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**STUDY ON THE EVALUATION OF THE VOLUNTARY AND**  
**INVOLUNTARY STRENGTH IN FOOTBALL**

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***Abstract***

In recent years, football all over the world has evolved from all points of view, including the dynamics of the game and the increase in the speed and strength with which most of the game phases take place. Technical and tactical skills of the top teams are incontestable, but the athletic potential and the strength of the players make the difference. The ability to have starting strength and flexible strength are critical elements that any athlete must possess. We intend to calculate the difference between voluntary strength (starting strength) and involuntary strength (explosive strength) to determine the deficit and rebalance the differences between them. We are convinced that balance is at the basis of any training program and that this deficit must be identified and balanced through individual training programs focused on maximum strength and plyometrics. Knowing all the mentioned aspects, we aimed to work according to the new approaches and methods of identification and balancing of the voluntary strength and explosive strength, using the Sargent two-jump test assessed through the plyometric platform. New research shows that involuntary strength must be greater than voluntary strength. To improve the voluntary strength, it is necessary to work in the gym with a higher intensity of 90% of 1RM to recruit as many muscle fibers. Regarding the involuntary strength, it should be improved through plyometric exercises.

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## **1. Introduction**

The Dynamic Strength Index (DSI), also called the Dynamic Strength Deficit, measures the difference between the maximal and explosive strength capability of an athlete. In the latest scientific research, it is preferred to use the term “index” to the detriment of the term “deficit”, as it represents the index of the athlete’s current performance ability. (Tavares, 2016)

The Dynamic Resistance Index can be used to identify whether the athlete needs maximal strength training, ballistic strength training or concurrent training as a stimulus in their program. It can also be used to reliably measure strength in both the lower- and upper-body in leisure, performance and high-performance activities. (Sheppard & Chapman, 2011)

According to Thomas, Jones, & Comfort (2015), the DSI represents the ratio between an athlete’s dynamic peak force and their ballistic peak force. This ratio can often be applied as a test to sum up their strength potential. From another point of view, the DSI shows the difference between an athlete’s ability to produce force during an activity, which also denotes their strength potential (Tavares, 2016).

## **2. Problem Statement**

In physics, power is defined as work divided by time. In applying this to athletic performance, it indicates how much muscle force the player can generate in such activities. The football game regards the ability to be fast and explosive.

The DSI provides trainers and strength and conditioning coaches with valuable information about how strong the athlete is and how much strength they use during the movements. This information allows the strength and conditioning coaches to design a more specific program to develop the athlete’s strength.

## **3. Research Questions**

Calculating the DSI allows coaches and strength and conditioning coaches to determine the maximal amount of force that an athlete can produce and develop in a high-speed movement. The IMTP (isometric mid-thigh pull) is used to measure an athlete’s maximal force potential (maximal strength), while the CMJ (countermovement jump), which is a ballistic movement, is used to determine how much of their total force potential they can produce in a very short timeframe (Kawamori et al., 2006).

## **4. Purpose of the Study**

We applied two tests to a sample of 24 athletes. 5 players ranked in the lower and upper zones of the optimal area, 60-80%; specifically, 2 players with a deficit of less than 60% and 3 with a deficit higher than 80%. Through these tests, we aim to establish the ratio between maximum strength and explosive strength. If the explosive strength is below 60% of the maximum, we need to improve the elastic/explosive strength by means of plyometric exercises. If the explosive strength is higher than 80% of the maximum, we need to improve the ability of the muscles to recruit as many motor units as possible to improve the maximum strength (Stone et al., 2003).

## 5. Research Methods

We designed an individual exercise program tailored to the needs of each player. The program lasted 1 month and consisted of 8 training sessions (2 training sessions/week). Each training session lasted 15 minutes and was executed before the actual training. The training took place at 72 hours of play and 48 hours before the game, respectively. After a preliminary warm-up exercise, the two players in group ‘A’ made 5 series of 5 continuous hurdle jumps (30-40-50-60-70 cm). The break between series was 2 minutes.

Group ‘B’ executed the same preliminary warm-up and then worked on maximum strength machines. We chose three apparatus for the extension of three muscles (gastrocnemius, quadriceps and gluteus).

The work was done at 95% of 1RM (1-repetition maximum), the intensity of which corresponded to 3 reps. Each apparatus was used twice as a circuit. The break between exercises was 1 minute.

### 5.1. Testing methods

Before the vertical jump, a warm-up procedure for all participants was performed. The vertical jump test begins with a set of semi-squats. Athletes performed jumps on a force rating platform. After they stepped on the platform, they were trained to move to the starting position, namely a squat position with a 90-degree angle in the knee joint. Once in the countdown position, “3, 2, 1” is given. It ‘isolates’ the position for 3 seconds to remove the stretch reflex. Two jumps were allocated to each athlete, with 1 minute break between jumps. The height of the vertical jump was calculated from the flight time by the force platform software. (Weiss, Haff, Newton, & Sheppard, 2014)

After testing their vertical force, players took a 3-minute break before starting the isometric drag. All attempts were performed at a frame above a force measurement platform. Each player had two attempts to warm up, one to 50%, and the other to 70% of the perceived maximum split effort of the 45-second break. After warming up, players were instructed to pull as fast and hard as they could. These instructions were used to optimise test results. Players start their maximum effort followed by the countdown. 1 minute was allocated between the two maximum efforts. If the difference between the two attempts is greater than 250 N, then a third attempt will be executed. The best two attempts are used to calculate the average and perform an analysis.

## 6. Findings

**Table 01.** Training recommendation based on DSI results

Score	DSI score	Training emphasis recommendation
Low	< 0.60	Ballistic strength training
Medium	0.60-0.80	Concurrent training
High	>0.80	Maximum strength training

In Table 01, we present the training recommendations, so, if the difference is less than 60% in contrast to the elastic strength, % (the value of explosive strength is below 60% of maximum strength), it is necessary to implement a complex of exercises aimed at improving the elastic/dynamic strength.

**Table 02.** Initial test

	<b>CMJ Peak force (N)</b>	<b>IMTP Peak force (N)</b>	<b>DSI</b>	<b>Recommendations</b>
S1	1.458	3.135	0.46 (46%)	Elastic strength training / Plyometrics
S2	1.621	2.904	0.55 (55%)	Elastic strength training / Plyometrics
S3	2.500	2.800	0.89 (89%)	Strength / Maximum training
S4	2.123	2.354	0.90 (90%)	Strength / Maximum training
S5	1.958	2.335	0.84 (84%)	Strength / Maximum training

If the strength percentage is between 60-80% (the value of explosive strength is between 60-80% of maximum strength), the same training system must be maintained, as there is a balance between the two forms of expression of strength (Table 02).

**Table 03.** Final test

	<b>CMJ Peak force (N)</b>	<b>IMTP Peak force (N)</b>	<b>DSI</b>	<b>Progress of the elastic strength %</b>	<b>Recommendations</b>
S1	1.996	3.205	0.62 (62%)	37%	Concurrent training
S2	1.951	2.938	0.66 (66%)	20%	Concurrent training
S3	2.598	3.511	0.73 (73%)	25%	Concurrent training
S4	2.149	2.869	0.75 (75%)	23%	Concurrent training
S5	2.001	2.758	0.72 (72%)	18%	Concurrent training

If the difference is more than 80% in favour of explosive strength (its value exceeding 80% of maximum strength), it is necessary to implement a complex of exercises aimed at improving maximum strength for the recruitment of as many motor units (Table 03).

## 7. Conclusion

Finally, we can say that we have managed to eliminate muscle imbalances in the 5 subjects who showed this explosive (dynamic/elastic) strength. We have also succeeded in improving performance and reducing the risk of injury, because the ability to express starting and explosive strength is decisive and fundamental, so it must be kept in a state of balance in the football game.

In two of the 5 subjects, the Dynamic Strength Index was less than 60% of maximum strength, indicating that we have found a weak point and need to correct it, since the purpose of a test is to collect as much information as possible and then use it to design an individual training program tailored to the needs of everyone.

Subject 1: has improved elastic strength by 37%, from 1.458 Peak Force (N) in the initial test to 1.996 Peak Force (N) in the final test, reaching the recommended range of 60-80%.

Subject 2: has improved elastic strength by 20%, from 1.621 Peak Force (N) in the initial test to 1.951 Peak Force (N) in the final test, reaching the recommended range of 60-80%.

Subject 3: has improved maximum strength by 25%, from 2.800 Peak Force (N) in the initial test to 3.511 Peak Force (N) in the final test, reaching the recommended range of 60-80%.

Subject 4: has improved maximum strength by 23%, from 2.335 Peak Force (N) in the initial test to 2.869 Peak Force (N) in the final test, reaching the recommended range of 60-80%.

Subject 5: has improved maximum strength by 18%, from 2.335 Peak Force (N) in the initial test to 2.758 Peak Force (N) in the final test, reaching the recommended range of 60-80%.

Three of the 5 subjects had an index higher than 80% of maximum strength, which showed that their ability to recruit motor units was deficient and needed to be improved.

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