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## ORIGINAL

### EFFICACY OF DIFFERENT RECOVERY STRATEGIES IN ELITE FOOTBALL PLAYERS

### EFICACIA DE DIFERENTES ESTRATEGIAS DE RECUPERACIÓN EN JUGADORES DE FÚTBOL DE ÉLITE

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## ABSTRACT

After a football match or high intensity training, suitable recovery will help not to decrease performance and to prevent injuries. The aim of this study was to test the effectiveness of different combined recovery strategies in comparison with a simple one, after a specific football training session. Twenty elite players participated in the study. A randomized crossover design was used to determine the effect of 4 post-training session recovery strategies. Tympanic temperature was measured, as well as Total Quality Recovery (TQR) and Category Ratio Scale (CR10) subjective scales. Results show that none of the recovery strategies proved more effective than the others. However, the use of combined strategies tended to be more effective than a simple strategy after a high intensity training session in football.

**KEY WORDS:** active recovery, passive recovery, subjective scales, tympanic temperature.

## RESUMEN

Una correcta estrategia de recuperación (ER) tras la competición o el entrenamiento de alta intensidad en fútbol ayudará a no disminuir el rendimiento y a prevenir lesiones. El objetivo de este trabajo fue estudiar la eficacia de diferentes estrategias de recuperación combinadas en comparación con una simple, tras una sesión de entrenamiento específico de fútbol. Participaron 20 jugadores de fútbol de élite y se utilizaron cuatro estrategias de recuperación de forma aleatoria y contrabalanceada a lo largo de 4 semanas de entrenamiento. Se midió temperatura timpánica y las escalas subjetiva *Total Quality Recovery* (TQR) y *Category Ratio Scale* (CR10). Los resultados exponen que ninguna de las ER estudiadas muestra ser más eficaz que las demás. No obstante, la realización de protocolos de recuperación combinados llevados a cabo tras la sesión de entrenamiento de fútbol, tiende a una mayor eficacia respecto al protocolo que incluía únicamente estiramientos.

**PALABRAS CLAVE:** recuperación activa, recuperación pasiva, escalas subjetivas, temperatura timpánica.

## INTRODUCTION

At present the level and amount of competitions in which football teams are immersed make them play many games in a short period of time. Moreover, the competition itself requires a very high physical demand that generate high levels of fatigue, with an observed decrease in the frequency with which players perform high intensity efforts as the game progresses (1, 2). These aspects make recovery strategies (RS) after competitions especially important. Furthermore, high intensity RSs need to be effective so that ongoing training is not affected due to a poor recovery that can affect performance in competitions. According to season planning there are high intensity training sessions that will require equally effective ER, looking to arrive in the best possible conditions to following training, since poor recovery could lead to a decline in the performance in subsequent competitions (2-4), short-term overtraining or increase the risk of injury (3, 5). It has been demonstrated that when performing a proper recovery from high-intensity training or competition, athletes can go back to training earlier and with better quality than when no recovery treatment is performed or improper practices are carried out (6). The relevance of this issue is evident when observing the growing literature on the matter, specific to football or other sports (2-5, 7-12), with various RSs being. These include techniques based on active recovery by means of low-intensity aerobic exercise (1, 11, 13), stretching (2, 14), cryotherapy (15, 16) or contrast baths (6, 12, 17), which according to some authors is one of the most common recovery techniques among elite athletes (5). On the other hand, passive recovery is often used in various research studies as a control technique (2, 4, 6, 13). Despite this, there is no evidence in the scientific literature to assert what strategy is most effective in the face of the recovery of athletes. However, it seems that strategies based on a combination of different techniques such as cryotherapy and active recovery could enhance the results of the recovery process (1, 3). However, this aspect remains to be investigated more thoroughly (3). Furthermore, the effects of the different RSs after specific training tasks remain unknown, due to the lack of studies carried out in field or real conditions (4). For these reasons, the aim of this study was to compare the effectiveness of different combined Rs compared with a simple one, following a specific training session with elite football players.

## MATERIALS AND METHODS

### Participants

A total of 20 male football players (Table I) from a 2nd division B Spanish National League team took part in the study. They had at least 5 years, 4 days a week, of continuous football training. Each one signed an informed consent form approved by the Ethics Committee of the Technical University of Madrid.

The requirements had to be met in order to be subjects in the study were:

1. Fully participation in training sessions.

2. No massage or any other recovery technique applied others than the ones included in this study.
3. No physical activity practised outside training scheduled.

**Table I.** Anthropometric data of the subjects (n=20)

	Mean	SD
Age (years)	21.8 ±	1.9
Weight (kg)	70.6 ±	6.8
Height (cm)	175.5 ±	5.9
BMI (kg/m <sup>2</sup> )	22.9 ±	1.3
Body Fat (%)	7.5 ±	2.2
Muscular Mass (kg)	29.8 ±	9.2

BMI: Body Mass Index.

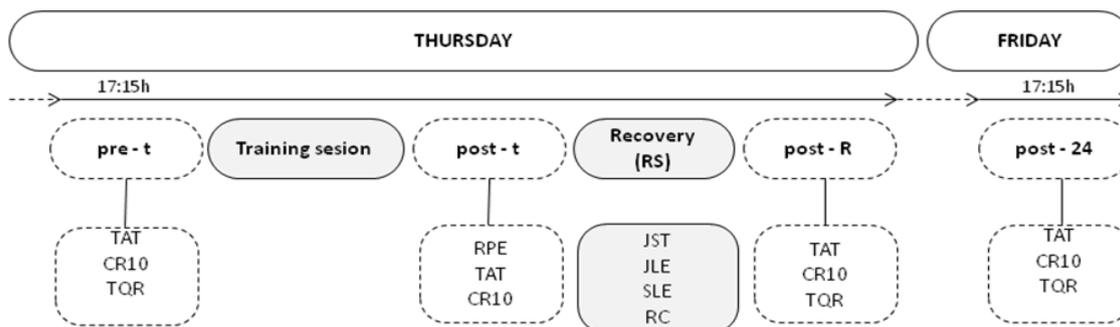
## Design

We used a randomized crossover design to compare the effects of four different techniques of post workout recovery. The study was conducted for four weeks, between the months of January and February of the 2010-2011 season. Each week consisted of two data collection sessions (Thursday and Friday). RS sessions took place on every Thursday of the period. The group was randomly divided into four groups of five players. Each Thursday, every one of the 4 groups adopted a different technique. The 4 groups of players completed the 4 techniques after completion of the 4-week study.

## Procedure

Every Thursday the players arrived at the facility 30 minutes before training (pre-training: pre-t). As they arrived and before changing clothes, they were asked to indicate their state of recovery from the previous day by the subjective test Total Quality Recovery (TQR) (18) and musculoskeletal pain (lower limb) perceived by the Category Ratio Scale (CR10) (19). They were also taken measure of the tympanic temperature (TAT) and were informed of the RS each group had to follow. The group had an anthropometry taken the first Thursday of the study carried out following the guidelines of the International Society for Advancement in Kinanthropometry (ISAK) and the Spanish Group of Kineanthropometry (GREC). To calculate the percentage of fat the Carter equation was used, as recommended by the consensus document of the Spanish Federation of Sports Medicine (20) and the Lee equation to calculate muscular mass (21). After each training session (post-t) the TAT was recorded and the perceived effort recorded by means of the subjective Rating of Perceived Exertion (RPE) (19), as well as the perception of muscle pain (CR10). After this, a 16-minute protocol of guided recovery would begin. Immediately after recovery (post-R) participants would be measured in terms of TAT levels and asked CR10 subjective scales and TQR. Players who conducted the study did not go through any additional therapy after recoveries

made during that day. On Fridays, after 24 h (post-24), we would continue with a routine data collection for a pre-training Thursday (pre-t) (Figure 1).



**Figure 1.** Experimental design of a standard week. RS: recovery strategies, RC: recovery control, SLE: stretching and leg raises; JLE: continuous running and leg raises; JST: continuous running and stretching, pre-t: pre-training; post-t: post workout; post -R: recovery post; post-24: 24 hours.

### Football specific training

The study was conducted during the training sessions of a Football team semi-professional competitive phase. The technical staff agreed to conduct RS on the days that players would realize high intensity training sessions on Thursday: 20-minute warming-up following an integrated technical workout, 20-25 minutes of tactic exercise in two thirds of the field and 35-45 minutes of 11-to-11 game.

This planning was repeated the 4 Thursdays that integrated the study. To check the intensity of the training sessions, heart rate (HR) and RPE would be measured.

### Recovery Strategies

We used four different recovery strategies during the study, with a total duration of 16 minutes (22). Recovery techniques employed in each RS are described below:

**Jogging - Stretching (JST).** It consisted of eight minutes of running at an intensity of 60-70% of the theoretical maximum HR (TMHR), which was calculated using the equation of Tanaka 2001 ( $TMHR = 208.75 - 0.73 * Age$ ) (23, 24) and 8 minutes of static stretching, doing 3 repetitions of 15 seconds of the following muscle groups: gastrocnemius, adductors, quadriceps, psoas, gluteus, hamstrings and lower back muscles.

**Jogging – Leg Elevation (JLE).** It consisted of 8 minutes of running at the intensity described above and 8 minutes of leg raises (lying supine on a mat with your legs propped up on a bench, with flexed hips and knees at an angle of 90 °).

**Stretching – Leg Elevation (SLE).** This strategy combined static stretching 8 minutes as described JST and 8 minutes of leg raises following the JLE methodology.

**Recovery Control (RC).** This recovery strategy is routinely being done by the team during the season. Control was done due to the impossibility of passive recovery (seated for 16 minutes) following indications of the coaching staff. It can be described as a simple (not combined) RS with a total duration of 5 minutes. It consisted in performing 20 seconds of stretching of the following muscle groups: gastrocnemius, adductors, quadriceps, psoas, gluteus, hamstrings and lower back muscles.

### Registered Variables

In terms of physiological variables HR and TAT were recorded. The first variable was used to determine the labour intensity of each training session, as has been done in other works in football when controlling the workload (25, 26). For this, all players used HR Polar<sup>®</sup> monitors (Polar Electro, Kempele, Finland) during the training period and also during recovery. The TAT was recorded with tympanic thermometers Thermoscan Pro 4000 model (Braun, Kronberg, Germany), having been used to measure the impact of different recovery methods in a previous study (1). The measurement of the subjective variables test was performed with the scales TQR, CR10 and RPE. The TQR scale is a subjective tool validated and reliable, which has been used in various investigations to measure the recovery process after exercise (1, 18, 19, 27, 28), while the CR10 is a scale that measures, among other aspects, pain musculoskeletal level (1, 19, 29). By using the RPE, we measured the perception of the intensity of the effort of the training session (19, 30, 31).

### Statistical Analysis

Results are expressed as mean  $\pm$  standard deviation (SD). ANOVA with repeated measures was used to compare the changes produced by the different recovery strategies in TQR, CR10 and TAT variables. One-way ANOVA was used to assess the change in RPE and HR between training sessions. The subsequent multiple comparisons were performed using the Bonferroni adjustment. Data were analyzed using SPSS 18.0 (SPSS Inc., Chicago, IL, USA). The statistical significance level was set at  $p < 0.05$ .

## RESULTS

Regarding the RPE we found no statistically significant differences between the training sessions (week 1:  $13.7 \pm 3.2$ , week 2:  $13.6 \pm 2.3$ , week 3:  $12.9 \pm 2.6$ ; weeks 4:  $14.1 \pm 2.6$ ) ( $F_{3,68} = 0.576$ ,  $P = 0.632$ ). Furthermore, no significant differences in the mean HR recorded in different sessions (week 1:  $144 \pm 5$  beats·min<sup>-1</sup>,  $76 \pm 2\%$  TMHR, week 2:  $142 \pm 6$  beats·min<sup>-1</sup>,  $77 \pm 2\%$  TMHR, week 3:  $146 \pm 5$  beats·min<sup>-1</sup>,  $76 \pm 2\%$  TMHR, week 4:  $141 \pm 7$  beats·min<sup>-1</sup>,  $74 \pm 3\%$  TMHR) ( $F_{3,68} = 0.643$ ,  $P = 0.573$ ).

In Table II we can see the behaviour of the variable TAT. Recovery techniques include no significant differences ( $F_{3,68} = 1.096$ ,  $P = 0.357$ ), except at post-R, while there were significant differences between times ( $F_{3,204} = 40.332$ ,  $p < 0.05$ ). After the training (post-t) the TAT decreased in all groups, this decrease being significant only in the SLE and JST. In the post-R players who performed SLE, JST and JLE showed an elevated TAT value in respect to the post-t. Post-24 values were not significantly different from the pre-t in none of the recovery techniques.

**Table II.** Mean  $\pm$  D.E. of the TAT according to time of measurement and technique of recovery

	RC	SLE	JLE	JST
TAT pre-t (°C)	36.3 $\pm$ 0.5	36.2 $\pm$ 0.5	36.4 $\pm$ 0.3	36.5 $\pm$ 0.4
TAT post-t (°C)	35.6 $\pm$ 0.9 <sup>a</sup>	35.4 $\pm$ 1.1 <sup>a</sup>	35.8 $\pm$ 1.0	35.6 $\pm$ 0.9 <sup>a</sup>
TAT post-R (°C)	36.4 $\pm$ 0.5 <sup>b</sup>	36.7 $\pm$ 0.4 <sup>a,b,*</sup>	36.7 $\pm$ 0.2 <sup>b</sup>	36.3 $\pm$ 0.4 <sup>b,#,\$</sup>
TAT post-24 (°C)	36.2 $\pm$ 0.3	36.3 $\pm$ 0.2 <sup>b,c</sup>	36.4 $\pm$ 0.3	36.3 $\pm$ 0.4 <sup>b</sup>

\*Significant differences with RC. #Significant differences with SLE. \$Significant differences with JLE. <sup>a</sup>Significant differences with TAT<sub>pre-e</sub>. <sup>b</sup>Significant differences with TAT<sub>post-t</sub>. <sup>c</sup>Significant differences with TAT<sub>post-R</sub>.

Table III shows the results of the variable CR10. As with the TAT, no significant difference between recovery techniques ( $F_{3,68} = 1.024$ ,  $P = 0.388$ ), but between measurement times ( $F_{3,204} = 19.375$ ,  $p < 0.05$ ) was found. In SLE, JST and RC techniques, values found that post-24 have a significant decrease when compared to post-t.

**Table 3.** Mean  $\pm$  D.E. of the CR10 according to time of measurement and technique of recovery

	RC	SLE	JLE	JST
CR10 pre-t	1.7 $\pm$ 1.0	1.5 $\pm$ 1.1	2.2 $\pm$ 0.8	1.7 $\pm$ 0.8
CR10 post-t	2.8 $\pm$ 2.2	3.9 $\pm$ 2.1 <sup>a</sup>	2.7 $\pm$ 1.4	3.0 $\pm$ 1.8 <sup>a</sup>
CR10 post-R	2.7 $\pm$ 1.7 <sup>a</sup>	2.9 $\pm$ 1.4 <sup>a,b</sup>	2.3 $\pm$ 0.9	2.4 $\pm$ 1.1
CR10 post-24	1.7 $\pm$ 0.9 <sup>b,c</sup>	2.1 $\pm$ 1.0 <sup>a,b</sup>	2.0 $\pm$ 0.6	1.3 $\pm$ 0.8 <sup>a,b,c,#</sup>

\*Significant differences with RC. #Significant differences with SLE. \$Significant differences with JLE. <sup>a</sup>Significant differences with CR10<sub>pre-e</sub>. <sup>b</sup>Significant differences with CR10<sub>post-t</sub>. <sup>c</sup>Significant differences with CR10<sub>post-R</sub>.

Finally Table IV shows the results of the TQR. No significant difference between recovery techniques ( $F_{3,67} = 1.874$ ,  $P = 0.142$ ), but between measurement times ( $F_{2,134} = 16.501$ ,  $p < 0.05$ ) was found.

**Table IV.** Mean  $\pm$  D.E. of the TQR according to time of measurement and technique of recovery

	RC	SLE	JLE	JST
TQR pre-t	15.9 $\pm$ 1.6	15.8 $\pm$ 2.3	16.4 $\pm$ 2.1	16.4 $\pm$ 2.2
TQR post-R	14.9 $\pm$ 1.4	12.9 $\pm$ 3.9 <sup>a</sup>	15.0 $\pm$ 2.1	15.0 $\pm$ 1.8
TQR post-24	16.0 $\pm$ 1.6	15.4 $\pm$ 1.6 <sup>b</sup>	15.6 $\pm$ 1.6	15.9 $\pm$ 1.7

<sup>\*</sup>Significant differences with RC. <sup>#</sup>Significant differences with SLL. <sup>§</sup>Significant differences with JLE.  
<sup>a</sup>Significant differences with TQR<sub>pre-e</sub>. <sup>b</sup>Significant differences with TQR<sub>post-R</sub>.

## DISCUSSION

Several authors report that the use of recovery strategies that combine different techniques can be more effective than the use of simple strategies (1, 3, 32). The main finding of this study was to verify that none of the studied RS caused changes in the analyzed variables that may be more effective. However, the realization of recovery protocols combined (SLE, JLE and JST), conducted after football training session, show a greater tendency to efficacy relative to simple recovery protocol (RC) on TAT variables and CR10, whereas for the TQR variable no specific technique showed to be more effective. Previous studies support the efficacy of different RS on performance-related parameters. The use of cryotherapy (cold water immersion at 15 °C) appears to help reduce stiffness and muscle damage after high intensity eccentric exercise (16), aerobic exercises and electro stimulation show a reduction of muscle pain (4) and contrast baths and low intensity aerobic activity appear to be effective in reducing levels of indicators of muscle damage such as creatine kinase (CK) (6). However, from the results obtained so far can not be concluded that there is an appropriate recovery strategy alone (2, 3). Wallet et al. (2000) concluded that the combination of techniques was more efficient to maintain the recovery performance than the passive or active recovery or massage techniques. Meanwhile, Kinugasa (2009) also shows how the combination of techniques such as cryotherapy and active recovery after a football game has better values in the perception of the recovery of the players.

There are different opinions about the appropriateness of using TAT in sport as a parameter to assess core temperature (CT). On the one hand, in terms of reliability research is expressing that there is a certain margin of error in measuring tympanic in respect to other known techniques for reliable CT, as could be the measurement of rectal or oesophageal temperature (33), while other studies support the TAT reflecting the CT (1, 34-36). However, it seems that among the non-invasive methods are best suited for measurements in the field, because of their quick use and best overall acceptance by the subjects (33, 36, 37). Furthermore tympanic membrane receives input carotid artery blood, as the hypothalamus, a brain region that regulates the temperature, so that the measurement of the eardrum through the CT appears to be a valid measure of this parameter (37). In our study we measured the temperature by TAT with an infrared tympanic thermometer, as other authors have used (1, 35, 36). Immediately after the training session (post-t) this variable declined in the

four strategies, making it significantly in RC, SLE and JST. In post-R in all groups TAT rise again retrieving baseline and even in the case of SLE, significantly surpassing it. These results contrast with those obtained in the study by Kinugasa and Kilding (2009), in which TAT measured at the same times and with the same thermometer after a football game, and in which observed values increased post-t and decreased in post-24. Other authors explain that during exercise the CT tends to increase (37, 38), either in submaximal activities (1, 39) or in maximum-level protocols (35). However, a study of Kistemaker et al. (2006) shows different behaviours depending on when the temperature takes place (40). So, after starting an exercise like Astrand cycle ergometer test, rectal and oesophageal temperature was raised slowly to the end of it, while axillary and sublingual measurements showed no increase during the test. Finally, the temperature measurement using infrared tympanic thermometer and a tactile tympanic thermometer showed disparate responses to exercise, since it increased in some subjects and decreased in others (40). Data collected after this study (unpublished data), showed that the behaviour of the TAT was similar to that presented in this study, descending immediately after exercise and then ascending again.

Decreased TAT in training and subsequent recovery can be explained by the fact that measurements were made outdoors and weather conditions may have lowered the TAT values (34). The relationship between the head temperature, which can indicate the hypothalamic temperature (internal temperature) and the heat production is inversed (41). Thus cranial temperatures higher than 37 °C triggers a constant decrease of the amount of heat produced and an increase in heat loss by evaporation (41). In training, temperature rises slightly and a major heat loss would occur in the head, so that by augmenting heat elimination the central temperature (tympanic) would decrease and that would explain the temperature decrease post-t. Differences with other studies may reside at the time and the conditions of measurement, which in many cases are not specified.

This study uses the CR10 scale to measure general muscle soreness in the lower limbs after training, following Copadoglio's (2001) (42), although in the literature this scale is usually presented to measure localized pain in muscle (19, 43, 44). However, no studies have been found to use this scale to assess the recovery process after exercise or after implementation of recovery strategies. In our case, after training (post-t) the variable CR10 increased in all groups, indicating that global perceived muscle soreness in the lower limbs increased at the end of the workout. Such evaluations and results are consistent with Capodaglio's (2001) in which they assessed every 4 minutes by the CR10 pain scale of the upper limbs, during and after a high test arm ergometer. In addition post-24 values in RC, SLE and JST decreased significantly compared to the values post-t, which may be indicative of recovery after 24 hours of these three techniques being equally effective in terms of decreasing muscle pain. Meanwhile CR10 also decreased in post-24 in JLE as compared with post-t, and this could indicate that a larger sample data would have corroborated the decrease. Regarding the comparison of the post-t and

with post-R, SLE results show that the only strategy that combined CR10 suffered a significant decrease, whereas the other techniques involving combined continuous running does not reflect significant decrease. It is possible that the implementation of the continuous run for 8 minutes in the recovery has negatively influenced the feeling / perception of muscular pain, compared to strategies which perform relaxation-stretching techniques without performing any motor activity. SLE implies supine resting with legs elevated, which could help promote venous return (45) and enhance the feeling of pain in the lower limbs, which may account for the difference in RC (which also has no motor activity).

As for the variable TQR the SLE strategy showed only variations in the different moments that were significant. Thus, there appears to be a negative trend of SLE over other RSs of our study in post-R, something that is consistent with other studies in which a recovery strategy similar to SLE, which were 7 minutes of static stretching and two minutes of leg raises, was the worst score obtained compared with a strategy of contrast baths (9 minutes) and another strategy combining contrasts with active recovery cycle ergometer (9 minutes) (46). Furthermore, King (2011) compared passive recovery (rest seated 25 minutes) with active recovery in professional players after Football practice (12 minutes of continuous running at 65% of maximal aerobic speed and 3 sets of 30 seconds of static stretching of the lower limbs), finding no significant differences in any of the strategies in the post-24 time, coinciding these with our results.

The negative trend found in the TQR in SLE contradicts the one obtained in the CR10 scale, because the SLE strategy showed to be more effective for the latter scale. TQR measured the process of recovery (18, 28) while CR10 estimates perceived muscular pain (19). The difference between combined strategies might be, as we said before, in the active part of the recovery that could adversely affect CR10, while the general level (physical and psychological) of a continuing race could have a positive effect on the mental level, something that could explain the contradictory results obtained for the SLE strategy.

This study has the advantage of being performed in 4 microcycles (4 full weeks) of 2nd division B of Spanish National League, so that the data refer to actual specific loads. This coupled with the ability to monitor the variables in a structured and standardized way, further reinforces the conclusions drawn in this work. The fact of working in a real context makes the sample be limited and the number of variables studied might have been small.

## **CONCLUSION**

We conclude that none of the studied RS shows a greater efficiency, after specific training with football players for the sample studied. Due to the size of the sample the findings may not be generalised to other populations.

However, the realization of combined recovery protocols (SLE, JLE and JST)

conducted after football training session, aimed at greater efficiency compared to CR protocols, which included stretching only.

## **PRACTICAL APPLICATION**

The study shows that there is not a substantial benefit to induce RS compared to simple combination at least in the variables studied, but a positive trend of the first in the perception of recovery. Thus, based on this variable, the use of combined strategies seems more advisable after training.

## **FUTURE LINES OF INVESTIGATION**

Based on the results future research lines proposed are the following:

1. The comparison of strategies combined or carried out alone, as can be cryotherapy or contrast baths.
2. Making a comparison between single and combined strategies in pre-season periods where training loads are higher and more sustained.
3. Conducting the study of different RSs after performing friendly matches or league.
4. Increase recovery times.

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