# Pre-season training improves perception of fatigue and recovery from a futsal training session

**Abstract**

**Purpose:** This study compared the post-training recovery timeline of elite Brazilian futsal athletes before (PrePS) and after (PostPS) a 10-week pre-season period of high-intensity tactical training. **Methods:** At the start (n=13) and at the end of the pre-season (n=7), under-20 male futsal players undertook fitness testing for aerobic power ($VO_2max$), countermovement jump (CMJ) and 10-m sprint with change of direction. Further, at both PrePS as PostPS, players participated in a training session where performance and psycho-physiological measures were recorded before, immediately, 3, 24 and 48h post-session. Measures included CMJ, 10-m sprint, creatine kinase (CK), total quality recovery scale (TQR) and Brunel Mood Scale. Effect size (ES) analyses compared fitness and post-training recovery values for each parameter at PrePS vs PostPS. **Results:** Only trivial ES (-0.02 to 0.11) were evident in $VO_2max$, CMJ and 10-m sprint at PostPS compared to PrePS. For the timeline of recovery, only trivial and small ES were evident for 10-m (-0.12 to 0.49); though CMJ recovery was improved at 3h (0.87) and 48h (1.27) at PostPS and CK was lower at 48h (-1.33) at PostPS. Perception of recovery was improved in PostPS at 3h (1.50) and 24h post session (0.92). Further, perception of effort was lower immediately after the session (-0.29), fatigue was lower at 3h (-0.63) and vigor responses were improved in all post-season assessments (0.59 to 1.13). **Conclusion:** Despite minimal changes in fitness, pre-season training attenuated players' perception of effort and fatigue and improved their recovery profile following a high intensity technical-tactical training session.


**Keywords:** CMJ, fitness, performance, team sport, TQR, training.

## Introduction

Futsal match demands lead to high physical and physiological strain[1] alongside increased inflammation and muscle damage[2]. In order to adequately prepare players, pre-season training programs involve 8-10 sessions/week[3], creating a condensed weekly schedule whereby appropriate post-training recovery is difficult, yet important to ensure readiness to perform[4]. However, knowledge of the post-training recovery timeline in futsal is limited[7,10]. In addition, cross-sectional studies have shown that underlying factors related to individual physical capacities (e.g. aerobic capacity) may affect the post-exercise recovery timeline[5,6, 7]. However, the effect of training on recovery in ecologically valid settings remains sparse.

Recovery is a multifactorial phenomenon in which central and peripheral factors interact to allow the return of performance, physiological or perceptual perturbations to near baseline values[8]. Regarding post-match recovery in futsal, a previous study[9] reported decreased countermovement jump (CMJ) and 10-m sprint speed at 5h post-match. Post-match decrements in CMJ and repeated-sprint ability were also observed[10], returning to pre-match values within 24h, despite muscle soreness remaining increased 24h post-match. These studies suggest recovery times are shorter for futsal matches than other team-sports[6,11]; likely due to lower external loads[4]. However, futsal players perform a higher number of training sessions in each microcycle during the in-season[3]. Therefore, understanding the timeline of post-training recovery is important to orient the prescription of load and recovery for optimal player readiness, though is yet to be investigated.

Importantly, recovery timelines vary according to players' characteristics, such as physical capacity and training exposure[12, 13]. Johnston et al.[6] reported rugby league players with higher aerobic power exhibited lower post-match impairment followed by faster peak power recovery in countermovement jump (CMJ) and plyometric press-up. Albeit interesting, individual factors related to aerobic power (e.g. age, performance level)[14] underlying such cross-sectional studies, limit inferences on the effect of training on recovery. The pre-season training period in team-sports is used to develop physical performance due to in-season congested schedules, and has been showed effective for high-level futsal athletes[3, 15]. Collectively, it seems reasonable to infer that increased training exposure may in turn benefit post-exercise recovery in futsal, though supporting evidence remains limited.

Accordingly, the aims of this study were to 1) characterize the 48h recovery timeline of physical performance and psychophysiological parameters of under 20 (U20) futsal athletes after a typical high-intensity technical-tactical training session; and 2) to investigate whether a pre-season training period improves recovery from high-intensity futsal training session using a multi-parameter recovery assessment.

## Materials and methods

### *Participants*

After explanation of all procedures, 13 male U20 futsal players from a professional Brazilian club provided informed consent and were cleared to participate by the team's medical physician. The study was approved by the University Ethics Committee (50166015.9.0000.5149). During the pre-season, 6 players were excluded from the sample after leaving the team due to technical proficiency or personal/career reasons. Therefore, we acknowledge the underpowered nature of data analysis with 13 (age 18.8±1.0 y; body mass

67.2±8.5 kg; stature 174±7 cm), and 7 players (age 18.7±0.7 y; body mass 65.0±5.5 kg; stature 174±6 cm) for the first and second objectives, respectively.

## *Methodology*

*Study design*

At the start of pre-season (PrePS) preceded by 6-8 weeks off-season break, and after 10 weeks of training (PostPS), national-level U20 futsal players underwent anthropometric and maximal aerobic power ($VO_2$max) measurements. Within 7 days, players undertook a high-intensity technical-tactical training session followed by 48h post-session recovery assessments. Physical, physiological and perceptual markers were assessed before, immediately and 3, 24 and 48h after respective PrePS and PostPS sessions. Both testing sessions occurred in the morning, on a standard 38m x 20m indoor futsal court.

*Participant characterization*

Anthropometry and $VO_2$max were measured at PrePS and PostPS at the same time of the day. Stature, body mass (MF100, Filizola®, Brazil) and skinfold (Lange®, Beta Technology, Seko Dosing Systems Corp., USA) assessments were followed by an incremental test to determine $VO_2$max, maximal heart rate (HRmax) and ventilatory threshold (VT)[16]. On a treadmill (HPX 380, Total Health®, Brazil) at 1% gradient, initial speed was set at 6 $km \cdot h^{-1}$, increased by 1.0 $km \cdot h^{-1}$/min, until volitional fatigue[7]. Oxygen consumption ($K4b^2$, Cosmed®, Italy) and HR (RS801, Polar®, Finland) were measured continuously. Rating of perceived exertion (RPE)[17] was provided at the end of each stage and end of the exercise. The spirometer was calibrated before each test according to the manufacturer's instructions. The highest 30s value on the respective variable was considered as $VO_2$max and HRmax. Due to technical malfunctions, 6 out of the 7 players completed this test before and after the pre-season.

*Recovery training session*

High-intensity 70-min technical-tactical training sessions were performed on the 3rd and 12th weeks of the pre-season. To ensure ecological validity, they were conducted by the coaches, aiming at 1) high-intensity technical-tactical training session and 2) intensity at PrePS should be replicated at PostPS, irrespective of tactical content (Table 1).

*** Table 1 around here ***

To monitor training load, players wore a Global Positioning Satellite device coupled with a triaxial accelerometer with a sampling frequency of 100 Hz (SPI ProX2, GPSports Systems®, Australia), with appropriate reliability[18], and a compatible HR receiver (Polar®, Finland). External training load was assessed by Player Load (PL)[19], and internal load by HR and RPE-derived parameters. Mean HR was calculated as a percentage of the incremental test HRmax (%HRmax), and training impulse (TRIMP) was calculated according to Edward's method[20]. Individual RPE values were used as an indication of intensity, and session RPE (sRPE) as an overall internal load index (RPE*sessions' duration)[17].

*Recovery timeline characterization*

Upon arrival for the training session, baseline assessments included a capillary blood sample collection for analysis of CK concentration (Reflotron, Roche®, Switzerland; intra-assay coefficient of variation <3%)[21]. Then, players answered to a wellness questionnaire including a) perceived sleep quantity and quality (1 = very bad and 5 = very good); b) total quality recovery scale (TQR)[22], reported as sensitive to weekly training accumulation[23]; and c)

Portuguese version of the Brunel Mood Scale (BRAMS), from which vigor and fatigue were analysed (Cronbach α = 0.79 to 0.85)[24].

A 15-min warm-up consisting of different speed running, change of direction, and futsal-specific drills, was followed by CMJ and 20-m sprint test with change of direction. For the CMJ, players performed hip and knee flexion up to approximately 90º followed by a rapid hip and knee extension to achieve the highest possible height, while maintaining hands on their waist. Four jumps were performed on a force platform (Ergo System®, Globus, Italy) interspersed by 15s, and the mean jump height was used for analyses. Previous studies have shown high reliability in the CMJ test (i.e. CV = 2.8%; ICC = 0.98)[25]. A 20-m sprint test with 180º change of direction at 10-m, based on the 505 test (ICC between 0.87 and 0.99)[26], was used to evaluate players' ability to accelerate, decelerate and change direction. The time to complete 10-m and 20-m were measured by timing gates (Multisprint, Hidrofit®, Brazil) positioned at the start/finish line and at 10-m. Due to technological malfunction, only the first 10-m times were used for analysis and this test is referenced as 10-m test.

Following baseline measurements, the training session was undertaken. Immediately after the session, players repeated the CMJ and 10-m tests and provided a blood sample to determine CK concentration. Approximately 15 min after the session, they reported RPE and BRAMS. To determine the recovery timeline for each variable, all procedures adopted prior to the beginning of the training session were repeated 3h, 24h and 48h after. During this period and 48h prior to the sessions, no recovery interventions or training sessions were performed, and participants were instructed to record their diet, abstain from alcohol, caffeine and the practice of high-intensity exercises.

*Pre-season training*

Training schedules during the pre-season included one technical-tactical session per day, from Monday to Saturday. Training was usually performed in the morning, on one of the three courts available at the training facilities: 36 × 20m; 31 × 19m; or 25 × 15m. Technical-tactical sessions' duration was approximately 90min and included activities aiming for the development of team shape, technical and decision-making skills. Additionally, 5 friendly matches were held against the professional team of the same club. Weekly routines also included 3 strength training sessions/week, usually in the afternoon. Sessions comprised general upper body, lower body and core exercises aiming for hypertrophy and strength.

Training loads in all technical-tactical training sessions were monitored, as described earlier. Furthermore, between 15 and 20 min following the sessions, players reported RPE. Training load parameters (PL, %HRmax, TRIMP and sRPE) were calculated for each session.

### ***Statistical Analysis***

To characterize the timeline of recovery following a high-intensity training session, data from the PrePS was used. After verifying data distribution using the Shapiro-Wilk test, normally distributed variables (CMJ, 10-m and vigor) (mean ± standard deviation; SD) were analysed using a repeated-measures one-way ANOVA with respective Partial Eta Squared ($\eta_p^2$) for the analysis of effect size, followed by the Tukey post-hoc test when applicable to determine changes over the time course of recovery (immediately, 3, 24 and 48h post). Non-normally distributed variables (CK, TQR and fatigue) (median ± interquartile interval) were compared using the Friedman test with respective Kendall's W (*W*) for the analysis of effect sizes, followed by Wilcoxon post-hoc test when applicable. The magnitude of effect for pairwise comparisons was analysed using Cohen's d with 95% confidence interval (*d*; [95% CI]). The magnitude of *d* was qualitatively interpreted using the following thresholds: < 0.2, trivial; 0.2–0.6, small; 0.6–1.2, moderate; 1.2–2.0, large; 2.0–4.0, very large and; > 4.0, nearly perfect [27].

Due to low sample size, the magnitude of differences of baseline measures and training load at PrePS and PostPS, as well as from the percentage change from baseline at each time (immediately, 3h, 24h and 48h post) between PrePS and PostPS was analysed using Cohen's d. The latest analysis was performed adding individual differences in sRPE (PostPS – PrePS) as a covariate in the comparisons to acknowledge a possible impact of this parameter on players' recovery, using an online-available spreadsheet[28].

## Results

### Characterization of post-training recovery timeline

#### *Training load*

The PrePS training session duration was 68 min, during which PL was 559 ± 92 AU. Mean HR was 81 ± 4 %HRmax and TRIMP was 229 ± 23 AU. Mean RPE was 6.1 ± 1.7, resulting in a sRPE of 413 ± 113 AU.

#### *Recovery timeline*

Relative to baseline values (Figure 1), no significant differences over time were observed in CMJ (p=0.957; $\eta_p^2$=0.336) and 10-m (p=0.655; $\eta_p^2$=0.490) performances throughout the 48h recovery period. Significant changes were observed in CK (p<0.001; *W*=0.642), TQR (p=0.003; *W*=0.353), vigor (p<0.001; $\eta_p^2$=0.520) and fatigue (p<0.001; *W*=0.776). Specifically, CK increased immediately post (p=0.001; *d*=0.48 [CI=0.29 to 0.68]), remaining increased at 3h (p=0.001; 1.03 [0.61 to 1.41]), 24h (p=0.003; 1.14 [0.60 to 1.68]) and 48h compared to baseline (p=0.024; 0.60 [0.19 to 1.02]). Players' perceived recovery (TQR) decreased 3h post session (p=0.001; -2.06 [-2.96 to -1.17]), then increased at 24h, showing similar values to baseline up to 48h post-session (p=0.387; -0.33 [-0.97 to 0.32] and p=0.178; -0.65 [-1.46 to 0.16]; respectively). Vigor scores decreased immediately (p<0.001; -1.57 [-2.10 to -1.05]), 3h (p<0.001; -1.70 [-2.27 to -1.13]) and 24h after the session (p=0.020; -0.69 [-1.16 to -0.23]), returning to baseline 48h post-session (p=0.156; -0.41 [-0.89 to 0.07]). Fatigue increased immediately after the session (p=0.001; 2.42 [1.80- 3.03]) and remained increased at 3h (p=0.002; 1.96 [1.26 to 2.65]); though was similar to baseline at 24h (p=0.776; -0.04 [-0.44 to 0.37]) and 48h (p=0.232; -0.21 [-0.56 to 0.13]).

*** Figure 1 about here ***

### Effect of pre-season training on recovery

#### *Training load during the pre-season*

During the 10-week pre-season, the team performed 54 technical-tactical sessions including 5 friendly matches (6 ± 1 sessions/week; 46 ± 9 sessions/player). Mean duration was 91 ± 19 min, in which PL was 670 ± 174 AU, or 7.8 ± 2.1 AU/min. Such external load resulted in mean HR of 74 ± 7 %HRmax, RPE of 4.1 ± 1.2 AU and sRPE of 373 ± 139 AU. Mean TQR during this period was 13.8 ± 1.1.

#### *Anthropometry and physical performance responses to pre-season training*

When comparing the 7 players that completed PrePS and PostPS sessions, only trivial ES (d=-0.02 to 0.11) were observed in body composition and physical capacity (Table 2).

*** Table 2 around here ***

***PrePS vs PostPS sessions***

In respect to the baseline assessments (Table 3), trivial effects existed for most variables (d=-0.63 to 0.27), though there was a small effect (-0.23) for lower vigor scores in the PostPS session compared to PrePS. The training session performed PostPS was five minutes shorter than the PrePS session, with a small effect for the time players spent in action (time played; i.e., excluding time between activities and substitutions). Differences between respective sessions for PL, PL/min, %HRmax, time spent above 80%HRmax and TRIMP presented only trivial effects (-0.09 to 0.10). However, RPE and sRPE presented small effects for lower values at PostPS compared to PrePS. Therefore, to acknowledge a possible impact on players' recovery, individual differences in sRPE (PostPS – PrePS) were further used as a covariate in the comparisons between PrePS and PostPS recovery timelines.

*** Table 3 around here ***

***Recovery timeline***

Figure 2 shows the percentage difference from pre-training values during the respective recovery timelines for PrePS and PostPS. CMJ changes from baseline presented a moderate effect for better results at PostPS than PrePS at 3h (d=0.87; [0.20 to 1.55]), and a large effect for better results at 48h post-training (d=1.27; [0.52 to 2.02]). ES for changes in 10-m performance immediately, 3h and 24h after the session were only trivial (*d* between -0.12 to -0.05) and small at 48h (d=0.49; [0.24 to 0.73]) between PrePS and PostPS. The post-session change from baseline in CK concentration showed a large effect to be higher in PostPS (1.18; [d=0.15 to 2.20), though was lower 48h post-training compared to PrePS (d=-1.33; [-2.04 to -0.63]). There was a large effect for a smaller decrease in TQR 3h post-session at PostPS compared to PrePS (d=1.50; [0.75 to 2.25]) and a moderate effect for higher subsequent increase in TQR at PostPS (d=0.92; [-0.01 to 1.84). The increase in fatigue was also lower 3h post-session at PostPS compared to PrePS (d=-0.63; moderate; [-1.02 to -0.25]), though differences from baseline were higher at 48 h (d=0.73; moderate; [-0.67 to 2.14]). Changes from baseline in vigor were improved (moderate ES) in PostPS at all time points (*d* = 0.59 to 1.13).

*** Figure 2 around here ***

## Discussion

This study describes the recovery timeline after high-intensity futsal-specific training and secondly, the influence of pre-season training on recovery. At the start of the season, physical performance assessed by CMJ and 10-m sprint was not impaired post-session; whereas perception of recovery, fatigue and vigor were worse in the hours post-training, returning to baseline within 24h. In addition, increases in CK showed moderate effects up to 24h post-training. At the end of the pre-season, despite limited fitness-based improvements in lower-body power, speed or aerobic power, an improved recovery timeline existed following a training session of similar load. Specifically, despite greater post-session increase in CK, a faster return to baseline was evident at the end of the pre-season. Furthermore, perceptual responses were improved at PostPS up to 24h (TQR) and 48h (vigor). These results provide an initial context for the role of physical training exposure to aid post-training recovery.

The training sessions used to compare recovery timelines before and after the pre-season showed high training loads, as evidenced by higher PL/min, %HRmax and RPE considering the loads in this pre-season program. Additionally, despite the training activities not being identical at PrePS and PostPS, loads were similar as evidenced by the trivial ES in external load (i.e. PL) and cardiovascular demand. Such absence of difference also aligns with previous study showing similar internal loads between different futsal-specific training activities[29]. However, players perceived the session as less intense (i.e. lower RPE for similar external load); which supports the notion that exposure to training may improve perception of the load[30], and in turn perhaps tolerance to fatigue[13].

Regarding recovery at PrePS, post-training CMJ and 10-m performances were not impaired, differing from previous studies that reported decreases in CMJ and sprint after friendly futsal matches[9, 10]. The shorter training duration in this study may have led to lower external loads and preservation of lower-body force and power[8], though such assumptions are limited as external load was not reported in previous investigations. Differing from physical performance, CK increased substantially, remaining elevated up to 48h post-training, consistent with previously reported increases in muscle damage and inflammatory markers after futsal matches[2, 31]. Finally, TQR and fatigue returned to baseline only after 24h. The fact that players reported worse readiness in the hours post-training despite the absence of performance decrements agrees with the multifactorial nature of perceptual parameters[22] and suggests that other factors than those measured herein were affected. Despite incongruent timelines between performance, physiological and perceptual measures, recovery of futsal players after high-intensity training seems evident by 48h.

The pre-season internal training loads during the 10-weeks were similar to previously reported values for individual sessions (≈74% HRmax, TRIMP≈153, RPE≈5, sRPE≈300-500 AU)[29]. The maintenance of jump and sprint performance was also consistent with former investigations in futsal[3,15]; which may be explained by the high number of aerobically-dominant technical-tactical training sessions, and the focus on hypertrophy rather than power/speed in the gym in the current program. However, such training characteristics would expectedly improve players' $VO_2$max and/or VT, which were not observed through the incremental treadmill test. This can be partially explained by its lack of specificity[6] to futsal demands, since performance in on-court tests has been shown to improve after futsal pre-season[15]. Consequently, following this 10-week pre-season program designed at team technical-tactical proficiency, players' physical capacities were not demonstrably improved.

When accounting for the reduced sRPE at PostPS, improved changes from baseline in CMJ (3h and 48h post-session) and CK (at 48h) were evident compared to PrePS. Despite no explicit fitness changes, pre-season training still resulted in improved neuromuscular recovery profiles in futsal players. Previously, Johnston et al.[6] observed that athletes with higher 3 repetition-maximum squat and YoYo IR-1 performance exhibited faster CMJ return to baseline and smaller increases in CK following a rugby league match. Whilst similar improved recovery is evident in both studies, the cross-sectional nature of the study by Johnston et al.[6], and the absence of both a strength test and a control group here make interpretation of the underpinning factors difficult. In addition, exposure to exercise without fitness changes has been reported to decrease muscle damage following subsequent eccentric training sessions in acute settings (repeated bout effect)[32], though such a rationale in ongoing training is speculative. Therefore, it is feasible that either unmeasured fitness improvement or greater tolerance to training due to exposure mediates the improved PostPS recovery profiles.

Players also exhibited positive changes in the recovery timeline of perceptual markers after the pre-season. Interestingly, the attenuated perception of load immediately post-session was followed by players perceiving themselves readier to perform 3h (improved TQR, fatigue and vigor), 24h (TQR and vigor) and 48h (vigor) after training, despite performing similar external and internal loads. Given RPE can be influenced by individuals' reference of "maximal effort"[33], it is also possible that similar absolute loads appear easier due to the pre-season exposure to high-loads. Post-training perceptual results also align with the improved neuromuscular recovery responses, and reinforce the argument of improved tolerance to load following training, partially via improved psychological ability to tolerate high-intensity efforts[13].

Understanding athletes' responses to training in ecologically valid settings is paramount to improve recovery strategies. However, it also presents limitations related to the uncontrolled environment, including the exposure to unexpected data loss, limitation to one experimental situation and the inability to include a control group. In this study, although 13 players were recruited, data of only 7 could be analysed to address the second objective, increasing the odds of errors and limiting our findings to the population studied herein. Further, the fact that training sessions performed for recovery timeline assessments were not identical at PrePS and PostPS included a co-factor (i.e. sRPE) to the effect of the pre-season training in the recovery timeline. Taken this into account, we included the one variable that differed between PrePS and PostPS as a covariate in our analysis, though we acknowledge kinematic and cognitive differences may also be present.

## Practical applications

Despite the distinct post-session timeline between parameters, recovery of futsal players after high-intensity training seems evident by 24-48h. Based on the improved recovery of CK, fatigue and recovery perception after the preseason, appropriate training exposure and accumulation may provide benefits to assist tolerate fatigue and recovery later in the season. Furthermore, given physical performance responses were not affected by the training session or the 10 weeks of pre-season, we suggest consideration of fitness tests other than CMJ and 10-m to infer recovery, or laboratory-based $VO_2$ and VT to infer training status in futsal players.

## Conclusions

In summary, after high-intensity technical-tactical training session performed at the start of the season, U20 players' physical performance showed only minimal post-training changes; markers of perceived recovery and mood returned to baseline after 3h and CK remained elevated up to 48h post-session. Ten weeks of futsal-specific pre-season training attenuated players' perception of effort and fatigue as well as improved the recovery of power, muscle damage and vigor markers' up to 48h after a training session with comparable load, irrespective of the maintenance of $VO_2max$, VT, 10-m and CMJ performances. Future studies are encouraged to address which factors mediate improvements in athletes' recovery profile following a training period.

## Disclosure of interest

The authors report no conflict of interest

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# FIGURE CAPTIONS

**Figure 1:** Timeline of recovery markers after a technical-tactical futsal training session. Grey lines represent individual data and black line represents mean values. a) countermovement jump high; b) 10-m time; c) creatine kinase concentration; d) total quality recovery scale (TQR); e) Vigor (BRAMS); f) Fatigue (BRAMS). a = different from pre session; b = different from post session, c = different from 3h post session; d = different from 24h post session.

**Figure 2:** Timeline of recovery markers after technical-tactical futsal training sessions held at the start (PrePS) and end (PostPS) of pre-season. Data is presented as percentage change from pre-training values (mean ± SD). a) countermovement jump (CMJ) high; b) 10-m time; c) creatine kinase (CK) concentration; d) total quality recovery scale, e) Vigor (BRAMS) and f) Fatigue (BRAMS). * = moderate effect size compared to PrePS; ** = large effect size compared to PrePS.

TABLES

**Table 1:** Description of the training sessions held before (PrePS) and after (PostPS) the pre-season for characterization of the 48h recovery timeline.

| Pre/ Post | Field players involved | Court size | Duration | Rules |
|---|---|---|---|---|
| **PrePS** | | | | |
| **1** | 4x4 | Full court | 21 min + 34 min with 8 min interval in between | Similar rules to an official match<br>Free time and number of players` substitutions allowed<br>Short (30 s to 120 s) pauses during each block for instructions |
| **PostPS** | | | | |
| **1** | 6x3 | Half court | 15 min | Similar rules to an official match |
| **2** | 2x1 followed by 3x2, 3x3 and 4x4 | Full court | 5 min | The team that started with the ball possession had to make a fast attempt to score a goal. Irrespective of the result (scored or not), either the goalkeeper or the coaching staff made a quick ball reposition to the opposite team that should perform a counter-attack as fast as possible. This sequence was repeated 4 times without interval. At each time, more players were added to the activity. |
| **3** | 4x4 | Full court | 7 min | Similar rules to an official match |
| **4** | 2x1 followed by 3x2, 3x3 and 4x4 | Full court | 5 min | Same as activity 2 |

**Table 2:** Anthropometric measures and physical performance of players before (PrePS) and after (PostPS) ten weeks of pre-season (n=7).

| | **PrePS** | **PostPS** | **ES** | **CI (95%)** | **Magnitude of effect** |
|---|---|---|---|---|---|
| Body mass (kg) | 65.0 ± 5.5 | 66.8 ± 6.4 | 0.10 | -0.02 to 0.21 | *Trivial* |
| Percentage body fat | 5.2 ± 2.3 | 6.0 ± 3.5 | 0.11 | -0.12 to 0.35 | *Trivial* |
| $VO_2max$ ($mlO_2.kg^{-1}.min^{-1}$) | 52.6 ± 3.5 | 52.8 ± 3.5 | 0.10 | -0.14 to 0.33 | *Trivial* |
| %$VO_2max$ at VT | 47 ± 13% | 53 ± 12% | 0.10 | -0.05 to 0.24 | *Trivial* |
| CMJ | 32.6 ± 4.2 | 32.3 ± 4.2 | -0.02 | -0.15 to 0.10 | *Trivial* |
| 10-m (s) | 1.57 ± 0.10 | 1.58 ± 0.07 | 0.02 | -0.15 to 0.20 | *Trivial* |

Data are expressed as mean ± SD. $VO_2max$ = maximal aerobic power; %$VO_2max$ at VT = percentage of maximal aerobic power at which the ventilatory threshold was attained; CMJ = countermovement jump. PrePS = before the pre-season, PostPS = after the pre-season, ES = effect size, CI (90%) = confidence interval of 90%.

**Table 3:** Baseline and training load measures from the testing training session performed before (PrePS) and after (PostPS) ten weeks of pre-season (n=7).

| | Pre PS | Post PS | ES | CI (95%) | Magnitude of effect |
|---|---|---|---|---|---|
| **Pre-training measures** | | | | | |
| Creatine Kinase (U/L) | 216 ± 136 | 227 ±168 | 0.03 | -0.32 to 0.37 | *Trivial* |
| TQR | 14.9 ± 1.7 | 14.1 ± 1.8 | -0.13 | -0.35 to 0.09 | *Trivial* |
| Vigor | 10.6 ± 2.7 | 8.6 ± 4.5 | -0.23 | -0.46 to 0.00 | *Small* |
| Fatigue | 2.6 ± 2.3 | 2.9 ± 1.3 | 0.04 | -0.25 to 0.32 | *Trivial* |
| Sleep hours | 7.2 ± 0.6 | 6.8 ± 1.3 | -0.18 | -0.72 to 0.36 | *Trivial* |
| Sleep quality | 3.6 ± 0.8 | 3.6 ± 0.9 | 0.00 | -0.19 to 0.19 | *Trivial* |
| **Training load** | | | | | |
| Duration (min) | 68 ± 0 | 63 ± 2 | - | - | |
| Time played (min) | 28 ± 2 | 26 ± 3 | -0.27 | -0.72 to 0.18 | *Small* |
| Player load (AU) | 596 ± 102 | 534 ± 111 | -0.09 | -0.26 to 0.08 | *Trivial* |
| Player load/min (AU) | 9.0 ± 1.6 | 9.0 ± 1.9 | -0.01 | -0.18 to 0.16 | *Trivial* |
| % HRmax | 81 ± 4% | 80 ± 4% | -0.06 | -0.30 to 0.18 | *Trivial* |
| Time >80%HRmax (min) | 35.9 ± 7.7 | 30.1 ± 4.5 | -0.02 | -0.44 to 0.40 | *Trivial* |
| TRIMP (AU) | 228 ± 23 | 204 ± 20 | 0.10 | -0.66 to 0.86 | *Trivial* |
| RPE | 6.0 ± 1.4 | 4.4 ± 1.4 | -0.29 | -0.51 to -0.07 | *Small* |
| Session RPE (AU) | 408 ± 111 | 280 ± 94 | -0.35 | -0.61 to -0.09 | *Small* |

Data are expressed as mean ± SD. PrePS = before the pre-season, PostPS = after the pre-season, ES = effect size, CI (90%) = confidence interval of 90%.