Effects and Sustainability of a 13-Day High-Intensity Shock Microcycle in Soccer

Patrick Wahl 1,2, Matthias Güldner 1 and Joachim Mester 1,2

1 Institute of Training Science and Sport Informatics, and 2 The German Research Centre of Elite Sport, German Sport University Cologne, Germany

Abstract
The preseason in soccer is a short period of 6-8 weeks where conditional abilities, technical and tactical elements need to be trained. Therefore, time is lacking to perform long term preparation periods for different abilities, especially endurance training. There is evidence that the implementation of high-intensity shock microcycles in preseason training could be one way to improve physical performance in a short period of time. Therefore, the purpose of the present study was to examine the effects and the sustainability of a high-intensity shock microcycle on soccer specific performance. Over 2 weeks, 12 male soccer players (26.1 ± 4.5 years) performed 12 high-intensity training (HIT) sessions in addition to their usual training. Before (pre), 6 days (6d) and 25 days (25d) after training, subjects performed Counter Movement Jump (CMJ), Repeated-Sprint Ability (RSA) test and Yo-Yo Intermittent Recovery Test Level 2 (YYIR2). Mean sprint time (RSA Mean) (cohen’s d = -1.15), percentage decrement score (RSA Index) (cohen’s d = -1.99) and YYIR2 (cohen’s d = +1.92) improved significantly from pre to 6d. 25d after, values showed a significant reduction for YYIR2 (cohen’s d = -0.81) and small to moderate but not significant increase for RSA Mean (cohen’s d = +0.37) and RSA Index (cohen’s d = +0.07) compared to 6d values. Small but no significant increases were found for CMJ (cohen’s d = +0.33) and no significant and substantial changes were found for RSA Mean (cohen’s d = -0.07) from pre to 6d. For competitive soccer players, block periodization of HIT offers a promising way to largely improve endurance and strength has negative effects on the development of each of the conditional abilities. By using these shock microcycle blocks with highly concentrated specialized workloads, previous studies already showed that it is possible to improve endurance performance/high-intensity running performance (Breil et al., 2010; Christiansen et al., 2011; García-Pallares et al., 2010; Mallo., 2011; Wahl et al., 2013). However, only three studies in soccer exist (Christensen et al., 2011; Mallo., 2011; Stöggel et al., 2010), with lacking information on soccer specific performance and especially on the sustainability of performance increases after a high-intensity training block. Therefore, the aim of the present study was to investigate the magnitude of effects and sustainability of a high-intensity shock microcycle according to block periodization in the preseason training of male semi-professional soccer players.

Methods

Subjects
12 healthy male soccer players (mean ± SD: 26.1 ± 4.5 years; 1.80 ± 0.05 m and 78.8 ± 6.5 kg) from a team of the sixth German league participated in the study. All players had more than 10 years of training experiences. Before the training intervention athletes had a break lasting 3 weeks where every player trained individually.
During the first half of the season weekly training amount was ~6-8 h plus one game per week. All subjects were informed about the aim of the investigation and gave their written consent to participate in the study. The study protocol was performed in accordance with the declaration of Helsinki and the Ethical Committee of the university.

**Design**

A 13-day HIT shock microcycle, including interval running, dribbling exercises and small-sided games was conducted (Figure 1). Before (pre), 6 days (6d) after training (in order to assure sufficient recovery) and 25 days (25d) after training (in order to test the sustainability) soccer specific tests reflecting the characteristics of high-intensity match periods were carried out (Figure 1). Between the last HIT session and the 6d post diagnostic only technical drills were carried out. Between the 6d diagnostic and the 25d diagnostic normal training without any HIT session was performed. Normal training consisted of 4 training sessions per week (90 min each), with the main focus on technical/tactical drills and game specific variations. The investigation was conducted during the winter preparatory period. All tests were applied outside on a grass field. Athletes were instructed to avoid heavy exercises 24 h before testing.

**Methodology**

During the shock microcycle players performed 12 additional high-intensity interval sessions with two sessions performed on day 6 and 13 (Figure 1). The HIT sessions were performed as interval running, on a dribbling track or as small-sided games (SSG) all consisting of 4 x 4 min bouts separated by 3 min active recovery. Although, the effectiveness of heart rate (HR) for controlling or adjusting the intensity of a HIT session may be limited for several reasons (Buchheit et al., 2013), we chose the HR to assess the training sessions online mainly due to practical reasons (Buchheit et al. 2013), we chose the HR to assess the training sessions online mainly due to practical reasons (Buchheit et al. 2013). To ensure the intended training intensity, the dribbling track was designed according to Hoff et al. (2002) and the 25d diagnostic normal training without any HIT session was performed. Normal training consisted of 4 training sessions per week (90 min each), with the main focus on technical/tactical drills and game specific variations. The investigation was conducted during the winter preparatory period. All tests were applied outside on a grass field. Athletes were instructed to avoid heavy exercises 24 h before testing.

![Figure 1. Arrangement of the 12 HIT sessions during the 10-day shock microcycle](image)
**Statistical analysis**

For all statistical analysis of the data Statistica (Version 7.1, StatSoft Inc., USA) software package for Windows® was used. Descriptive statistics of the data are presented as means ± standard deviation (± SD). To test the two hypotheses, if a 10-day high-intensity shock microcycle improves performance variables of high-intensity match periods of soccer players and if these improvements are maintained without HIT for several weeks, ANOVA repeated-measures with Bonferroni post-hoc test was used. Statistical differences were considered to be significant for p < 0.05. Furthermore, the effect size “partial η²” was calculated for the main time effect. The thresholds for small, moderate, and large effects were defined as 0.1, 0.25 and 0.4, respectively. Cohen’s effect size (d) was calculated for the comparison of pre to 6d and 6d to 25d values. The thresholds for small, moderate, and large effects were defined as 0.20, 0.50, and 0.80, respectively.

**Results**

In the first session, athletes reached a mean heart rate of 183 ± 10 bpm which was 93.2 ± 2.6 % of maximal heart rate.

Post-hoc analysis showed no significant changes for CMJ (Figure 2). However, results nearly reached statistical significance from pre to 6d (p = 0.06), with small partial η² (0.23) when considering the variations over the 3 testing sessions. Small increases were present from pre-6d (cohen’s d = +0.33) and no substantial changes were present from 6d-25d (cohen’s d = -0.13).

![Figure 2. Changes in counter movement jump (CMJ) performance. Cohen’s d (pre-6d) = 0.33; Cohen’s d (6d-25d) = 0.13. Values are presented as mean ± SD.](image)

For RSA_best over-all ANOVA showed no significant changes over time (p = 0.24) (Figure 3a), with small partial η² (0.12) when considering the variations over the 3 testing sessions. No substantial changes were present from pre-6d (cohen’s d = -0.07) and from 6d-25d (cohen’s d = +0.15).

For RSA_mean (Figure 3b) post-hoc analysis revealed that time significantly decreased from pre to 6d after (p < 0.001) and remain significantly decreased 25 d after compared to pre (p = 0.001), with large partial η² (0.64) when considering the variations over the 3 testing sessions. Large decreases were present from pre-6d (cohen’s d = -1.15) and small increases were present from 6d-25d (cohen’s d = +0.37).

![Figure 3. Changes in best sprint time (Repeated-Sprint Ability (RSA_best)) (a) Cohen’s d (pre-6d) = 0.07; Cohen’s d (6d-25d) = 0.15, mean sprint time (Repeated-Sprint Ability (RSA_mean)) (b) Cohen’s d (pre-6d) = 1.15; Cohen’s d (6d-25d) = 0.37 and the fatigue index (Repeated-Sprint Ability (RSA_index)) (c) Cohen’s d (pre-6d) = 1.99; Cohen’s d (6d-25d) = 0.7. * = significantly different to pre (p < 0.05). Values are presented as mean ± SD.](image)

For the percentage decrement score (RSA_index) (Figure 3c) post-hoc analysis revealed that fatigue significantly decreased 6d after compared to pre (p < 0.001) and remain significantly decreased 25 d after compared to pre (p < 0.001), with large partial η² (0.71) when considering the variations over the 3 testing sessions. Large decreases were present from pre-6d (cohen’s d = -1.99) and moderate increases were present from 6d-25d (cohen’s d = -
For YYIR2 post-hoc analysis revealed that the distance covered was significantly increased 6d and 25d after compared to pre (both p < 0.001) (Figure 4). However, values significantly decreased from 6d to 25d (p<0.05). Large changes were present (partial $\eta^2 = 0.73$) when considering the variations over the 3 testing sessions. Large increases were present from pre-6d (cohen’s d = +1.92) and large decreases were present from 6d-25d (cohen’s d = -0.81).

No significant and substantial changes were found for the items perceived physical energy, perceived physical flexibility, perceived physical fitness and perceived physical health of the PEPS scale (Figure 5a-d). In addition, no significant and substantial changes in resting heart rate, weight, sleep duration and sleep quality occurred during the high-intensity shock microcycle (Figure 6a-d).

**Discussion**

The main findings of this investigation are 1) that a 13 day shock microcycle including 12 additional high-intensity sessions largely improved parameters (RSA Mean, RSA Index and YYIR2) that can impact physical performance during critical match periods in soccer and 2) that these improvements sustain on a significantly higher level, even ~ 4 weeks without any further HIT sessions. However, the effect size revealed that the 4 weeks without HIT had moderate to large decreasing effects on performance.

Improvements of the endurance performance of elite soccer players largely depend on training intensity (Baar, 2006; Bangsbo et al., 2006; Iaia et al., 2009). However, the analysis of 504 training sessions of the preseason in soccer revealed that only 8% of the training time was high-intensity exercise (>HR 4 mmol·L$^{-1}$ blood lactate) (Castagna et al., 2011). An increase of training intensity can be realized by the implementation of HIT sessions, but still little is known about its periodization. In the
study of McMillan et al. (2005) professional youth soccer players performed two additional HIT sessions per week over 10 weeks. Despite the high initial level, McMillan et al. (2005) found a significant improvement of maximal oxygen uptake (VO2max) (cohen’s d = +1.05). Sporis et al. (2008) implemented 3 HIT sessions per week in the pre-season of Croatian first division soccer players, which resulted in a significant improvement (cohen’s d = +0.76) in a 300-yard shuttle run. Dupont et al. (2004) showed that high-intensity training can be performed during the season with no doubt. Besides large improvements in maximal aerobic speed (cohen’s d = +1.41) and 40-m sprint time (cohen’s d = -1.42), the investigated team won 78% of their matches. Besides the integration of single HIT sessions, HIT shock microcycles might be another promising method to include HIT sessions in the daily training cycle. In accordance to studies of Wahl et al. (2013) with triathletes and Breil et al. (2010) with alpine skiers, the present study showed the effectiveness of a HIT shock microcycle to improve high-intensity running performance. In addition, two studies already investigated the effects of a shock microcycle on soccer players. Large but not significant improvements (cohen’s d = +0.88) were found for YYIR2 performance after a 10-day HIT block (Christensen et al., 2011). The effects and sustainability of a HIT shock microcycle on VO2max were investigated by Stöggl et al. (2010). During the 12-day intervention period soccer players performed 14 high-intensity sessions. The block training was followed by 4 weeks of maintenance training with one HIT session per week. VO2max showed a similar trend as the YYIR2 performance of the present study, with an improvement from pre to post (cohen’s d = +0.76) and a decrement (cohen’s d = -0.32) after the maintenance period. In their study, even maintenance training was not able to stabilize VO2max values. Due to the close relationship between VO2max and YYIR2 performance, shown in previous studies (Bangsbo et al., 2008), the results of Stöggl et al. (2010) are comparable with these of the present study, despite different measured parameters. Furthermore, Rampinini et al. (2009) found that HIT improves VO2 kinetics and identified significant relationships between RSA, VO2max and VO2 kinetics in soccer players. Although we did not measure aerobic capacity and VO2 kinetics in the present study, it can be hypothesized that both parameters increased after the HIT shock microcycle, due to the mentioned relationships (Bangsbo et al., 2008; Rampinini et al., 2009). Consequently the enhancement of these parameters could be one explanation for the significant increase of RSAIndex as the importance of the aerobic capacity increases progressively with the number of sprints (Spencer et al., 2005).

Despite the higher demand of the shock microcycle, HRRest, weight, sleep duration, sleep quality and PEPS-scale showed no significant and substantial changes. The fact that CMJ and sprint performance (RSABest) showed no significant and substantial changes shows that there was no overload on the neuromuscular system. The unchanged weight status is comparable to the results of Sperlich et al. (2011) and McMillan et al. (2005). Wahl et al. (2013) found significant decreases in some dimensions of the PEPS-scale, but more high-intensity sessions were performed compared to the present study. Although the risk of overreaching or even

Figure 6. Changes in Resting HR (a), Weight (b), Sleep duration (c) and Sleep quality (d). Values are presented as mean ± SD.
overtraining exists, it seems that intensive sessions are needed to generate adaptations and increases in performance.

The design of the present HIT shock microcycle was able to increase performance in a short period of time. However, future studies need to prove the results with highly trained and more professional soccer players. Furthermore, the present study did not use a control group performing regular training in the preparation period and the load of the training sessions between the last HIT session and the 25d post diagnostic was not documented, which is a clear limitation and should be considered in future studies. Anyhow, the standardized improvement in performance was >0.2, which suggests that this kind of training is substantial practically to improve performance. To get a clearer idea of the sustainability, a comparison of different training regimes (e.g. single HIT sessions vs. no HIT sessions) after a HIT shock microcycle should also be investigated.

**Conclusion**

The present study showed that a 2-week HIT shock microcycle is a promising tool in preseason training of semi-professional soccer players to largely improve RSA$_{\text{Index}}$ by 46% (cohen’s $d = -1.99$), RSA$_{\text{Mean}}$ by 2.3% (cohen’s $d = -1.15$) and YYIR2 performance by 24% (cohen’s $d = +1.92$) of semi-professional soccer players. Despite the decrement from 6d to 25d testing (RSA$_{\text{Index}}$ cohen’s $d = +0.7$; RSA$_{\text{Mean}}$ cohen’s $d = +0.3$; YYIR2 cohen’s $d = -0.81$), values of the 25d testing of RSA$_{\text{Mean}}$ RSA$_{\text{Index}}$ and YYIR2 remained significantly higher than pre levels (cohen’s $d$ pre-25d = -0.74 (RSA$_{\text{Mean}}$), -1.66 (RSA$_{\text{Index}}$), +0.97 (YYIR2)). Therefore, it seems necessary to perform further additional HIT sessions per week. However, the exact “dose” of HIT that has to be performed to sustain the improvements still needs to be defined.

**References**


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**Key points**

- HIT shock microcycle increases performance in semi-professional soccer players in a short period of time.
- Despite moderate to large decreases in performance in the 19 day period without HIT, values still remained significantly higher 25d after the last HIT session compared to pre-values.
- This kind of training block increases YYIR2 performance and the ability to repeated sprints, based on the RSAIndex.

**AUTHORS BIOGRAPHY**

**Patrick WAHL**

*Employment*

German Sport University Cologne, Germany

*Degree*

PhD

*Research interests*

Exercise science, endurance training, HIT.

*E-mail:* Wahl@dshs-koeln.de

**Matthias GÜLDNER**

*Employment*

German Sport University Cologne, Germany

*Degree*

MSc

*Research interests*

Exercise science, HIT.

*E-mail:* matze0301@web.de

**Joachim MESTER**

*Employment*

Prof., German Sport University Cologne, Germany

*Degree*

PhD

*Research interests*

Exercise science, endurance training

*E-mail:* Mester@dshs-koeln.de

**Dr. rer. nat. Patrick Wahl**

Institute of Training Science and Sport Informatics, German Sport University Cologne, Am Sportpark Müngersdorf 6, 50933 Cologne, Germany