

# Module 4. Load and Specificity in Coadjuvant Training



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☰ References

# 1. Load and Specificity in Coadjuvant Training

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In this module, we will explore the interaction between load and specificity in coadjutant training, highlighting its close relationship with the main topic of this course: **Load Control and Monitoring. Performance and Injury Prevention in Indoor Team Sports.** This module provides a detailed explanation of how to structure exercises for better control, monitoring, and evaluation.

## **Load vs. Specificity**

Overload occurs when training stimuli exceed what the body is currently prepared for, requiring adaptations. Traditionally, it has been linked to quantitative measures such as increased weight, sets, or repetitions. However, assessing, controlling, and measuring overload qualitatively is more effective when addressing strength training in terms of coordination. As a result, creating overload becomes a matter of introducing variation and designing sensorimotor stimulation exercises unfamiliar to the player. This is especially crucial when aiming to transfer to a more complex, coordinated sports movement.

Such transfer follows its own dynamics and is separate from the increase in force production seen in basic strength exercises.

In many team sports, high specificity reduces the potential for significant overload, and the opposite is also true (Figure 1).

**Figure 1. The higher the specificity, the lower the load we can apply; conversely, the higher the load, the less specific the task can be.**



+ LOAD			+ SPECIFICITY

- LOAD			- SPECIFICITY
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Source: Original work

Generating overload is...

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- A stimulus-response relationship that, when exceeded, causes different injuries in the athlete
- A matter of variation and creation of sensorimotor stimulation exercises that the player is not yet familiar with

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## Approximation levels

In his doctoral thesis *La variabilidad de movimiento en el entrenamiento de fuerza en los deportes de equipo* (Movement

Variability in Strength Training for Team Sports), Bruno Fernández-Valdés Villa (2020) explains:

Based on athlete structures and movement families, Seirullo (1993) and later Moras (2000) developed a training approach that views training as a sequence of movement tasks with varying orientations and levels of specificity. In this approach, the involvement of different athlete structures becomes increasingly emphasized until tasks are created in which all structures behave similarly to how they would in competition, reaching their highest level of complexity and representativeness. To help classify and relate structures with different tasks and levels, a basic structure is proposed, typically involving conditional (and bioenergetic), coordinative, or cognitive structures. Meanwhile, socio-affective, emotional-volitional, and creative-expressive structures, considered auxiliary, complement the primary (or base) structures (Seirullo, 1993a; Sole Forto, 2016). (<https://goo.su/nebICrn>)

It's important to note that none of these structures are more important than the others; those used as a base are simply more directly related to the load of the simulated situation, while the auxiliary ones reflect the complex nature of the human playing football.

Seirullo's (2017) proposal outlines five types of exercise orientation based on specificity:

**Table 1: Five Types of Exercise Orientation by Specificity**

Orientation	Description
<b>Generic Exercise</b>	All structures are engaged with little to no resemblance to the athlete's competition demands. For example: a player cycling during a recovery session.
<b>General Specific Exercise</b>	The conditional and bioenergetic structures are highly specific, but other structures are less so.
<b>Directed Specific Exercise</b>	There is high specificity for the conditional, bioenergetic, and coordinative structures. Decision-making is either unspecific or absent.
<b>Special Specific Exercise</b>	Decision-making is specific. This increases the specificity of the cognitive structure.
<b>Competitive Specific Exercise</b>	All structures are involved, with a clear winner and loser, increasing demands on the socio-affective structure.

Source: Adapted from Seirullo, 2017

In 1994, Gerard Moras expanded Seirullo's ideas in his book *La preparación integral en el voleibol* (Comprehensive Preparation in Volleyball), increasing the levels of specificity to seven: Level 0

(complementary and compensatory), Oriented Level 0 (L0), Level 1 (L1), Level 2 (L2), Level 3 (L3), Level 4 (L4), and Level 5 (L5) (Fernández-Valdés Villa, 2020).

### **Level 0 CP/CL (Complementary and Compensatory Training)**

It focuses on exercises related to complementary and compensatory training.

- **Compensatory Exercises**

These exercises aim to immediately address imbalances created by more specific tasks. The purpose is to reduce the imbalances generated by these exercises, linking them directly to their contents. The abdominal muscles are the most frequently targeted, although antagonist and stabilizing (rotator) muscles should also be included. Therefore, it's essential to perform abdominal exercises after sessions where the spine has been subjected to heavy loads (e.g., plyometrics, Olympic lifts) to mitigate the stress. However, compensatory abdominal exercises have a different goal from strengthening exercises included in specific abdominal training, which is why they need to be distinguished. Among abdominal exercises, those that focus on the internal oblique and transverse

muscles are the most effective at compensating for lower back overload.

- **Complementary Exercises**

These exercises address imbalances or potential injury risks specific to the sport and are typically planned across the macrocycle. The aim is to prevent the most common injuries in a given sport, or if they do occur, to reduce their severity as much as possible. Depending on the objective, various exercises can serve as complementary or compensatory in a team's microcycle, tailored to the sport's demands. We'll now explain the core, quadriceps-hamstring compensation, the stabilizing role of the popliteus, and periarticular hip muscles, along with general guidelines to minimize neuromuscular injury risks.

### ***Core***

The core includes the abdominal and lumbopelvic regions, comprising muscles such as the abdominals, lower back, diaphragm, pelvic floor, and glutes. It also involves the shoulder and waist muscles, as they play an important role in transferring energy from the trunk to the limbs.

The core is critical for spinal stabilization, maintaining proper alignment, and ensuring efficient movement of the trunk relative to the pelvis. It acts as a link between the upper and lower body, allowing for effective force transfer between the two.

For optimal performance, having a strong and stable core is essential. This helps avoid energy leaks within the kinetic chain. Conversely, when the core does not function properly, force transfer becomes inefficient, increasing the risk of injury. No single exercise works all core muscles, so achieving full stability requires a variety of exercises addressing different planes of motion, force vectors, and intensity levels.

The core comprises local stabilizers (the internal unit) that provide segmental stabilization, and global stabilizers and movers (the external unit) that generate and control movement. The internal and external units work together to stabilize the core and generate powerful limb movements as needed during sports activities.

Core demands during sports practice involve multiple positions and directions. To fully develop core stability, a variety of exercises that address different planes of motion and force vectors must be included. Isometric exercises, where movement is resisted, should be combined with dynamic exercises that challenge neuromuscular control, range of motion, capacity, and strength.

Traditional core exercises can improve the activation and endurance of stabilizing muscles, while multi-joint free-weight exercises enhance stability under heavy loads or fast movements during functional positions, specific to the demands placed on the core in the sport. Core exercises are divided into four categories:

- **Anti-extension**

Anti-extension refers to the core's ability to resist lumbar spine hyperextension. This is achieved by coactivation of the abdominal muscles, which increases core stiffness. The anterior oblique system is the outer unit that supports anti-extension stability. It's essential to understand that the abdominal obliques consist of various neuromuscular compartments activated regionally. As a result, a variety of exercises are needed to fully engage the abdominal wall.

When aiming to enhance core stability, it's better to focus on motor patterns that activate multiple muscles simultaneously, rather than targeting just a few. This ensures comprehensive engagement of the abdominal muscles and improves lumbar spine stability and resistance to hyperextension.

- **Anti-rotation**

The anti-rotation function of the core helps stabilize the trunk during transverse plane movements. Most athletes don't need to increase

their lumbar rotation range of motion. Instead, emphasis should be placed on thoracic spine mobility and maintaining good hip range of motion to avoid excessive lower back rotation.

Exercises that enhance core rotational stability focus on separating hip and spine movements. If the spine lacks dynamic control during rotation, the hip joints will stiffen to protect the lower back from excessive motion. Improving core stability allows greater hip movement without affecting the neutral position of the pelvis and lumbar spine. This means improved rotational stability and core strength can enhance hip power and range of motion.

Spinal stability during rotational movements is crucial in sports training, as excessive lumbar spine rotation is known to be harmful. Many human movements involve rotation, such as the counter-rotation of the pelvis and trunk during a futsal kick. Controlling and stabilizing lumbar rotation is vital for better performance and back health. Core stability exercises that challenge rotational forces should be included in most training programs. The posterior and anterior oblique systems are the key outer units involved in generating and stabilizing trunk rotation.

- **Anti-lateral flexion**

Anti-lateral flexion is the body's ability to stabilize itself during lateral movements. In these movements, the pelvic stabilizers work with the

core muscles to resist lateral bending.

The lateral system plays a critical role in anti-lateral flexion stability. If this system is not functioning well, it can affect the entire kinetic chain, increasing the risk of lower limb injuries and back pain. In other words, poor lateral stabilization can predispose individuals to leg injuries and lower back discomfort.

- **Anti-flexion**

Core anti-flexion stability refers to the ability to resist spinal flexion and counteract forces that push the trunk forward. Traditional strength exercises like squats, lunges, back extensions, and knee and hip exercises are effective for developing this stability.

During exercises like squats and deadlifts, the spinal erectors and multifidus muscles are highly engaged. These muscles are vital for providing support and resisting trunk flexion.

- **Quadriceps-hamstring compensation**

The hamstring muscles play a critical role in various injuries, such as anterior cruciate ligament (ACL) tears, one of the most severe injuries an athlete can face. These muscles contract to prevent the tibia from moving forward relative to the femur. Normally, the quadriceps-to-

hamstring strength ratio is 3:2, but it's suggested to shift this balance in favor of the hamstrings for better stability.

However, some studies haven't shown a significant reduction in injuries by adjusting this ratio. This may be due to the way hamstrings are typically trained. Emphasizing the rotational function of these muscles seems to have a greater impact on knee stability. It's recommended to use weighted shoes or pulleys while performing hamstring exercises. Rotations at the knee and ankle can be performed by placing the foot in inversion or eversion, depending on the targeted area. These techniques can effectively strengthen and stabilize the hamstrings.

- **The popliteus and its stabilizing role**

The popliteus muscle is part of the knee's posterior-lateral complex and serves both static and dynamic functions. Its main action is knee flexion and internal rotation. When contracted, it causes external rotation of the femur relative to the tibia, moving the lateral condyle backward. It's considered one of the key structures responsible for posterior-lateral knee joint stability.

Additionally, the popliteus helps stabilize the lateral meniscus during flexion and rotation movements, controls tibial rotation, and is thought to unlock the knee in deep squats. To target this muscle, knee flexion exercises that resist internal tibial rotation are

recommended. One approach is to sit with your legs bent at about 90 degrees, using a resistance band around your foot to counter internal tibial rotation.

- **Periarticular hip musculature**

The adductor and abductor muscles play a vital role in area stability due to their connection with the vastus medialis. Strengthening these muscles can enhance overall stability in this region. To work these muscles, use pulleys or elastic resistance around the feet for specific exercises targeting the adductors and abductors.

Along with the exercises mentioned earlier, the following movements can also be incorporated:

- 1 Hip adduction in prone position (PP);
- 2 Hip abduction in PP;
- 3 Internal hip rotation in supine position (SP);
- 4 External hip rotation in SP;
- 5 Lateral adduction kicks in standing position;
- 6 Lateral abduction kicks in standing position.

Additional exercises for the hip area include:

- 1 Hamstring kick with hip extension in supine position (SP).
  - 2 Quadriceps kick in PP.
  - 3 Knee flexion in SP targeting the distal hamstrings.
  - 4 Psoas exercises in quadruped position.
  - 5 In a standing position (facing away from resistance), perform forward kicks, focusing on the anterior chain (especially psoas-quadriceps).
-

6

In standing position (facing the resistance), perform backward kicks for the posterior chain.

7

In a standing position (facing away from resistance) and holding onto a support, perform a psoas kick (hip flexion while maintaining knee flexion at 90°).

These exercises should follow these principles:

- Ensure trunk stability during each exercise, especially during the transition between eccentric and concentric phases.
- Perform movements elastically (not reactively). This means that the deceleration of the eccentric phase will be done progressively, and the eccentric-concentric transition will be carried out, equally, with great tension, but without causing any kind of jerk or sudden pull.
- Engage the non-working limb for stabilization during the exercises. Although prone position exercises may not challenge balance, standing position exercises will.
- Work on achieving the maximum range of motion in the joints during these movements.

Below is a table outlining proposed interventions in coadjuvant training at different levels, focusing on the specificity of some recommendations. These are designed with a complementary or compensatory focus.

**Table 2: Possible neuromuscular risk factors that should be evaluated and corresponding training strategies**

<b>Muscle fatigue</b>	<ul style="list-style-type: none"> <li>- Strength and power-endurance training</li> <li>- High-intensity interval training</li> <li>- Progression to training under fatigue conditions</li> </ul>
<b>Altered timing and magnitude of muscle activation</b>	Strength/power training (plyometric)
<b>Delayed peroneal muscle reaction time</b>	Dynamic stabilization training
<b>Imbalances in muscle activation between the medial and lateral quadriceps and hamstrings</b>	Proprioceptive training
<b>Decreased coactivation of agonist and antagonist muscles</b>	Muscle activation awareness exercises
<b>Reduced hip muscle activation</b>	Muscle activation awareness exercises
<b>Deficits in trunk stability and muscle activation</b>	Muscle activation awareness exercises
<b>Weakness in strength</b>	<ul style="list-style-type: none"> <li>- Agonist/antagonist strength balance</li> <li>- Compensatory muscle strength training</li> <li>- Strength/power training</li> <li>- Eccentric overload training</li> </ul>
<b>Knee control in the frontal plane: dynamic valgus</b>	Proper alignment of lower limbs during trunk-hip-knee-ankle flexion in landings, changes of direction, and deceleration actions
<b>Neuromuscular imbalances between limbs</b>	<ul style="list-style-type: none"> <li>- Symmetry in bilateral tasks</li> <li>- Unilateral tasks</li> </ul>
<b>Insufficient muscle stiffness</b>	<ul style="list-style-type: none"> <li>- Strength</li> <li>- Power</li> </ul>
<b>Deficits in postural stability</b>	Balance / dynamic stabilization training
<b>Altered proprioception</b>	<ul style="list-style-type: none"> <li>- Fundamental movement skills training</li> <li>- Balance/dynamic stabilization training</li> <li>- Functional mobility</li> </ul>
<b>Altered feedforward mechanism</b>	<ul style="list-style-type: none"> <li>- Training with unpredictable tasks</li> <li>- Task variability</li> <li>- Open agility tasks</li> <li>- Coordination skills</li> </ul>

Source: Adapted from Fort-Vanmeerhaeghe et al., 2016

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Seirul-lo's (2017) proposal is based on five types of orientation according to specificity. They are:

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- Generic / General Specific / Directed Specific / Special Specific / Competitive Specific
- General / Specific / Transfer / Competition
- General / Directed / Dynamic / Variable

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### **Level 0 - Oriented (L0)**

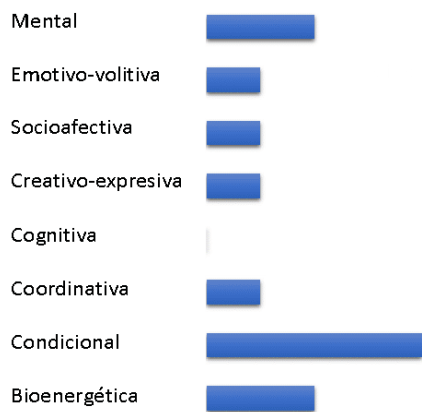
At this level, Fernández Valdés Villa (2020) explains:

The key muscle chains involved in sports movements are trained, but without a dynamic connection to the actual technique. Dynamic correspondence refers to the similarity between the movement performed and the previously

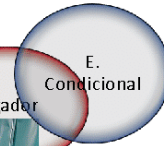
explained families of sports movements. Some form of external resistance should be applied at this level, which can vary in magnitude. This is referred to as microtraining, as the main goal is to help muscle tissues better handle training loads, rather than focusing on transferring strength to real-game situations. It primarily emphasizes the conditional and bioenergetic structures [Figure 2]. (<https://goo.su/nebICrn>)

These exercises are used in structural sessions and specific quality sessions as general exercises when aligned with the session's objectives.

**Figure 2. Example of a level 0 exercise aimed at training jump shots for basketball or handball, or heading in futsal.**



Ejercicios estructurales



Source: Original work

Mental	0+ GENERAL	Structural Exercises	Player Conditional Structure
Emotional-Volitional			
Socio-Affective			
Creative-expressive			
Cognitive			
Coordinative			
Conditional			
Bioenergetic			

The following figure offers a proposal for basic exercises designed to train different exercise families at the oriented level 0.

**Figure 3. Proposal of basic exercises to train different exercise families at the oriented Level 0.**



### O+ GENERAL

	<b>Acceleration / Deceleration</b>	Russian belt squat, Front lunge Single-leg deadlift
<b>Movement Strength</b>	<b>Change of direction (cross and open starts)</b>	Lateral lunge Single-leg squat Lateral split squat
	<b>Rotations</b>	Bulgarian split squat Rotational lunge Hip thrust
<b>Jumping Strength</b>	<b>Vertical jump (bilateral / unilateral)</b>	Yoyo squat Squat
<b>Throwing Strength</b>	<b>Passing or shooting</b>	Leg extension Unilateral deadlift Back lunge
<b>Combat Strength</b>	<b>Contact with an opponent from behind/side/front</b>	Horizontal press-pull Vertical press-pull Lunge

## **Level 1 (L1)**

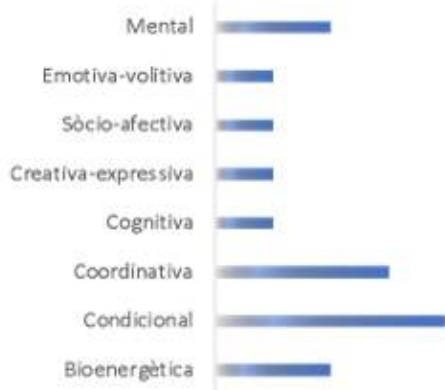
According to Fernández Valdés Villa (2020):

This level has dynamic correspondence with the technique, and the external resistance applied should be high. In many training proposals, achieving full dynamic correspondence with sports movements may not be possible, as the high external resistance will not allow it, as mentioned earlier. This level still focuses on the conditional and bioenergetic structures, but compared to oriented L0, the coordinative structure becomes more important [Figure 4]. (<https://goo.su/nebICrn>)

**Figure 4. Example of a Level 1 exercise**



Resistencia Externa – alta  
(aproximación al gesto deportivo)

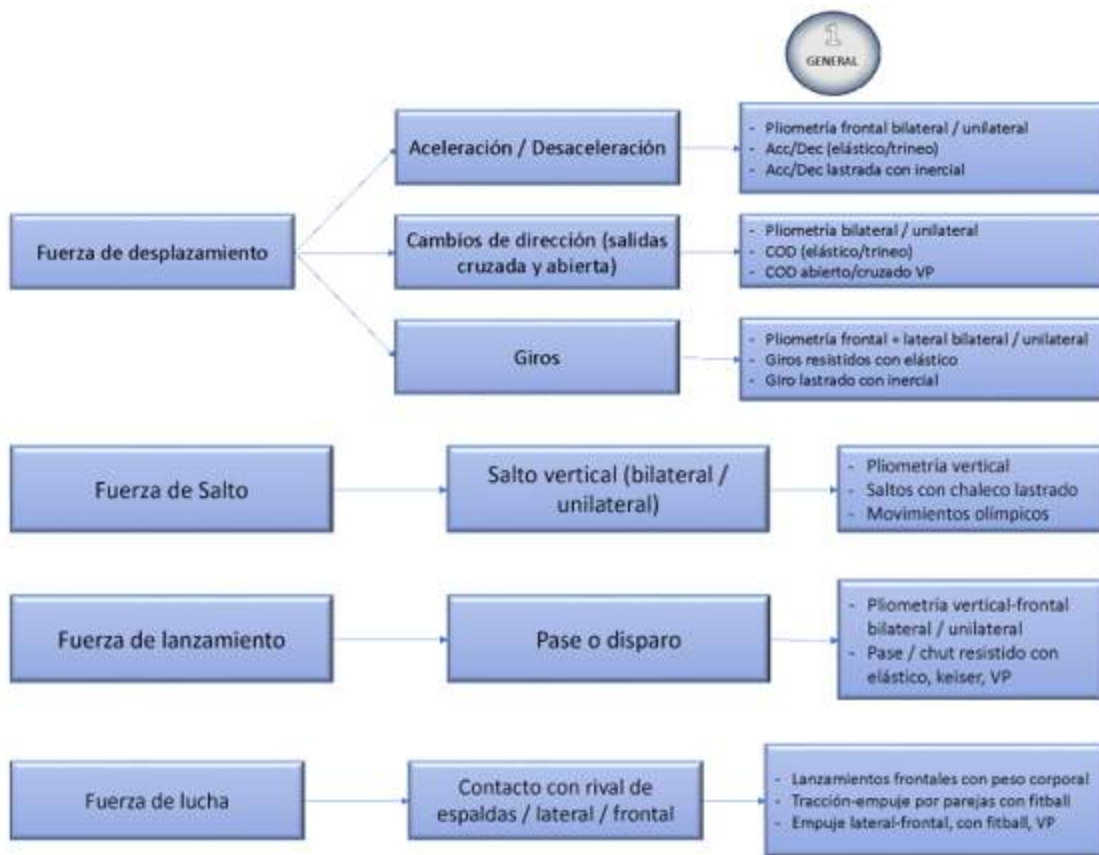


1 GENERAL	External Resistance – High (approximation to the sports gesture)		Conditional structure Player Coordinative Structure
Mental Emotional-Volitional Socio-Affective Creative-expressive Cognitive Coordinative Conditional Bioenergetic			

Source: Original work

Below is a proposed set of basic exercises designed to train the various exercise families at Level 1.

**Figure 5. Proposal of basic exercises to train different exercise families at Level 1**



Source: Original work

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	<b>Acceleration / Deceleration</b>	<ul style="list-style-type: none"> <li>- Bilateral/unilateral forward plyometrics</li> <li>- Acc/Dec using resistance bands or sleds</li> <li>- Acc/Dec with added inertial load</li> </ul>
<b>Movement Strength</b>	<b>Change of direction (cross and open starts)</b>	<ul style="list-style-type: none"> <li>- Bilateral/unilateral plyometrics</li> <li>- COD with resistance bands or sleds</li> <li>- COD with open or crossed patterns, incorporating VP</li> <li>- Bilateral/unilateral frontal and lateral plyometrics</li> </ul>
	<b>Rotations</b>	<ul style="list-style-type: none"> <li>- Resisted rotations using elastic bands</li> <li>- Rotations with inertial load equipment</li> </ul>
<b>Jumping Strength</b>	<b>Vertical jump (bilateral / unilateral)</b>	<ul style="list-style-type: none"> <li>- Vertical plyometrics</li> <li>- Weighted vest jumps</li> <li>- Olympic movements</li> </ul>
<b>Throwing Strength</b>	<b>Passing or shooting</b>	<ul style="list-style-type: none"> <li>- Bilateral/unilateral vertical-forward plyometrics</li> <li>- Resisted passes/shots with elastics/Keiser/VP</li> <li>- Front bodyweight throws</li> </ul>
<b>Combat Strength</b>	<b>Contact with an opponent from behind/side/front</b>	<ul style="list-style-type: none"> <li>- Partner push-pull exercises using fitballs</li> <li>- Lateral and frontal pushing with fitballs, VP</li> </ul>

□

## Level 2 (L2)

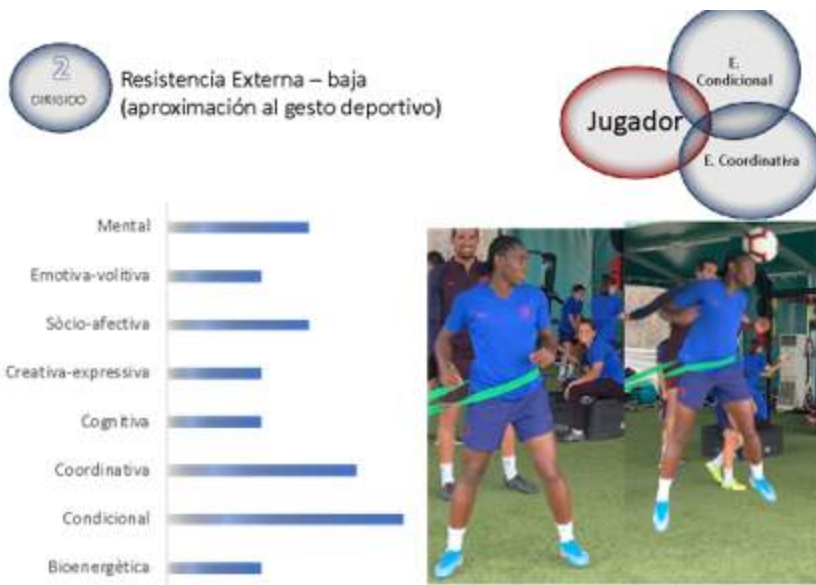
At this level:

There should be a high level of dynamic similarity to sports movements, but the external resistance should be

moderate to low, always lighter than in Level 1. Equipment like elastic bands or other weights can be used to ensure movements stay close to actual sports performance. This is a crucial intermediate step between gym exercises and on-field tasks, often neglected in traditional strength programs for indoor team sports. Both the conditional and bioenergetic structures, alongside the coordinative structure, are prioritized at this level.

It's important to recognize that the determination of whether the external load is high or low in both L1 and L2 depends entirely on the athlete, which influences the most suitable equipment for each level. For example, the external load offered by a conical pulley and its benefits for adaptation (Tous-Fajardo et al., 2016) can be classified as L1 for novice athletes due to the high load it represents. However, for trained athletes accustomed to its use, it may be considered as L2 resistance [Figure 6]. (<https://goo.su/nebICrn>)

### **Figure 6. Example of a Level 2 exercise**

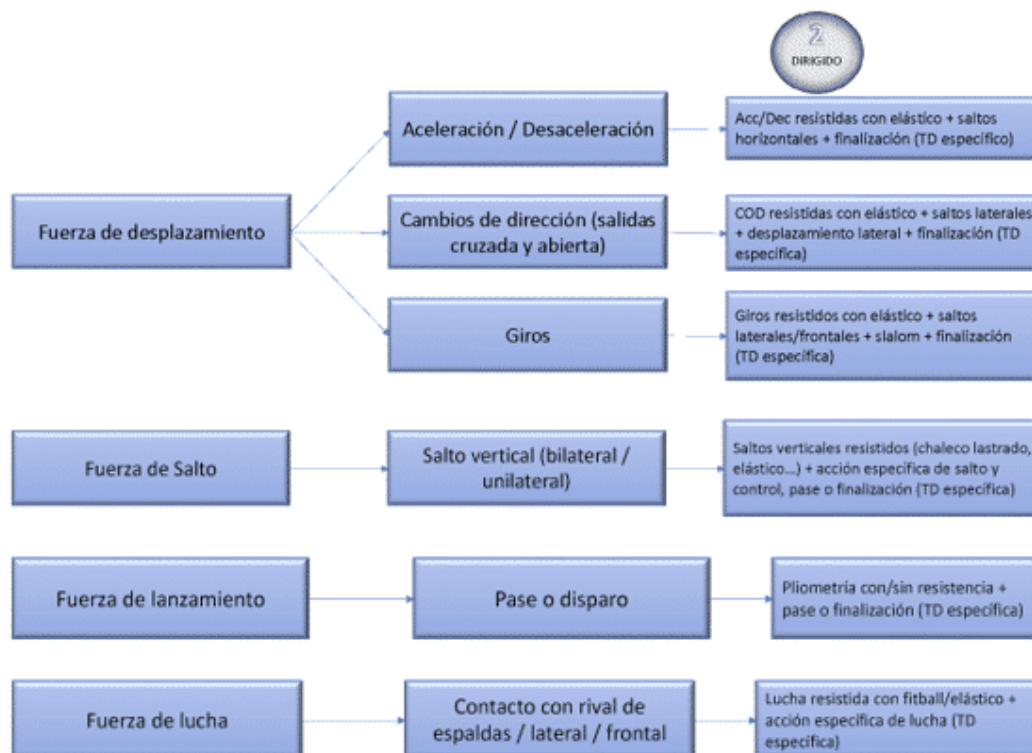


2. DIRECTED	External Resistance - Low (approximation to the sports gesture)		Conditional structure Player Coordinative Structure
Mental Emotional-Volitional Socio-Affective Creative-expressive Cognitive Coordinative Conditional Bioenergetic			

Source: Original work

Below is a proposed set of basic exercises designed to train the various exercise families at level 2.

**Figure 7. Proposal of basic exercises to train different exercise families at level 2**



## 2. DIRECTED

<b>Movement Strength</b>	<b>Acceleration / Deceleration</b>	- Resisted Acc/Dec with elastic bands + horizontal jumps + finish (specific TD)
	<b>Change of direction (cross and open starts)</b>	- Resisted COD with elastic bands + lateral jumps + lateral movement + finish (specific TD)
	<b>Rotations</b>	- Resisted rotations with elastic bands + lateral/frontal jumps + slalom + finish (specific TD)
<b>Jumping Strength</b>	<b>Vertical jump (bilateral / unilateral)</b>	- Resisted vertical jumps (weighted vest, elastic bands) + specific jump action and control, pass, or finish (specific TD)
<b>Throwing Strength</b>	<b>Passing or shooting</b>	- Plyometrics with/without resistance + pass or finish (specific TD)
<b>Combat Strength</b>	<b>Contact with an opponent from behind/side/front</b>	- Resisted combat using fitballs/elastics + specific combat action (specific TD)

Source: Original work

Next, we will address the optimization levels (Levels 3, 4, and 5), where exercises are performed using body weight, eliminating the use of artificial external resistance. In this context, Fernández Valdés Villa (2020) clarifies:

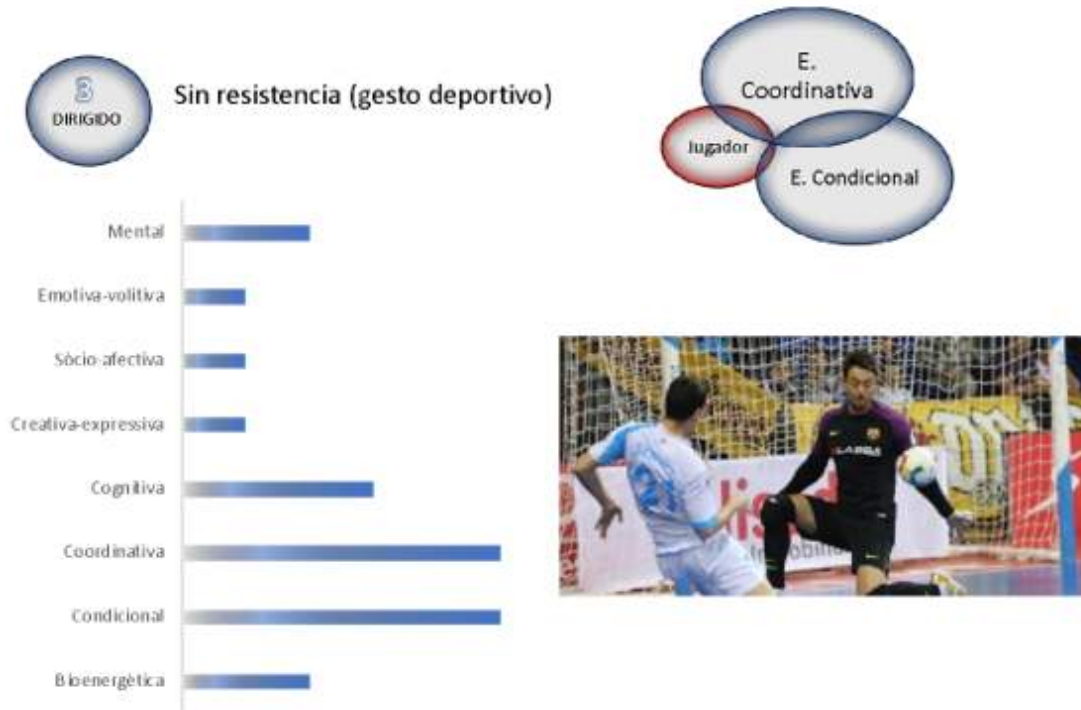
The only external resistance used at these levels comes from interactions with other athletes (combat strength). We won't detail the exercises, as they have already been discussed in other modules related to conditional structure training based on short-duration (speed) or long-duration (endurance) force production, given the close connection. (<https://goo.su/nebICrn>)

### **Level 3 (L3)**

This level is closely tied to actual sports gesture. It is trained without external resistance to enable the correct execution of movements. Strength is expressed according to the family of sports movements specific to each sport. This level is a key part of the new strength training paradigm that emphasizes human movement. It allows exercises to be organized into sets and repetitions, guiding them towards one type or another and emphasizing the conditional and bioenergetic structures. No decision-making is required at this stage. While conditional and bioenergetic structures are

developed, the focus is also on the coordinative structure [Figure 8]. (<https://goo.su/nebICrn>)

**Figure 8. Example of a Level 3 exercise**



3. DIRECTED	No resistance (sports gesture)		Conditional structure Player Coordinative Structure
Mental Emotional-Volitional Socio-Affective Creative-expressive Cognitive Coordinative Conditional Bioenergetic			

Source: Original work

#### **Level 4 (L4)**

This level, too, has a strong connection to the actual sports gesture. The exercise base is similar to that of L3, but in this case, simple decision-making is introduced. The focus here is on the coordinative and cognitive structures, as it encourages simple decision-making. (<https://goo.su/nebICrn>)

#### **Level 5 (L5)**

These are reduced or full game-like situations within training. Continuing the progression from previous levels, this level is built on L3 and L4, but now introduces complex decision-making, requiring players to find optimal solutions for in-game situations, encouraging creativity. All structures align in a way similar to actual competition [Figure 9]. (<https://goo.su/nebICrn>)

The figure below summarizes the load characteristics according to the levels of specificity, enabling control, monitoring, and evaluation of training load.

**Figure 9. Load characteristics according to the levels of specificity**



Source: Original work

5 Competitivo.	5 Competitive.
Juego real.	Real game.
4 Especial	4 Special
Toma de decisiones.	Decision making.
3 Dirigido.	3 Directed.
Gesto técnico sin carga externa, pero la orientación es condicional. Ejercicios poliarticulares específicos de fútbol, ejecutados a la velocidad real del juego. Ejemplo: circuito con diferentes habilidades.	Technical gesture without external load, but the orientation is conditional. Specific polyarticular exercises for soccer, executed at the real speed of the game. Example: circuit with different skills.
2 Dirigido.	2 Directed.
Resistencia externa baja: aproximación al gesto deportivo con sobrecargas que permitan realizar el gesto sin alterarlo. Ejemplo: un lastre en la carrera o aceleraciones con banda elástica.	Low external resistance: approach to the sports gesture with overloads that allow the gesture to be performed without altering it. Example: a weight in the run or accelerations with an elastic band.
1 General.	1 General.
Resistencia externa alta: aproximación al gesto deportivo, con ejercicios con cadenas cinéticas y posiciones semejantes al movimiento deportivo.	High external resistance: approach to the sports gesture, with exercises with kinetic chains and positions similar to the sports movement.
0+ General.	0+ General.
Cualquier carga: ejercicios no específicos, pero con cierta transferencia al gesto deportivo: ejercicios multiarticulares sin toma de decisión o muy simples.	Any load: non-specific exercises, but with some transfer to the sports gesture: multi-joint exercises without decision-making or very simple ones.
0- Genérico.	0- Generic.
Cualquier carga: ejercicios sin transferencia directa al gesto específico. Compensatorios: core stability, control neuromuscular, ADM. Complementarios: ejercicios de fuerza que previenen desequilibrios o estructuras en las que el entrenamiento no incide especialmente.	Any load: exercises without direct transfer to the specific gesture. Compensatory: core stability, neuromuscular control, ROM (range of motion). Complementary: strength exercises that prevent imbalances or structures in which training does not particularly affect.

## Grouping of levels

As Fernández Valdés Villa (2020) explains in his doctoral thesis:

Training exercises often don't belong to just one level but may cover two, forming groupings (A, for its initial in Spanish). Just like in a game, all structures overlap and interact non-linearly. Therefore, true sports specificity cannot be achieved by applying the levels in a strictly linear or hierarchical manner. Thus, it is often recommended to combine levels, seeking their interaction and referring to studies on combined or complex training (Alves et al., 2010). To classify these combinations, we will keep the number of the base level on the left and add the specific variant as the conditioning factor on the right [Figure 10]. (<https://goo.su/nebICrn>)

**Figure 10. Combined training**

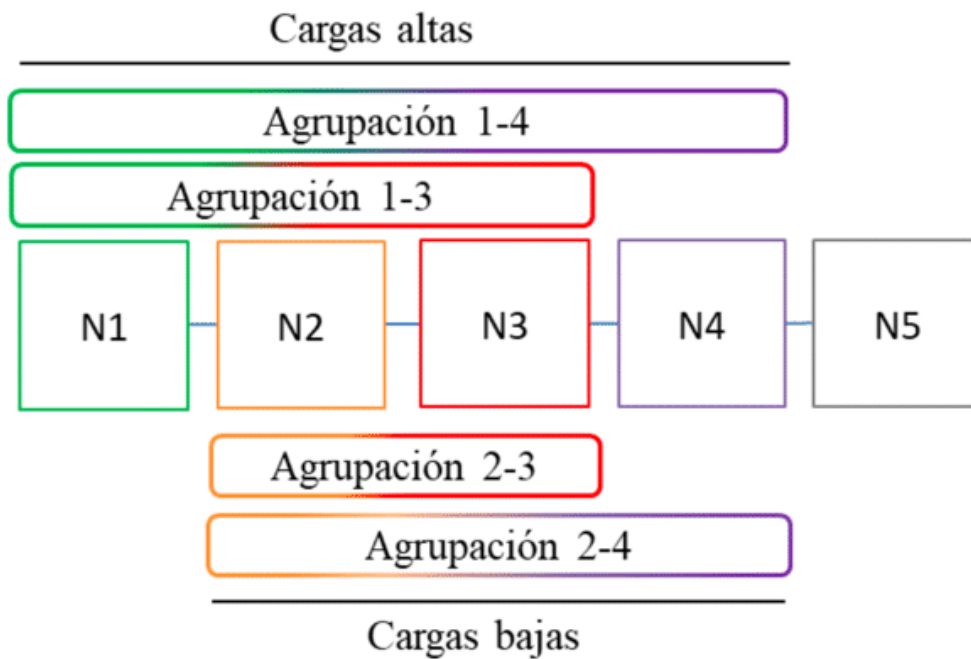
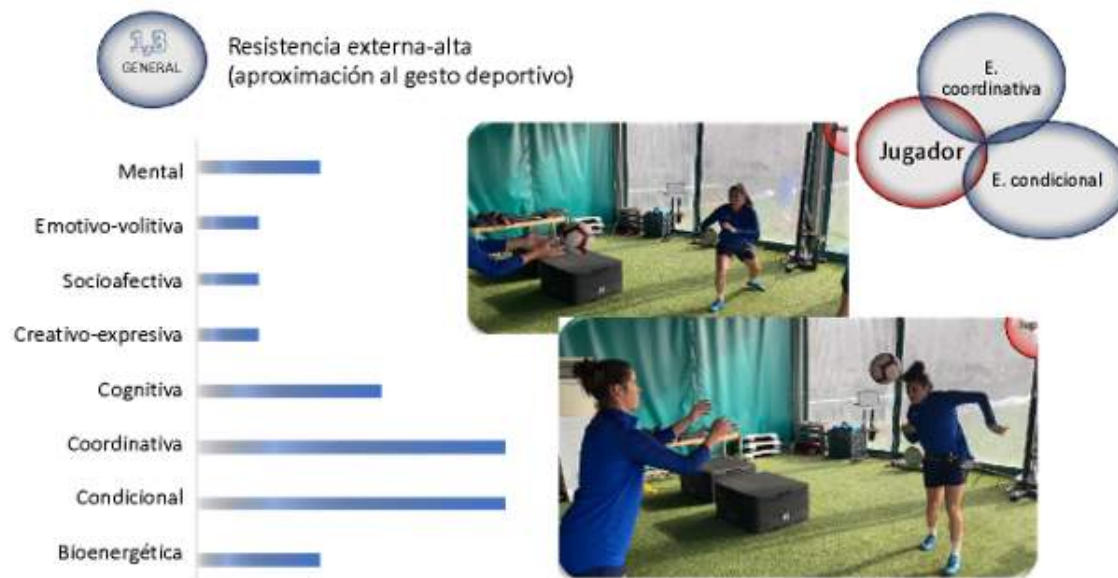


Figura 6. Niveles de aproximación deportiva y sus agrupaciones.

Source: Fernández Valdés Villa, 2020, <https://goo.su/nebICrn>

For example, if we are performing a high-load exercise with strong dynamic correspondence (L1) and add a technical action like ball interaction, which relates to the coordinative structure (L3), we would say the exercise is a combination of L1 and L3, labeled as A1-3 [Figure 11]. Or if we add decision-making to an elastic-resisted exercise with high dynamic correspondence (L2), which relates more to L4, we would call this task an A2-4 combination [Figure 12]. (<https://goo.su/nebICrn>)

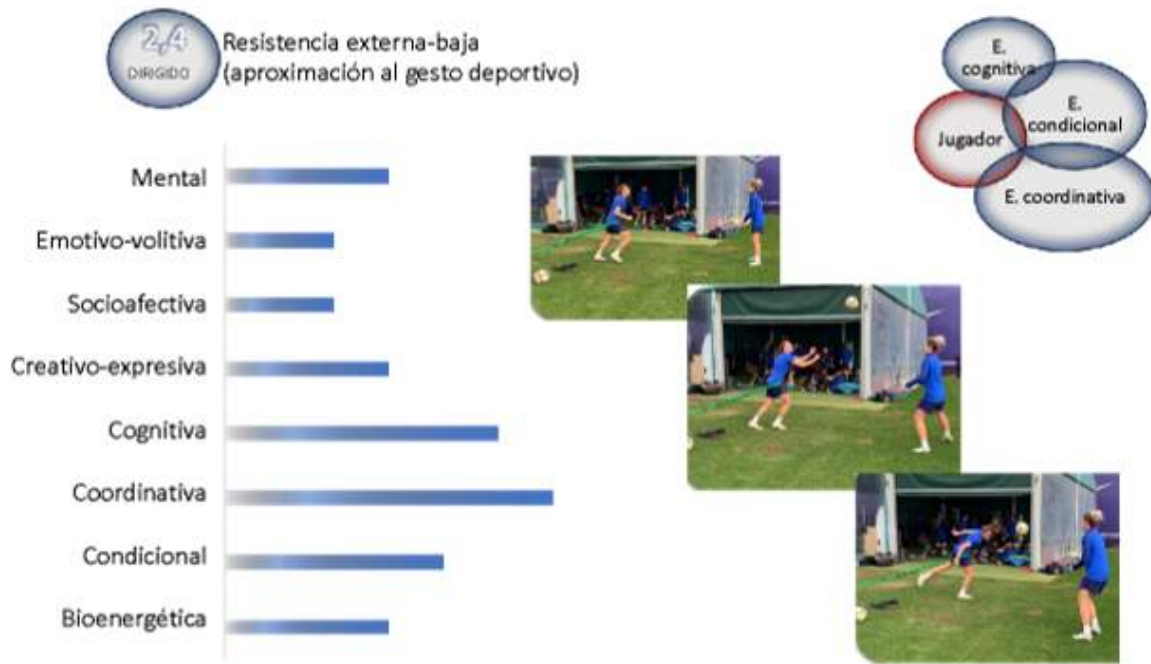
**Figure 11. Grouping task A1-3**



1.3. DIRECTED	External Resistance — High (approximation to the sports gesture)		Conditional structure Player Coordinative Structure
Mental Emotional-Volitional Socio-Affective Creative-expressive Cognitive Coordinative Conditional Bioenergetic			

Source: Original work

**Figure 12. Grouping task A2-4**



2.4. DIRECTED	External Resistance - Low (approximation to the sports gesture)		Conditional structure Player Coordinative Structure
Mental Emotional-Volitional Socio-Affective Creative-expressive Cognitive Coordinative Conditional Bioenergetic			

Source: Original work

### Conditioning factors in strength training

Fernández-Valdés Villa (2020) states:

One defining feature of indoor team sports is the unpredictability of actions due to the high level of uncertainty that arises from interactions with opponents and teammates in a shared space. Landings on one or both feet, combat with an opponent, receptions, and passing or striking the ball happen constantly in variable conditions, requiring athletes to quickly adapt to new situations. These unpredictable actions are often more stressful on the athlete's structures (Besier et al., 2003). Therefore, training should introduce unexpected situations as a key element for shaping strength and helping athletes develop anticipatory mechanisms (Seirullo, 2017). (<https://goo.su/nebICrn>)

Newell (1986, as cited by Fernández-Valdés Villa, 2020) introduces the idea of a "conditioning factor," which he defines as the boundaries or qualities that limit the interactions of a system's components.

These conditioning factors relate to the athlete's structures and are also connected to the levels of sports approximation. For instance, incorporating a ball into an exercise as a conditioning factor emphasizes the coordinative structure, corresponding to L3 or A1-3. (<https://goo.su/nebICrn>)

This way, we highlight the course's key objectives—performance optimization and injury risk reduction—and their relationship with

load control, monitoring, and evaluation. Next, we will explore these final elements (control, monitoring, and evaluation) and how they allow for individualized training.

According to the levels of approximation, at Level 2 there should be...

---

- A low dynamic correspondence with the sports movement
- A high dynamic correspondence with the sports movement, but the applied external resistance must be moderate or low.
- A high dynamic correspondence with the sports movement, but the applied external resistance must be greater than Level 1.

SUBMIT

**Individualization, control, and evaluation of strength.**

In recent years, studies have shown that training conditional, coordinative, and cognitive structures is crucial for developing effective training programs. Evaluating these factors has become a challenge and, at the same time, a valuable tool.

Typically, evaluation methods focus on breaking down what is being measured into smaller components (for example, muscle activation in an exercise) and analyzing the changes separately. However, from the perspective of complexity sciences, it has been proposed to evaluate the different elements that make up the phenomenon and observe the relationships established between them (for example, player coordination during a match) (Araujo et al., 2006; Button et al., 2020).

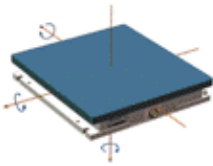
Although instruments exist to measure isolated and simple phenomena, we still lack a tool to evaluate the overall training load. It is challenging to obtain a measure that fully captures the impact of a training session due to the interaction between conditional, coordinative, cognitive loads, among others. Currently, we must settle for partial explanations of the phenomena that occur in practice, knowing that the sum of these partial phenomena will not provide a complete understanding of overall performance.

For many years, sports scientists have been studying and developing methods to monitor the movements of athletes during coadjutant training sessions. This allows us to understand the physical demands

on athletes and, in turn, intervene with personalized training programs. Various technological tools have been used for this purpose, such as video analysis, force platforms, linear encoders, force gauges, accelerometers, and positioning systems, whether local or global. Moreover, there are now mobile applications that can collect indirect data through videos, which is useful for monitoring various relevant elements (Figure 13).

**Figure 13. Systems and devices for measuring strength and other related variables.**

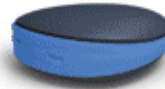
**Plataformas de fuerza**



**Galgas extensiométricas**



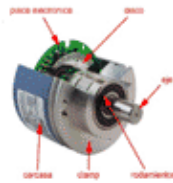
**Dinamómetros de presión**



**EMG\***



**Encoders**



**Acelerómetros**



**APPs**



Force platforms	Strain gauges	Pressure dynamometers	
EMG*	Encoders	Accelerometers	Apps

Source: Original work

The most commonly used and researched are positioning and inertial measurement systems (IMU) or their combination. These systems are widely used and have been the subject of numerous studies in collective sports, both outdoor and indoor. While they are primarily known for their ability to provide positioning information, it is important to highlight that these devices offer many other tools. In fact, it is more accurate to refer to them as microtechnology devices, as they consist of several microsensors, such as accelerometers,

gyroscopes, and magnetometers (IMU). These microsensors allow for the collection of additional data on acceleration, orientation, and magnetic fields, providing a more comprehensive and accurate view of athletes' movements and actions during sports practice. In exercises with low levels of specificity (Level 0 and Level 1 of approximation), measurement tools such as linear encoders, force gauges, force platforms, and mobile applications are the most commonly used. These tools provide objective data regarding the magnitude of certain exercise variables, such as force, speed, and displacement.

To accurately measure and quantify training loads, it is essential to use valid and reliable technology. This is particularly important for sports professionals who rely on this information to make decisions regarding future training sessions. Encoders and force platforms are useful tools for evaluating movements performed on the vertical axis and linear movements, such as jumps or sprints. They can also be beneficial in tests or exercises involving olympic movements or lifts that use gravity as resistance. These tools enable the evaluation of thresholds for speed loss, which is useful for mitigating the effects of fatigue and making programming decisions based on the strength, speed, and power characteristics of a specific exercise.

In summary, these technologies provide important information to optimize training and effectively adjust loads. Therefore, these linear tools will be increasingly used to objectify changes in the athlete's

conditional structure. Generally, linear transducers have shown the highest accuracy in controlling speed.

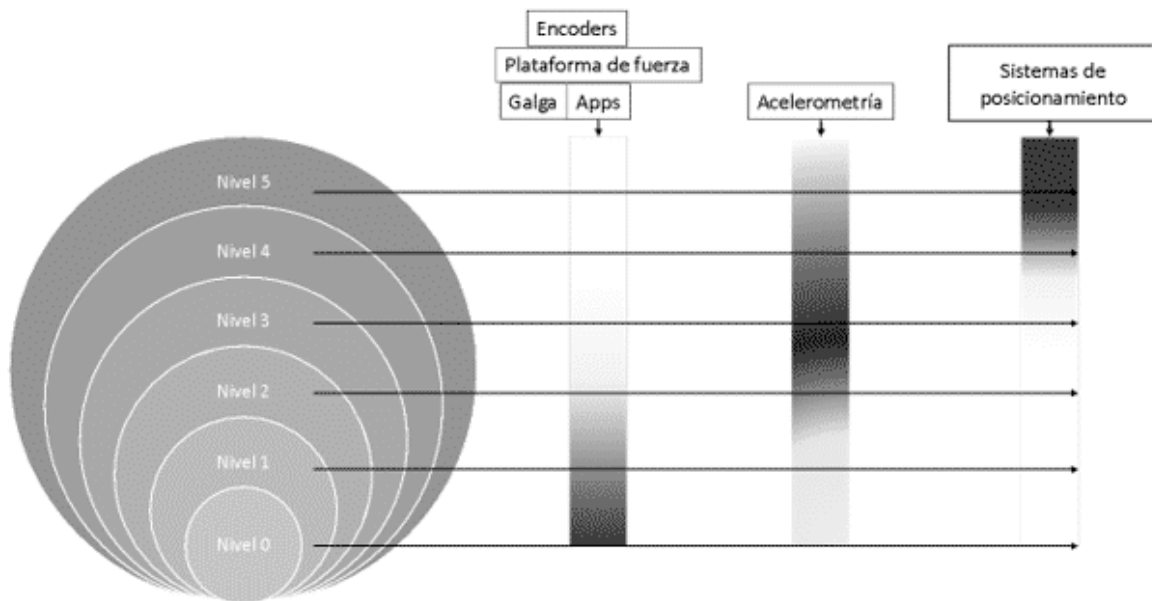
The main challenge arises when measuring Levels 2 and 3 and their groupings (A1-3, A1-4, etc.), where the coordinative structure is more present. To monitor these intermediate levels, appropriate technology and algorithms for processing the data were lacking.

Advances in technology and measurement tools have improved the evaluation of physical training. We can now measure (or estimate) the coordinative structure using accelerometers, which are small devices with motion sensors. These accelerometers record movement data at up to 1000 times per second, providing detailed information about movement. To analyze these data more precisely, we use nonlinear methods such as entropy.

Entropy helps us analyze patterns of human movement and provides quantitative and qualitative information about how the motor system operates. By applying entropy analysis to movement data, we can measure the predictability of the signal. A signal with low entropy is more regular and predictable, whereas a signal with high entropy is more unpredictable. The use of nonlinear tools, such as entropy, allows us to explore the nature of human movement and its relationship with coordination more deeply. These tools give us a more comprehensive understanding of the patterns and organization of athletes' movements.

However, to measure L4 and L5 tasks, other tools, such as video analysis, are used. Additionally, the microtechnology explained earlier is also utilized, allowing us to quantify the physical demands at play (Vázquez-Guerrero et al., 2019).

**Figure 14. Systems and devices for measuring variables related to strength training and their relationship with levels of approximation.**



	Encoders			
	Force platforms		Accelerometry	Positioning systems
Level 5	Gauge	Apps		
Level 4				
Level 3				
Level 2				
Level 1				
Level 0				

- **Control of the conditional and bioenergetic structure training**

The maximum amount of force that the neuromuscular system can produce during a movement depends on the speed of the movement, regardless of the task and muscle groups involved. In team sports, where rapid changes in speed and direction occur, players need to generate force against the ground to accelerate, decelerate, or change direction. While producing maximum force is not always necessary due to the complexity of actions in sports, players must be prepared to face resistances, such as contact with an opponent.

Performance in ballistic actions, which require impulses and mechanical power, depends on force and speed, as well as the level of force that can be generated in the specific context of the game. Therefore, evaluating force in relation to speed and power is crucial. Although not all actions can be evaluated and controlled, assessments and monitoring can be performed in exercises such as vertical jumps and sprint acceleration.

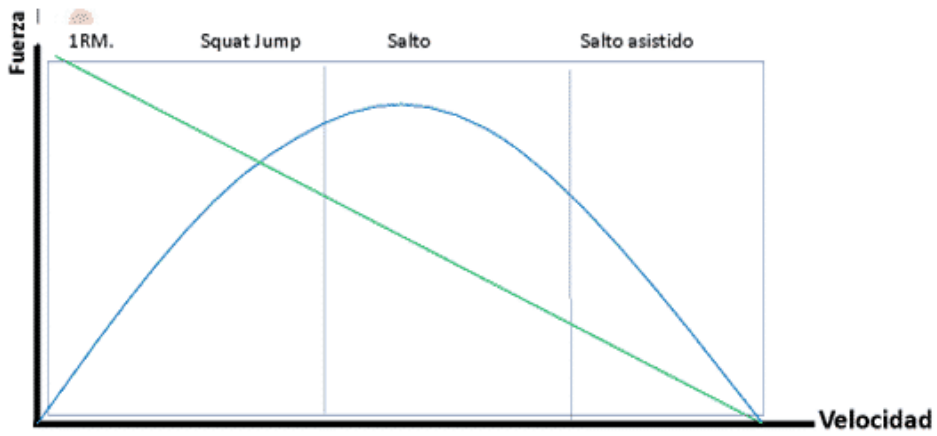
In functional movements involving multiple joints, such as running, a linear relationship between force and speed can be observed. This linear relationship is maintained up to—at least—90% of theoretical

maximum force and 80% of theoretical maximum speed. This difference in force-speed models is explained by the different biological levels at which force production capacities have been evaluated. During multi-joint movements, the force-speed relationships are a complex integration of various mechanisms, such as the mechanical properties of muscle-tendon units, morphological factors, neural mechanisms, and segmental dynamics.

An individualized approach to force-speed profiles allows for a deeper analysis of strength and performance, considering each player's individual characteristics. This information can be used to enhance training interventions and optimize each player's performance in their respective sport.

The aforementioned inverse F-S relationship refers to a decrease in an athlete's maximum force production capacity as movement speed increases. Moreover, since it is the product of force and speed, the power output that an athlete can develop also changes with variations in speed. Individual F-S and P-S relationships provide an overview of strength and power (Figure 15).

**Figure 15. Force produced in different exercises**



STRENGTH		Squat Jump	Jump	Assisted Jump
				SPEED

Source: Original work

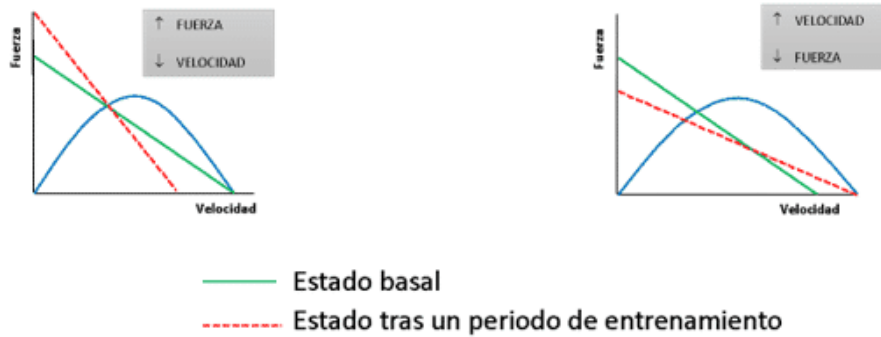
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With training, we can modify this curve (Figure 16).

**Figure 16. Force-Speed profile and changes with training**

## Entrenamiento para la mejora de la fuerza

## Entrenamiento para la mejora de la velocidad



*Training to improve strength - Training to improve speed*

*Ejes: Strength – Speed*

*Baseline State*

*State after a training period*

Source: Original work

---

Players exhibit different individual profiles in terms of force, speed, and power (F-S-P) as well as fatigue, resulting in varying training needs. Furthermore, players may adapt differently to the proposed specific training in terms of magnitude and response time. Therefore, a modern and evidence-based approach to enhancing jump and sprint performance should incorporate these analyses into the monitoring and tracking of strength to control conditional adaptations.

- **Coordinative structure training control**

Historically, the focus of coadjutant training has been primarily on developing and controlling strength, often neglecting the coordinative aspects of movement in sports. Typically, exercises

performed in predictable and controlled environments have been utilized. In essence, coadjuvant training has concentrated on improving the strength of specific muscles involved in exercises, without considering how those muscles collaborate in a coordinated manner for particular movements.

This traditional approach relies on closed exercises, characterized by predictable and repetitive movements. However, there is a growing emphasis on integrating the coordinative structure into training sessions. This involves enhancing the ability to coordinate and control movements in more realistic situations that reflect the specific demands of the sport. A proposed strategy within movement-based training is to prioritize coordination improvement during strength tasks.

One effective method for achieving this is by introducing constraints to the task, which alters its structure, making it less predictable and increasing movement variability, ultimately producing a more adaptable player. With training, these constraints may lose their disruptive effect, causing tasks to become predictable again, thereby diminishing the emphasis on the coordinative structure, even if a coordinative constraint was used. When this occurs, it becomes necessary to modify the task by varying the nature of the constraint again.

The ability to measure movement variability during exercises is valuable for establishing a progression of tasks with various challenges and tailoring them to individual needs. Additionally, it aids in detecting when a task has become overly predictable and requires modification. Entropy serves as a useful tool for measuring movement variability, providing an assessment of the complexity and unpredictability of movement patterns. By applying entropy, we can evaluate how movement variability shifts when different challenges or constraints are introduced in training tasks. For instance, if an exercise becomes too predictable, movement variability decreases, leading to low entropy levels. This indicates that the movement pattern becomes more regular and less complex. Conversely, if changes or challenges are introduced to the task, movement variability is likely to increase, resulting in higher entropy, which suggests that the movement is becoming more unpredictable and complex. Using entropy as a measurement tool enables us to identify changes in movement variability and adjust training tasks based on individual requirements. This approach ensures an appropriate progression tailored to each athlete, helping to prevent monotony and foster a more comprehensive and challenging development (Fernández-Valdés et al., 2020).

However, an entropy value alone does not provide adequate information to determine whether a stimulus represents an excessive, insufficient, or appropriate challenge for the athlete; it must be contextualized and compared with that player's values. Criteria such

as the level of approximation or grouping, series number, repetitions, and scheduled breaks during the exercise, as well as the novelty level of the task for the athlete, should also be considered. For example, an increase in variability may indicate the incorporation of a constraint that compels the athlete to seek solutions to those situations (Araujo et al., 2004), or it may signal a coordinative mismatch due to inexperience in the task (Newell and Vaillancourt, 2001).

Similarly, a decrease in variability may have different interpretations depending on the context; it could result from fatigue, leading to greater rigidity in movement and/or a reduction in degrees of freedom, or it may reflect a challenge that is too low and predictable for the athlete due to repetitive movements during training and competitions.

Thus, we can propose a relationship between movement variability and adaptability (the degree of adaptation to training loads). To prioritize the coordinative structure, we must create situations where the task is novel for our athletes, either by introducing a constraint or by varying the degree of familiarization with the task. When variability decreases, it suggests a reduction in coordinative training stimulation, but it is crucial to analyze the conditions that caused that low level of variability, as it may sometimes indicate sufficient or desired adaptability.

Variability may decrease due to fatigue, which asks for task modification if our goal is to enhance athletes' performance, particularly in the closing minutes of a game or during its most demanding phases. This type of training should be approached with caution due to the heightened rigidity exhibited by players when they experience low variability due to fatigue, which can elevate the risk of injury (Cortes et al., 2014).

Conversely, low variability, in the absence of fatigue, may be of interest if the task's goal is conditional. Low variability can facilitate a higher execution speed.

However, low variability resulting from systematic task repetition over time, or from an athlete fully mastering a movement, should be corrected, as this will not yield the desired adaptations.

### **Structuring and controlling strength training (levels of approximation).**

The structuring and control of strength training involve addressing the conditional, coordinative, and cognitive needs of players (Moras, 2000). To structure coadjuvant training using levels of approximation, it is essential to understand the relationship between these levels and the different structures within a structured microcycle. It is also necessary to know which variables and analysis methods (both linear and non-linear) should be monitored to evaluate exercises at each

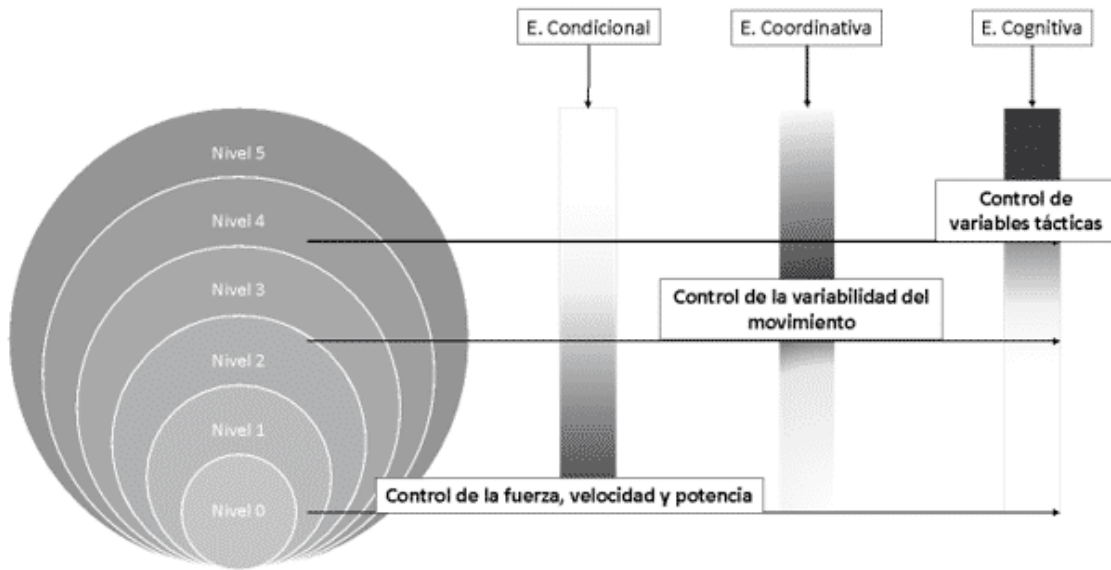
level (Figure 17), enabling us to determine when to change levels and the corresponding measurement tools. All structures are present, but certain ones are prioritized over others, and for clarity, the less preferred structures are kept broad. Additionally, monitoring variables have been narrowed down to those deemed most relevant for each predominant orientation (speed, power, strength, movement variability, and tactical variables) in training (conditional, coordinative, or cognitive). Consequently, we can outline the following:

- For levels 0 and 1, where the conditional structure is dominant, the most suitable measurement tools are those that provide insights into speed, strength, and power. Depending on the movement being analyzed and the information required, we may utilize encoders, force gauges, electromyography, and other tools.
- When transitioning from a L1 exercise to a grouping of 1-3, understanding movement becomes crucial, prompting us to use accelerometry and subsequent non-linear analysis methods, such as entropy, to detect potential changes at the coordinative level. This demonstrates the potential of these movement evaluation methods when the coordinative structure is emphasized in the proposed strength tasks. This does not imply that the previously used tools for

monitoring strength training and their linear analyses are ineffective; rather, they should be viewed as complementary. Selecting the appropriate tool to measure exercises at a specific level of approximation will help us identify when movement variability stagnates, prompting the need for task modifications.

- For higher levels, such as 4 or 5, we will employ tools like video analysis or positioning systems.

**Figure 17. Structuring and controlling strength training. Relationship with structures and levels of approximation**



		Conditional Structure	Coordinative Structure	Cognitive Structure
Level 5				
Level 4				Tactical variable control
Level 3				
Level 2			Movement variability control	
Level 1				
Level 0		Control of strength, speed, and power		

Source: Original work

In planning coadjuvant training, adaptations occur at the micro (or nano) level, involving tasks of L0 and L1, with a focus on conditional and bioenergetic structures. This training is conducted in the gym and relates to traditional strength training methods. In contrast, adaptations occur at the meso level, with tasks of L2 and L3 and all groupings (A1-3, A1-4, A2-3, A2-4), where the predominance of

coordinative and cognitive structures is equal to that of conditional and bioenergetic structures. These tasks may be performed in the gym, particularly for groupings A1-3 and A1-4, but can also be executed on the field with weights in specific movements, especially for all L2-related exercises, and with body weight for L3. Finally, adaptations are observed at the macro level, with L4 and L5, where all structures play a role, similar to competition settings, involving tasks performed on the training field with predominant technical-tactical characteristics.

The predominance of the conditional and bioenergetic structure allows for monitoring variables such as changes in acceleration or execution speed through linear analyses, aimed at understanding microadaptations at the strength level; whereas a predominance of the coordinative structure leads us to analyze movement variability through non-linear analysis tools to understand these meso-adaptations at the coordinative strength level.

### **Load Quantification (Levels of Approximation)**

It's essential to bear in mind that quantifying load in training doesn't rely on a single formula; it considers multiple variables and individualized factors to adjust and optimize the training program based on each athlete's needs and capabilities. However, to streamline the available data, we propose a complementary method of quantification alongside existing methods.

The most common ways to quantify strength training include:

- Volume = sets x repetitions x load.
- Intensity = total load lifted / total repetitions. This measures the average load used during a training session.
- The percentage of 1MR (maximum repetition) is calculated as: load used / 1MR x 100. This percentage quantifies the relative intensity of the training.
- Density = total volume / total time. This measures training efficiency in terms of the work done in a specific time frame.

These formulas are valuable for evaluating and planning training, adjusting program variables, and monitoring progress over time, but they still lack some elements to fully represent the proposed approach. The levels of approximation introduced by Gerard Moras (2000), previously explained, help classify exercises based on their complexity and motor demand. They include parameters like the load mobilized by the athlete on an individual basis, meaning what constitutes high load for one athlete may be low load for another. To determine the approximation of an exercise, the levels account for the dynamic correspondence with the exercise, reflecting its significance

in competition. Thus, they emphasize the importance of motor structure in addition to the quantitative aspect. Besides quantitative variables, qualitative movement variables are also included, such as:

- The number of joints involved in executing the exercise. A greater number of involved joints results in a higher coordinative demand.
- Type of movement, classified into unidirectional, multidirectional, and sequential exercises.
- Type of stability, whether static or dynamic.
- Degree of difficulty of motor tasks, including coordination of different muscle groups, movement synchronization, or execution of complex motor patterns.
- Level of movement predictability. The most predictable movements repeat the same movement pattern (lower levels), while unpredictable movements (higher levels and groupings) involve constant changes and adaptations.

All these previously mentioned variables are incorporated into the levels of approximation for exercises, ranging from more basic and less

coordinative levels to more advanced and complex levels. Therefore, classifying into levels of approximation aids in designing progressive training programs tailored to the individual needs and capacities of athletes, as well as quantifying the load of coadjuvant training. The choice of quantification measures will depend on the specific objectives of the strength training program. Maintaining an accurate record of quantitative variables is crucial for assessing progress and adjusting the training program as necessary.

To develop this quantification tool, we present an adaptation of the formula proposed by Solé (2002), which considers the total session volume, average heart rate, and specificity index.

Load is calculated by multiplying the total volume (in minutes) by the average heart rate and the specificity index (which compares the task type with the maximum specificity of the sport), then dividing by 500 to reduce the size of the resulting number.

$$\frac{(Volumen) \times (FC + Índice de especificidad)}{500}$$

(Volume) x (HR + Specificity Index)
500

Adhering to the principle of multiplying volume x intensity to obtain load, the adaptation of Joan Solé's formula replaces heart rate with RPE from the coadjuvant session to obtain an intensity value, while specificity will use the levels of approximation from Gerard Moras. The formula would be as follows:

$$\frac{(Series \times Repeticiones) \times (RPE \text{ de la sesión} + Nivel \text{ de aproximación})}{10}$$

(Sets x Repetitions) x (RPE of the session + Level of Approximation)
10

A practical example is illustrated in Figures 18 and 19.

**Figure 18. Practical Example**

### EJERCICIOS

Mañana	Tipo	Tiempo	Tarea 1	Series	Repeticiones	Nivel	Carga
Preventivo complementario	Pubis	15	Bridge + ADD	2	10	0,5	3
Estructural	Upper or Lower	60	Pull-Up	1	6	0,5	2,7
Calidades Paso/Piso	Desplazamiento	20	Hip Thrust	2	12	1	7,2
Estructural	Upper and Lower	60	Bent Row	2	10	0,5	7,5
Preventiva movilidad	Hamstring and ADD	20	Hip Mobility	3	100	0,5	45

Nivel de aproximación

0,1 = nivel 0 no orientado  
 0,5 = nivel 0 orientado  
 1 = nivel 1  
 1,3 = agrupación nivel 1 y 3  
 1,4 = agrupación nivel 1 y 4  
 2 = nivel 2  
 2,3 = agrupación nivel 2 y 3  
 2,4 = agrupación nivel 2 y 4  
 3 = nivel 3

$$\frac{(Series \times Repeticiones) \times (RPE \text{ sesión} + Nivel \text{ de aproximación})}{10}$$

### EXERCISES

Morning	Type	Time	Task 1	Sets	Repetitions	Level	Load
Complementary Preventive	Pubis	15	Bridge + ADD	2	10	0.5	3
Structural sessions	Upper or Lower	60	Pull-Up	1	6	0.5	2.7
Specific Qualities	Displacement	20	Hip Thrust	3	12	1	7.2
Structural sessions	Upper and Lower	60	Bent Row	2	10	0.5	7.5
Preventive Mobility	Hamstring and ADD	20	Hip Mobility	3	100	0.5	45

Level of Approximation

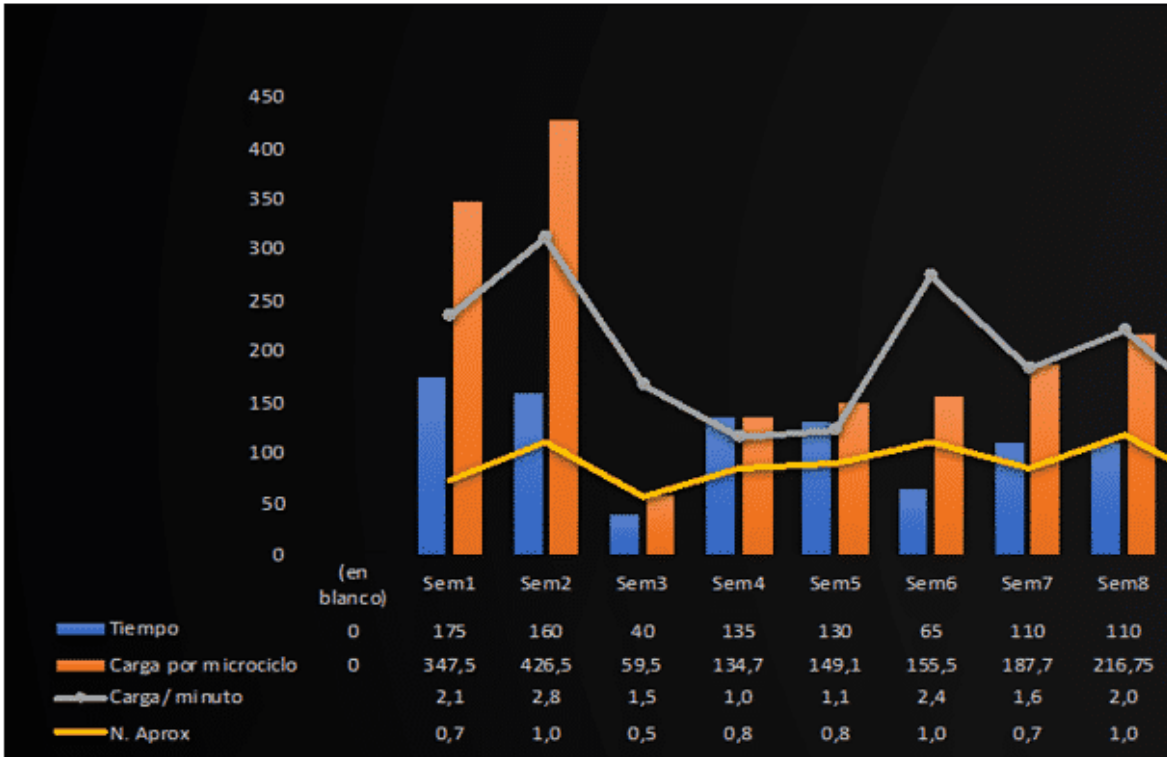
- 0.1 = Level 0 non-oriented
- 0.5 = Level 0 oriented
- 1 = Level 1
- 1.3 = Grouping Level 1 and 3
- 1.4 = Grouping Level 1 and 4
- 2 = Level 2
- 2.3 = Grouping Level 2 and 3
- 2.4 = Grouping Level 2 and 4
- 3 = Level 3

$$\frac{(Sets \times Repetitions) \times (RPE \text{ of the session} + Level \text{ of Approximation})}{10}$$

Source: Original work

In figure 18, we see that each training simulation situation must be categorized into its corresponding level of approximation (depending on the previously mentioned variables). The values used in the different levels will be 0.1 for Level 0 non-oriented; 0.5 for L0; 1 for L1; 1.3 for L13; 1.4 for L14; 2 for L2; 2.3 for L23; 2.4 for L24; and 3 for L3. As we have already noted, levels above 3 are rarely encountered in coadjuvant training.

### **Figure 19. Practical Example**



	(Blank)	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Semana 8
Time									
Load per Microcycle									
Load/Minutes									
N. Approx									

Source: Original work

Figure 19 depicts the preseason of a team. It shows how, in the initial weeks of training, the coadjutant load was higher, as the player only engaged in coadjutant training. Starting from week 3, team training begins, resulting in a decrease in coadjutant load, which progressively increases as training weeks pass.

As previously discussed, there is no universally accepted formula for all aspects of sports training. Coaches typically utilize a combination of principles, methods, and variables to create effective training programs tailored to athletes' needs and the demands of each sport. We propose a tool that helps organize coadjuvant training and provides a comprehensive perspective (an overview) of the athlete's activities. This information should be supplemented with the objective measurements available to us.

**CONTINUE**

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