrained?

2) On training days after the match (day +1, day +2 or even day +3), would it be interesting to allow more complete recoveries between sets, considering the restoration process of the athlete's body?

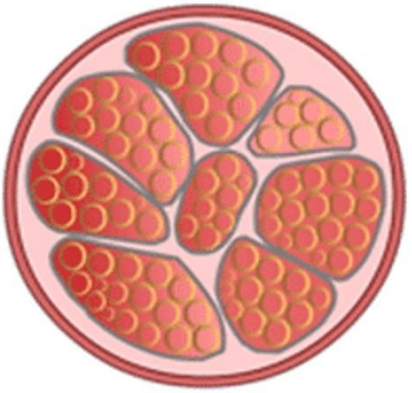
3) With the aim of applying a more intense training, would few interventions by the coach during the exercises be more appropriate, so that the athletes do not "return to calm" at all times?

Thinking about the smallest details of the training application creates the possibility of achieving a high level of intensity and concentration of the athletes throughout the entire session.

Thus, we can classify the training as metabolic and neural, depending on the predominance of the type of recovery (complete and incomplete) and the type of action performed in the field.

Figure 20: Training orientation

Metabolic



Neutral

Source: own elaboration

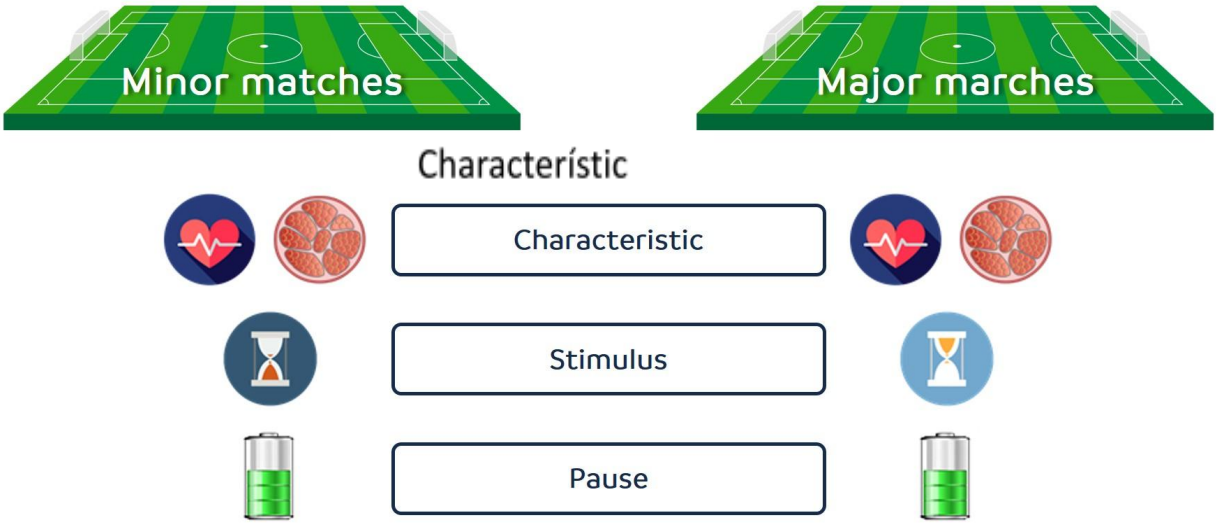
Metabolic training means longer set/exercise duration, shorter pause intervals, constantly demanding of the athlete's cardiorespiratory fitness (i.e., high heart rate most of the time).

Neural training presents actions of high mechanical demand such as accelerations, decelerations and high intensity running, which generate a characteristic peripheral fatigue (often referred to by athletes as "heavy leg", "swollen leg").

Given all this information about the planning and implementation of the training session, the range of possibilities is enormous. Regardless of the types of games, you can manipulate the variables by creating the stimuli and the predominance you want within the training objective.

We are nearing the end of this topic and would like to encourage you to analyze the different scenarios faced in a football routine (see figure below). The most important thing here is to awaken your critical sense.

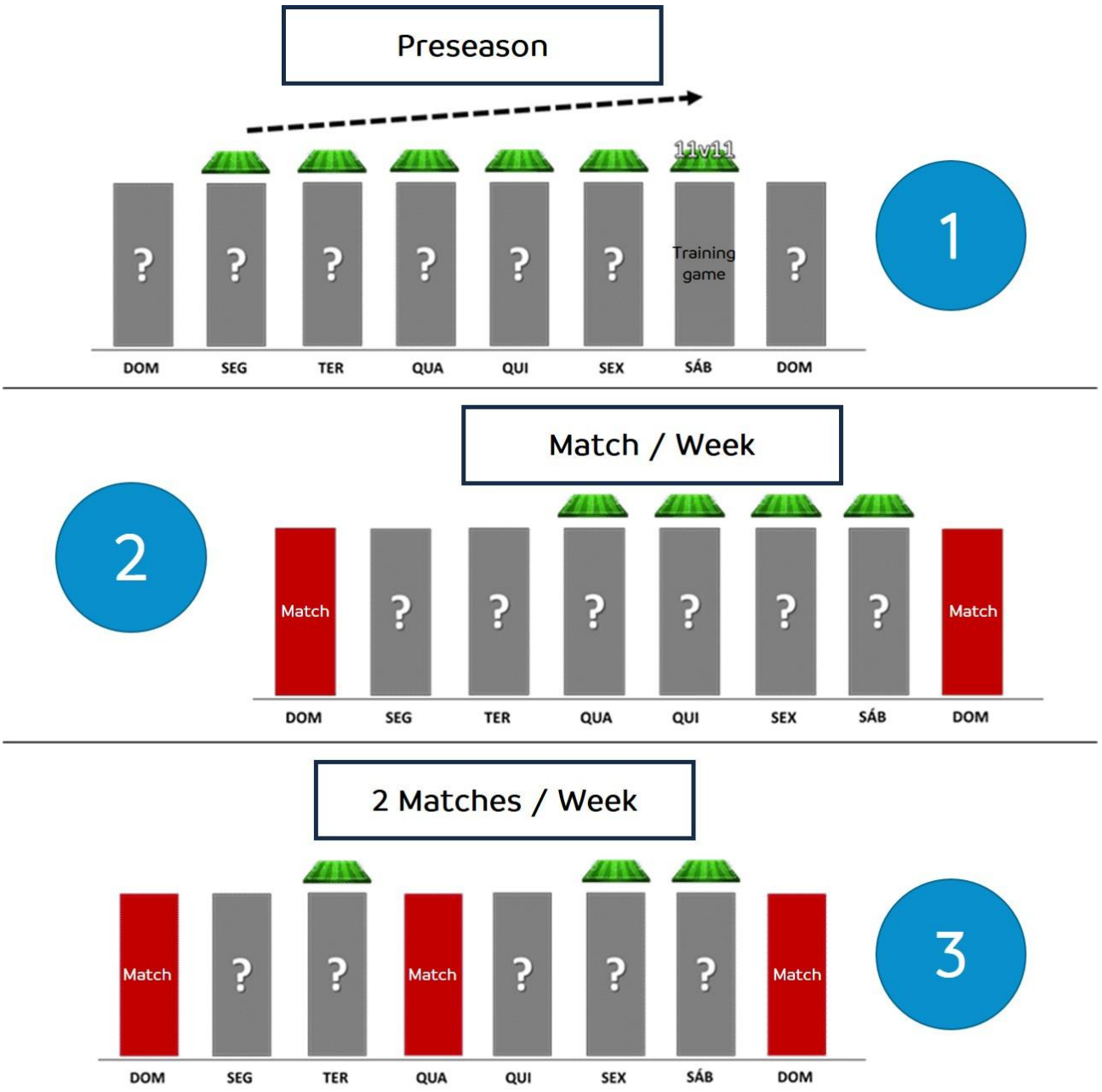
Figure 21: Differences between small-field and large-field games



Source: own elaboration

1. What wear and tear does each type of game cause?
2. How to create the connection between content and training days?
3. How to build the wall (training) that protects the athlete at the moment of performance (game)?

Figure 22: Different alternatives according to training days



Source: own elaboration

Having presented the external load variables that make up the planning and prescription of football training, it is now necessary to address the internal load. After all, what are the responses generated by training in the athlete's body?

Heart rate

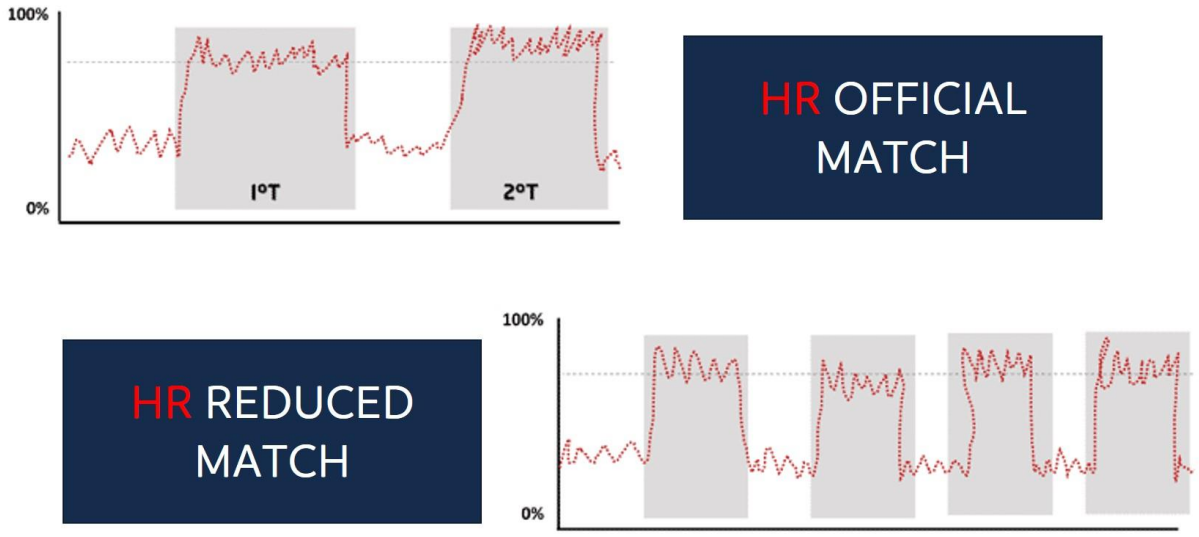
The measurement of heart rate (HR) is widely used as a valid method with good applicability for estimating intensity during sports practice (Esposito et al., 2004; Capranica; Tessitore; Guidetti, 2001). Its use as a parameter for intensity control is based on its linear relationship with oxygen consumption (VO2), even in intermittent activities such as football (Bangsbo, 1994).

Because HR is influenced by several factors such as training capacity, gender, environmental conditions and hydration status, Karvonen and Vuorimaa (1988) recommend that HR be expressed as percentage of maximum heart rate (% HRmax) to be properly used in intensity control in football players (Impellizzeri; Rampinini; Marcora, 2005; Achten; Jeukendrup, 2003).

The intensity of play observed in some studies indicates that athletes play most of the time with HR above 85% of RCmax (Kanope; Morandi; Pepper, 2018; Coelho et al., 2011; Helgerud et al., 2001; Tumilidad et al., 1993).

When characterizing the average intensity of a game, we can think about the prescription of training sessions based on this reference, either for isolated physical training or through reduced games. Let's look at the following example:

Figure 23: Comparison of heart rate during official matches and reduced games



Source: own elaboration

As we can observe, the use of reduced game configurations that demand an official game intensity can be a way to prepare athletes for the real demands of competition. This does not mean that everyday training at these intensities will be applied, because athletes need to deal with the stimulus and recovery in a safe manner. Obviously, to prescribe any type of training, there must be control and connection of the loads throughout the week.

To measure and monitor the internal load of training sessions, Banister et al. (1991) proposed a method called training momentum (TRIMPBANISTER) calculated by the CR. Based on the fact that exercise increases CR between its resting and maximal values, the authors proposed that the athlete's CR response, along with duration, could be a measure of internal training load (Kanope; Morandi; Pimenta, 2018).

Another method used to calculate the internal load of the CR is the TRIMP proposed by Edwards (1993). It consists of the division of CR into five intensity zones: (Zone 1 - 50 to 60% CRmax, factor 1; Zone 2 - 60 to 70% CRmax, factor 2; Zone 3 - 70 to 80% CRmax, factor 3; Zone 4 - 80 to 90% CRmax, factor 4; Zone 5 - 90 to 100% CRmax, factor 5).

Figure 24: Banister's TRIMP method

TRIMP (Banister) method

$$TRIMP_{Banister} = DT \times FX_{reserva} \times 0.64 \times e^{1.92 \times FCreserva}$$

Example:
HR rest = 58 bpm
HR max = 201 bpm
HR Reserve = 74% (0.74)

DT = 68 min

TRIMP = 133 UA

Source: own elaboration

Figure 25: Variables measured through TRIMP

ZONES	50-60%	60-70%	70-80%	80-90%	90-100%
Factor	1	2	3	4	5

Example:

Time in the zone 50-60% = 7 min x 1 = 7 a.u.

Time in the zone 60-70% = 23 min x 2 = 46 a.u.

Time in the zone 70-80% = 14 min x 3 = 42 a.u.

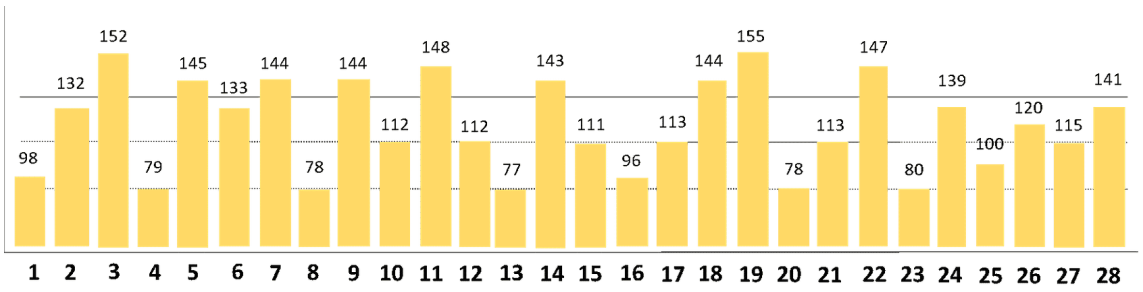
Time in the zone 80-90% = 10 min x 4 = 40 a.u.

Time in the zone 90-100% = 8 min x 5 = 40 a.u.

TRIMP = 175 (a.u.)

Source: own elaboration

Figure 26: Internal loading of an athlete using TRIMP



Source: own elaboration

With this information by the TRIMP method, we can generate longitudinal graphs that allow a more detailed analysis of the behavior of the athlete's internal load (see below).

PSE-SESSION

Subjective perception of exertion (PSE) is one of the most widely used methods for load monitoring in sports, including football. The adapted Borg scale (CR-10) is simple, low-cost and non-invasive. The scale consists of a scoring grid from 0 to 10, with color differentiation and anchors that help in the evaluation of the athlete.

Figure 27: Subjective Perception of Effort Scale (PSE)

Rate	PSE
0	No effort (rest)
1	Very weak
2	Weak
3	Moderate
4	Slightly stronger
5	Strong
6	
7	Very strong
8	
9	
10	Maximum effort

Source: own elaboration

It correlates well with physiological stress markers such as heart rate and lactate concentration. Moreover, it is strictly linked to psychophysiological stress as it also takes into account the cognitive demands of the activity.

From the PSE, Foster et al. (2001) developed a load control method called PSE-Session. This method consists of evaluating the realized load of the whole training session, considering the previous warm-up, the main part and the last exercise. To calculate the PSE-session, the value of the reported PSE must be multiplied by the total duration of the session, in minutes.

And how do we apply PSE-Session in practice, during the routine of a football club?

At the end of each training session, the athlete answers the following question:

How was today's training for you?

It is important to point out a few precautions when making it:

1) Recall, if necessary, the training session;

Often, the athlete needs to be reminded of all the activities that were performed in that session, so that he/she can accurately report his/her perception, being more reliable.

2) Do not collect PSE immediately after training;

Although the scientific literature recommends collecting the PSE 30 minutes later, in practice, it is often not possible. The athlete in this period of time has already showered and left. Even so, it is not indicated to collect immediately after the session, as the athlete's perception may be affected by the recent effect of the last exercise performed. Therefore, allow the athlete to calm down after the end of the workout, reset and then yes, for about 15 minutes, collect the information (PEDRO et al., 2014).

3) Individualize the approach.

If you are not using automated resources such as a tablet or cell phone, where the athlete records their PSE directly on the device without interference, try to approach the athlete individually when collecting information. It is very common for the athlete's response to be influenced by others around them.

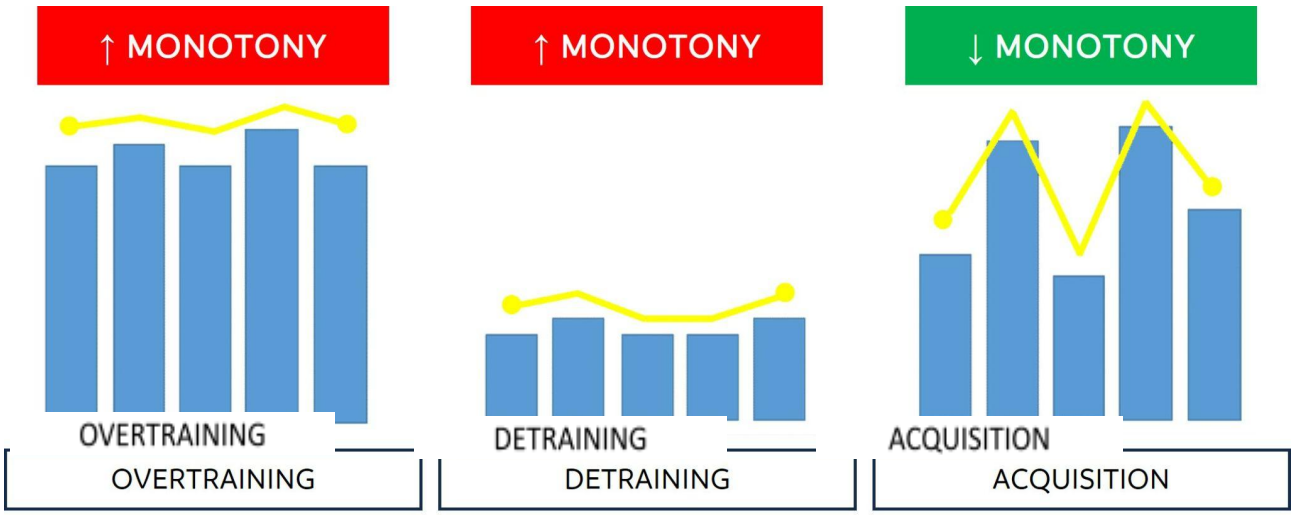
That's it! Now, with this PSE-session information, we can analyze the workload performed. There are some very interesting variables derived from methods to complement the training load control.

Monotony

It means how much the training varied in load during the week. It is calculated as follows:

Average of seven training sessions per week divided by the standard deviation.

Figure 28: Monotonicity analysis at different training loads.



Source: own elaboration

Three situations can occur throughout the load control, analyzing the monotony.

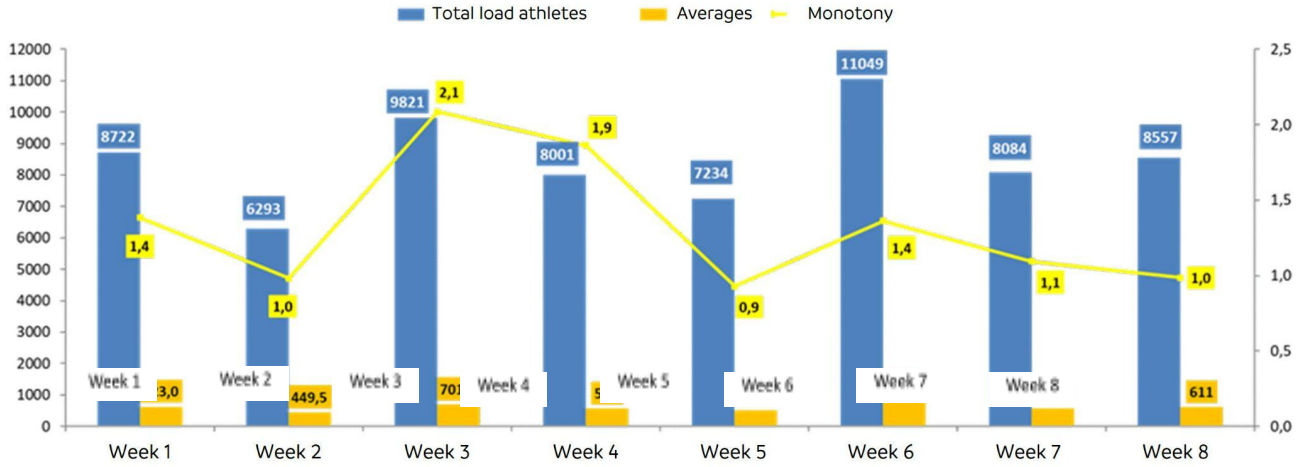
High monotony (overtraining): high and similar loads, with little or no variation throughout the week. There is a possibility of excessive overload on the athlete's body.

High monotony (detraining): low and similar loads, with little or no variation in the seven days of the week. There is the possibility of stabilization of the athlete's athletic form. What we call "shutting down the athlete's body" can happen.

Low monotony (acquisition): variation of loads throughout the week, with light, moderate and heavy characteristics. This allows to create an adequate scenario of stimulation and recovery, developing the athlete's sporting form.

See a practical example below:

Figure 29: Monotonicity variables in different training weeks.



Source: own elaboration

As a highlight, weeks 3 and 6 had the highest loads among the 8 weeks analyzed. However, each of them had a specific characteristic. Although week 6 presented a load of 11,049 a.u. (arbitrary units), the monotonicity was 1.4 indicating a greater variation of total load during the 7 days. Week 3, although not the strongest of all (9,821 a.u.), presented monotony of 2.1, i.e., very similar week loads.

As a final analysis, we can conclude that the total load of the week does not always reflect the highest stress for the athlete and that, after a week of high monotony such as week 3, it makes sense to adjust the load of the following weeks (weeks 4 and 5).

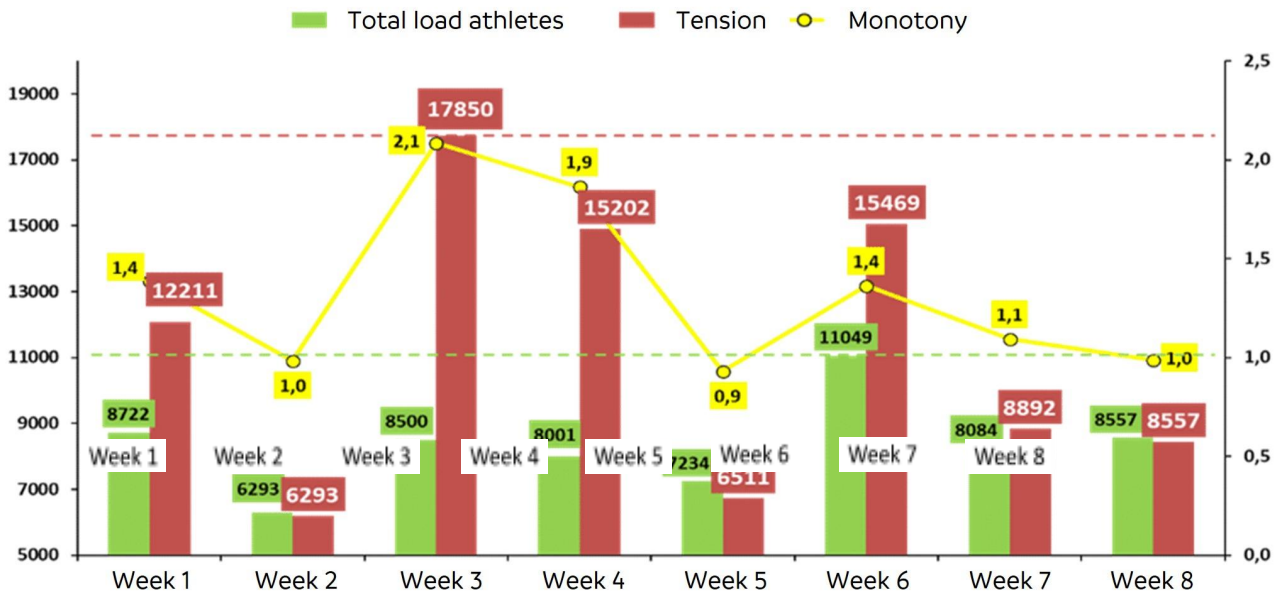
Tension

Another variable derived from the PSE-session, which can complement your analysis of training load control, is Strain.

Stress Consists of the total stress generated by the load applied in the week (PSE-session x Monotony).

Note that, as Tension considers the total weekly load of the athlete and also the monotony, valuable information can be extracted from this variable. In the following example, although week 6 had the highest combined load of training days, it was not the week with the highest Tension.

Figure 30: Relationship between load of two athletes, strain and monotony.



Source: own elaboration

On the other hand, week 3 was the most stressful training period generated mainly due to high monotony (low load variability). Here it is clear how much we can manipulate the training loads in various ways throughout the week.

Subjective perception of recovery (PSR)

In addition to the PSE-session, another scale widely used in the sports and scientific environment is the subjective perception of recovery (Laurent, 2011). This scale aims to analyze the current state of the athlete in terms of training routine and matches.

Figure 31: Subjective perception of recovery

Rate	RECOVERY
0	Very poorly recovered
1	
2	Not very well recovered
3	
4	Poorly recovered
5	
6	Moderate recovery
7	
8	Well recovered
9	
10	Very well recovered

Source: own elaboration

It includes physiological, psychological and emotional responses perceived by the athlete. Suitable, mainly, to evaluate the state of recovery relative to the training or the previous day. Allows immediate feedback of the athlete's sensations and perceptions, facilitating load adjustments of the upcoming training.

The PSR should be applied in the training routine, before the start of the session, with the following question:

How do you feel about your recovery?

It is important to point out some care when applying it:

1) Ask before training;

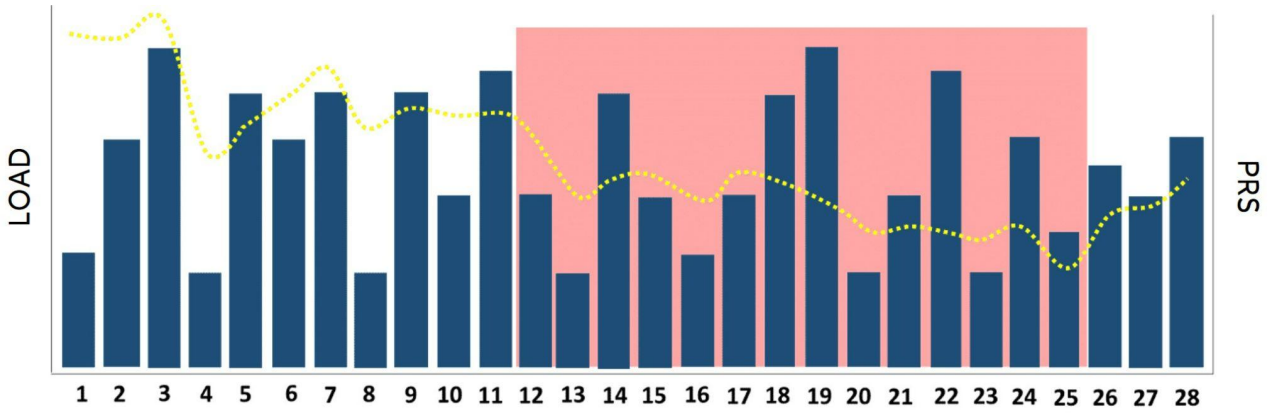
In conjunction with the PSR, take the opportunity to collect information to talk with the athlete about more details of that perception of recovery, including recording complaints and pain.

2) Individualize the approach;

As in the PSE, try to approach the athlete individually so that he/she is not influenced by the opinion of third parties.

For a better understanding of the practical application of PSR, we will analyze the table below.

Figure 32: Data and relationship between athlete load and PSR



Source: own elaboration

The graph represents approximately one month of training with 28 sessions performed. The columns are the loads recorded by the PSE-session and the yellow line, the PSR reported by the athlete.

Note that, from session 12 onwards, the athlete's recovery decreases over time and, regardless of load variation, the athlete does not show an improvement in PSR values.

It is clear that there is no opportunity for the athlete to restore his sporting form and that an adjustment is necessary. The great contribution of load control throughout the monitoring of the athlete's responses consists in intervening at the right time, so that the low recovery does not last to the point of generating more serious consequences.

In the above example, from the moment the PSR continues to decrease, the load in session 14 should have been adjusted, considering that even with low loads in session 12 and 13, the athlete was not responding correctly.

Wellness and recovery scale

As a final example of subjective scales that can contribute to athlete monitoring, the Wellness and Recovery Scale (Hooper, 1995) is presented as a tool that goes beyond the physical/physiological aspect. There are 4 questions on a Likert scale from 1 to 7, involving: sleep quality, mental stress, general fatigue and muscle soreness.

Figure 33: Well-being scale

Well-being scale

How was the quality of your sleep?	
1	Very very good
2	Very good
3	Good
4	Regular
5	Bad
6	Very bad
7	Extremely bad

What is the level of your mental stress?	
1	Very very low
2	Very low
3	Low
4	Regular
5	High
6	Very high
7	Extremely stressed

What is the level of your general fatigue?	
1	Very very low
2	Very low
3	Low
4	Regular
5	High
6	Very high
7	Extremely fatigue

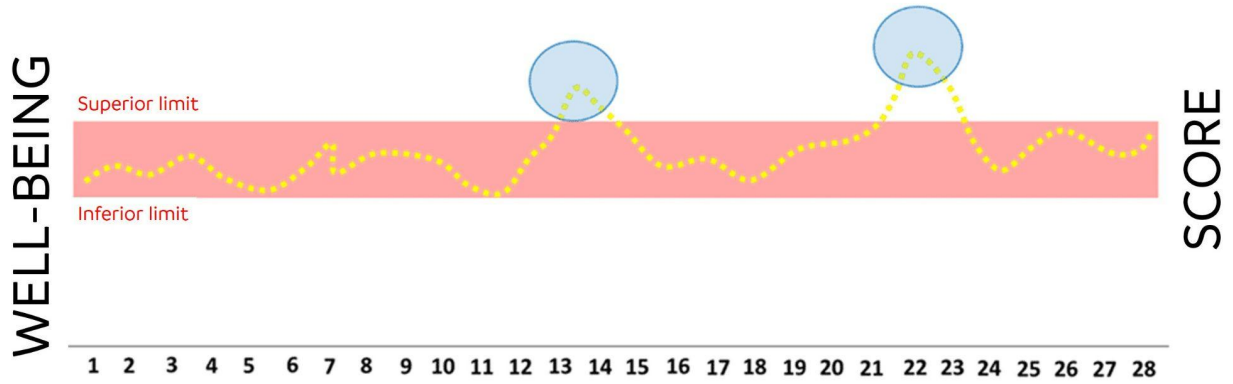
What is the level of your muscle pain?	
1	Very very low
2	Very low
3	Low
4	Regular
5	High
6	Very high
7	Extremely high

Source: own elaboration

Unlike the PSR, it allows separate classification of physiological and emotional responses. In addition, it differentiates general (central) fatigue from specific (peripheral) muscle soreness. It allows immediate feedback of the athlete's sensations and perceptions, facilitating load adjustments of the upcoming training.

See the example below, on what it would be like to analyze the wellness and recovery scale on an individualized basis:

Figure 34: Individualized analysis with the wellness and recovery scale



Source: own elaboration

In the graph we can see that the athlete's monitoring over 28 days presents two alert moments. Using an individual approach to the athlete's data history, there is a range (upper and lower limit) that shows the athlete's response pattern. When the data exceeds the upper limit, an alert should be triggered to investigate the reason for this altered response. And so, the athlete is always compared with himself, creating an individual routine evaluation.

Biochemical markers

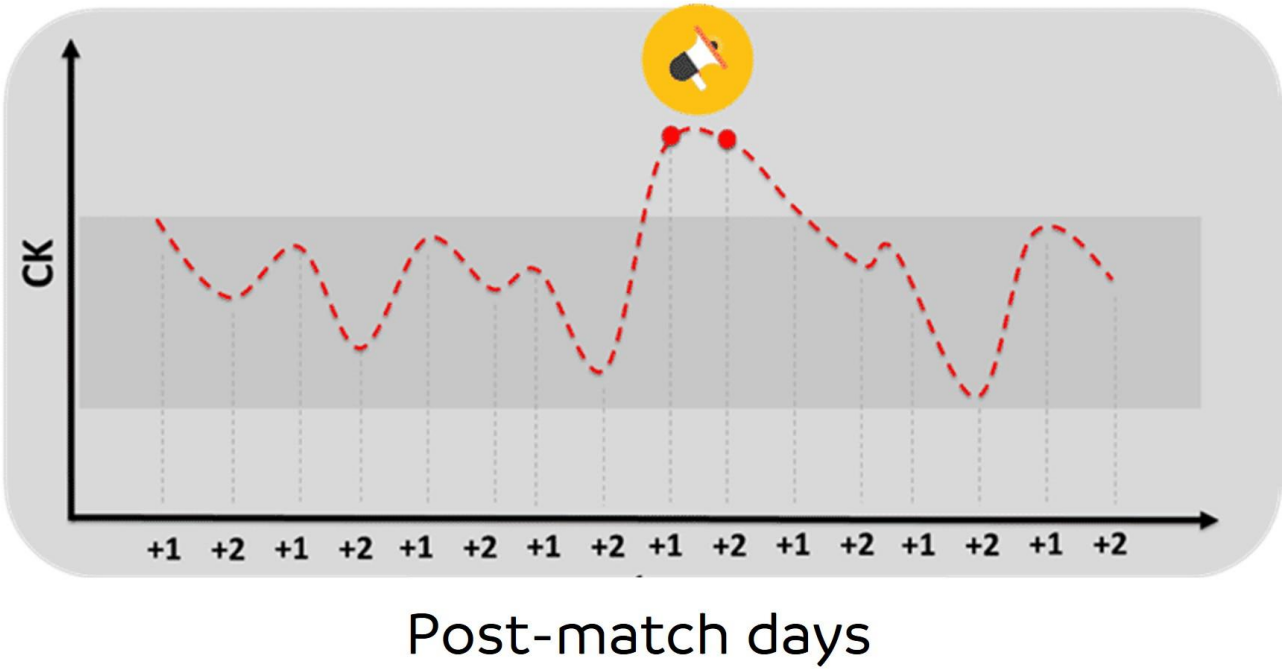
Among the internal load variables, we cannot fail to highlight biochemical markers. Unlike subjective scales, biochemical markers are objective and invasive measures that require a device to collect information, such as blood or saliva tests.

There are numerous markers such as testosterone, cortisol (hormones), C-reactive protein, TNF-α and IL-6 (inflammatory) that reflect the functioning of the athlete's body. The best known marker in football is Creatine Kinase (CK), an enzyme that reflects muscle

wasting. With a single drop of blood from the finger, it is possible to analyze the enzyme activity in the athlete's body and with this, together with the other relevant information, to interpret and decide assertively.

Commonly used as a way to assess an athlete's state of recovery, some care must be taken as with all other measures of internal loading. CK values should always be analyzed on an individual and circumstantial basis. Here are two practical examples:

Figure 35: Analysis of CK in relation to two days after the match.

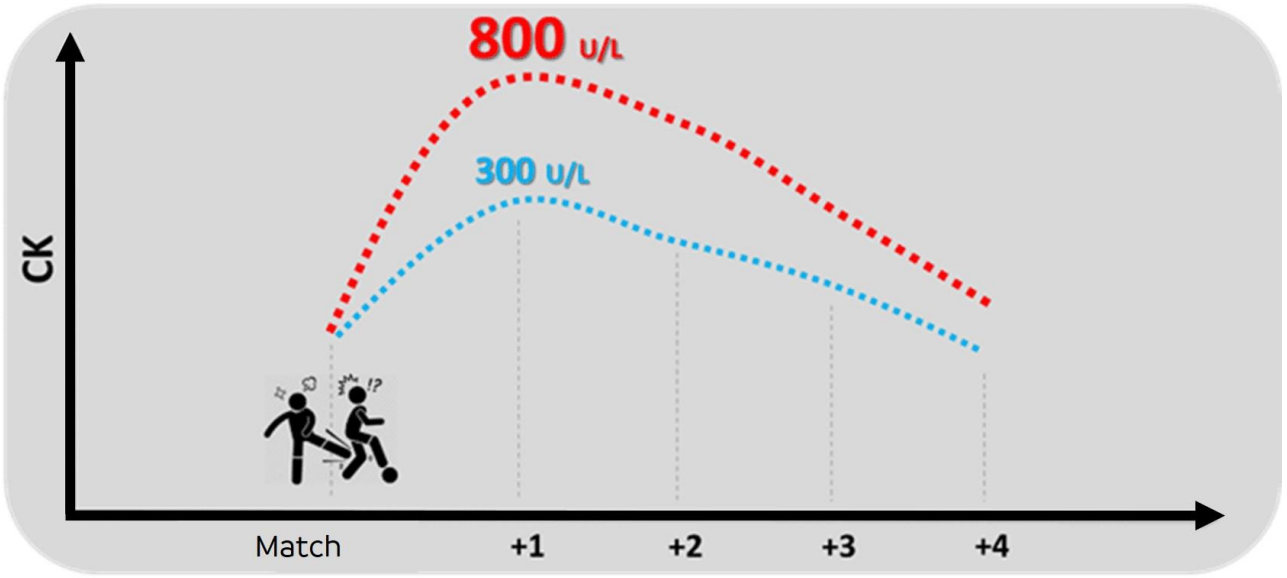


Source: own elaboration

As we saw in the subjective scale of well-being and recovery, in which the athlete's data history is the reference for comparison, CK values are also collected over time to create an individual bank of information.

In the example above, CK activity is collected 24 hours (day +1) and 48 hours (day +2) after the match, to understand the athlete's responses to each effort in an official match. As we can see, there is a gray area (lower and upper limit) indicating the pattern of the athlete's responses after the matches. As the values exceed the upper line, showing that something has gone out of normal, a warning signal can be triggered for further investigation of the athlete's condition.

Figure 36: CK analysis during a match and on subsequent days.



Source: own elaboration

In this second example, we see the analysis of the CK of a match and the behavior of the enzyme activity in the 4 subsequent days. For each athlete, there is a characteristic range of CK values, i.e. for one athlete 300 U / L may be high and for another athlete it may be low. Therefore, we must always compare the athlete's data with himself and not with his peers.

In the above case, the athlete in question presented CK values of 800 U/L 24h (day +1) post-match, when his pattern in other evaluations was 300 U/L. Under normal conditions, we could interpret that the athlete was worn out more than expected, but in this specific match, he suffered a trauma from an opponent. And we know that, depending on the trauma, CK values can change due to the cellular overflow of that specific condition. Therefore, it may be a mistake to analyze only this information, considering all the variables that reflect the athlete's current condition.

Therefore, as an important note on this topic, decision making should not be based on just one piece of information, but on the whole, so that the choice of what to do is assertive. We cannot make the mistake of deciding whether an athlete trains or not based on a single piece of information, just as we are not at the point in science of predicting injuries from a few pieces of information (if this will ever be possible, with so many variables interfering in the outcome).

Finally, there are many ways to control the athletes' load; the most important of all is to use what best corresponds to their reality, environment, methodology, financial and structural resources. Each and every tool to be applied in the team/athlete's routine must be presented in advance and at the most opportune moment. It is necessary that the coaching staff, athletes and even the coordination / management know the objectives, applications and their importance.

And it is important to note that the process of educating and familiarizing athletes with the routines and tools is ongoing and will often require reaffirmation of load control guidelines and directives throughout the season.

Thus, we have reached the end of this Module 2. In the next module, we will detail one of the most discussed topics in professional football today: the calendar.

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