

The effects of short-term detraining on exercise performance in soccer players

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The aim of the present study was to determine whether 1 week of training cessation can affect exercise performance in well-trained soccer players. Upon the completion of a competitive season, 11 male soccer players went through 1-week training cessation. Performances in the 5-m (1.05 ± 0.04 sec vs 1.02 ± 0.03 sec, $P=0.03$) and 10-m (1.79 ± 0.06 sec vs 1.74 ± 0.06 sec, $P=0.03$) sprints were significantly increased after 1 week of detraining with a trend for an increase in the 20-m sprint performance (3.07 ± 0.06 sec vs 3.02 ± 0.07 sec, $P=0.06$). However, the repeated sprint performance (total sprint time [45.7 ± 2.6 sec vs 48.0 ± 2.6 sec, $P=0.01$] and fatigue index [$5.8\% \pm 2.8\%$ vs $7.8\% \pm 3.2\%$; $P=0.04$]) were reduced. In addition, no significant differences were observed for the 30 m (4.23 ± 0.06 sec vs 4.24 ± 0.09 sec, $P=0.63$), agility (right:

8.08 ± 0.17 sec vs 8.03 ± 0.37 sec, $P=0.54$; left: 8.05 ± 0.21 sec vs 8.04 ± 0.30 sec, $P=0.84$), coordination (13.98 ± 1.21 sec vs 14.06 ± 1.34 sec, $P=0.75$), Yo-Yo intermittent recovery level 2 ($1,040.0 \pm 291.8$ m vs $1,134.5 \pm 232.7$ m, $P=0.08$), and knee extensors and flexors peak torques at all applied angular velocities ($P<0.05$) after detraining. These results indicate that short-term detraining for well-trained soccer players has a significant effect on the speed endurance performance. It is therefore important for the players and their coaches to plan a suitable training program to maintain exercise performance especially speed endurance during off-season.

Keywords: Soccer players, Detraining, Exercise performance


INTRODUCTION

Soccer players need to develop a high level of fitness to cover long distance on a large playing field without regular rest periods and perform technical skills through a match. During season, the players carry out high-intensity training to development and maintain fitness level due to its effectiveness in promoting numerous morphological and metabolic adaptations in the skeletal muscle (Morton et al., 2009) and conducting consecutive competitive matches. Consecutive high-intensity training and matches during season lead to mental and physical fatigues which impair ability to maintain optimal exercise performance. After the season, it is important for the soccer players to rest mentally and physically. Therefore, many soccer players take a break immediately after the season until the first preseason training without conducting intensive fitness training in between.

High level of fitness during season is a result of several physio-

logical adaptations in response to regular physical training that induce increase in the players' performance. The soccer coaches and players on the field believe that significant reduction in fitness level occurs if the players stop the soccer training sessions for just a couple of days. Indeed, detraining can cause a partial or complete loss of training-induced adaptations in response to an insufficient training stimulus (Mujika and Padilla, 2000). However, there have been very few studies conducted to determine the effects of short-term detraining (less than 1 week of insufficient training stimulus) on the soccer players' fitness level.

Several studies have shown that more than 1 week of training cessation caused decrease in the exercise performance and affected the expression of molecular factors associated with the effects of exercise training in soccer players (Melchiorri et al., 2014; Thomassen et al., 2010). However, Burgomaster et al. (2007) indicated that 1 week of detraining of active male subjects after 6 weeks sprint interval training program did not change in the 250-kJ

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Received: December 28, 2015 / Accepted: February 4, 2016

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self-paced laboratory time trial on an electronically braked cycle ergometer. According to previous studies, 1 week of training cessation may not cause marked decreases in exercise performance and may be helpful in mental recovery of the soccer players. The aim of this study, therefore, was to determine whether 1 week of training cessation can affect exercise performance in soccer players accustomed to performing repeated high-intensity exercise. It was hypothesized that 1 week of detraining after the season would not lead to decrease in exercise performance.

MATERIALS AND METHODS

Subjects

Eleven male soccer players volunteered to participate in the study (mean \pm standard deviation [SD]: age, 22 ± 2 yr; height, 174 ± 6 cm). All players were members of a university team. After a full and detailed explanation of the study procedures, all subjects gave written informed consents to participate. All of the experimental protocols and related procedures were approved by the Ethical Committee of Honam University.

Experimental procedures

The 1-week detraining period started immediately after the last match of the season. The subjects completed the 30-m sprint test, Yo-Yo intermittent recovery level 2 (Yo-Yo IR2) test, arrowhead agility test, coordination test, repeated sprint test (RST), and isokinetic strength test. The tests were carried out for 2 days, i.e., on the day of the test, which was after the detraining period, the participants arrived at the laboratory having completed the appropriate diet regime to monitor the diet level. The participants were instructed to ingest water 5 mL of water for every kilogram of their body mass 2 hr before arriving at the laboratory. Upon the arrival at the laboratory, body mass (kg; InBody 520, InBody Co., Seoul, Korea) and height (BSM, InBody Co.) were measured. Following the completion of the baseline assessments, the participants commenced the tests. 30-m sprint test, arrowhead agility test, coordination test, and RST were performed in the morning and Yo-Yo IR2 was carried out in the evening with 5 hr of recovery. Isokinetic strength test were performed on the next day.

30-m sprint test

The sprint tests which consisted of 2 maximal sprints of 30 m with 2-min rest between each sprint were conducted. The sprint times at 5, 10, 20, and 30 m were recorded using the photocell gates (Witty, Microgate, Bolzano, Italy). The participants started

to run 50 cm before the photocell gate recordings. The fastest times at the distances were recorded for data analysis.

Yo-Yo IR2

The Yo-Yo IR2 test was performed on an artificial turf. The Yo-Yo IR2 test consists of 2×20 -m shuttle runs at increasing speeds, controlled by audio signals from a compact disk. Between each bout of running, the subjects completed 10 sec of active recovery, consisting of 2×5 -m jogging. The test was terminated when the subjects failed twice to reach the start line on time and the distance covered at the end point was recorded.

Arrowhead agility test

The protocol of the arrowhead agility test is shown in Fig. 1. The arrowhead agility tests consisted of 4 sprints (two right, two left), with 2-min rest between each sprint. Each subject started 50 cm behind the start line and sprinted 10 m forward to point A on the diagram. From point A, the subjects turned to point B before turning to point C, and from point C, they turned again from point C to accelerate in a straight line for 15 m over the initial start line to complete the run. The fastest times were recorded for

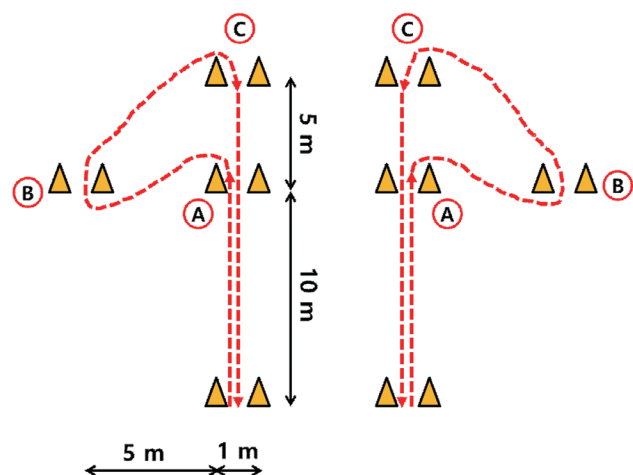


Fig. 1. Arrowhead agility test.

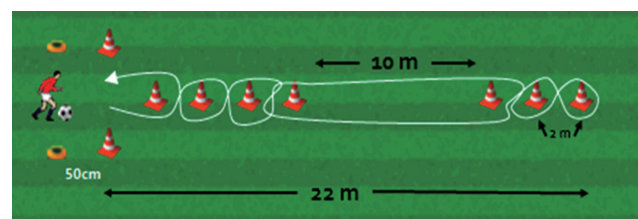


Fig. 2. Coordination test.

data analysis. Timing gates were used to accurately assess the time to completion.

Coordination test

The protocol of the coordination test is shown in Fig. 2. The subjects completed the 44-m slalom dribble twice with 5-min rest between each test. Each subject started 50 cm behind the start line and dribbled a soccer ball around 14 cones. If the subject touches the cones, 2 sec were added to the recording time. The fastest times were recorded for data analysis. Timing gates were used to accurately assess the time to completion.

Repeated sprint test

The protocol of RST is shown in Fig. 3. The protocol consisted of seven maximal 34.2-m sprints, interspersed by 25 sec of active recovery (40-m jogging distance). Recovery was timed so that the subjects returned to the start line between the 23rd and 24th second. Additionally, verbal feedback was given at 5, 10, 15, and 20 sec of the recovery. Performance was measured as the total sprint time in seconds and fatigue index. A sprint fatigue index was calculated as $SFI = (\text{slowest sprint time} - \text{fastest sprint time}) / \text{fastest sprint time} \times 100\%$.

Isokinetic strength

The subjects performed the isokinetic dynamometry (Cybex MET-300, Cybex International Inc., Medway, MA, USA) to evaluate the unilateral strength of the concentric contraction of the

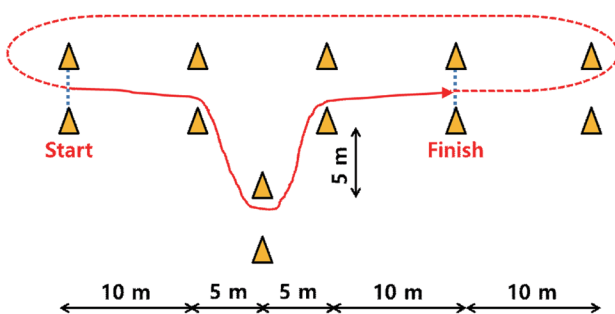


Fig. 3. Repeated sprint test.

Table 1. Body weight of the subjects before and after the 1-week detraining period (n = 11)

	Pre	Post
Body weight (kg)	69.4±6.8	70.1±6.9*

Values are presented as mean ± standard deviation.

* $P < 0.05$, significantly different from Pre.

flexors and extensors of the knee (Kılınc et al., 2015). The angular speed parameters of $60^\circ \times s^{-1}$, $180^\circ \times s^{-1}$, and $240^\circ \times s^{-1}$ were used for the measurements. The results of the measurements were expressed in absolute peak torque (Nm) for the purposes of the off-seasonal variation comparisons.

Statistical analysis

All data are presented as mean ± SD. Any systematic changes in body weight, sprint (5 m, 10 m, 20 m, and 30 m), agility (right, left), coordination, speed endurance (total sprint time, SFI), Yo-Yo IR2 (running distance) and isokinetic strength were assessed using paired *t*-test. The $P < 0.05$ criterion was used to indicate statistical significance.

RESULTS

Body weight

Change in body weight is presented in Table 1. Body weight increased significant after 1 week of detraining period (69.4 ± 6.8 kg vs 70.1 ± 6.9 kg, $P = 0.03$).

Sprint, agility, and coordination

Performances in the 5-m ($P = 0.03$) and 10-m ($P = 0.03$) sprint tests improved after 1 week of detraining (Table 2). Similarly, there was a trend for an increase in 20-m sprint performance ($P = 0.06$). However, no significant differences were observed after the detraining period for the 30 m ($P = 0.63$), agility (right, $P = 0.54$; left, $P = 0.84$) and coordination ($P = 0.75$) tests.

Speed endurance

After 1 week of detraining, performance in RST was reduced (Fig. 4). Longer total sprint time (45.7 ± 2.6 sec vs 48.0 ± 2.6 sec,

Table 2. Sprint, agility, and coordination before and after the 1-week detraining period (n = 11)

Variable	Pre	Post
Sprint		
5 m	1.05±0.04	1.02±0.03*
10 m	1.79±0.06	1.74±0.06*
20 m	3.07±0.06	3.02±0.07
30 m	4.23±0.06	4.24±0.09
Arrowhead agility test		
Right	8.08±0.17	8.03±0.37
Left	8.05±0.21	8.04±0.30
Coordination test	13.98±1.21	14.06±1.34

Values are presented as mean ± standard deviation.

* $P < 0.05$, significantly different from Pre.

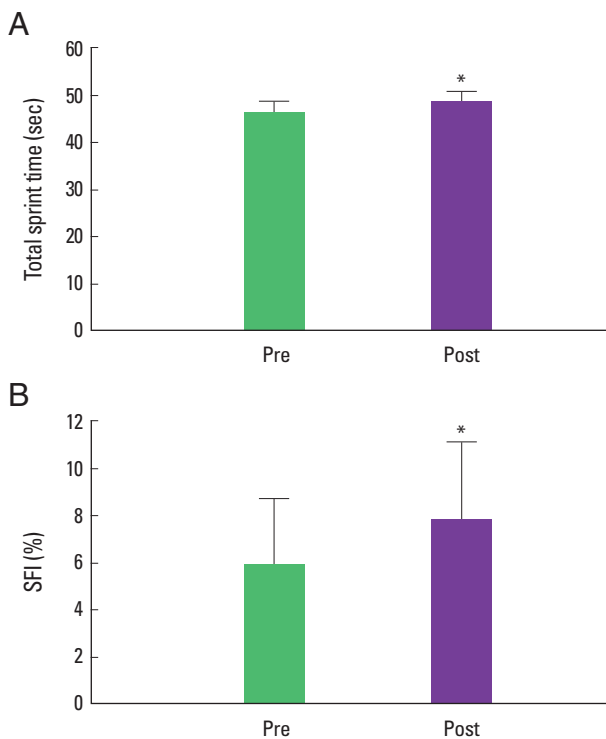


Fig. 4. Total sprint time (A) and sprint fatigue index (SFI) (B) in repeated sprint test before and after the 1-week detraining period (n = 11). Values are presented as mean ± standard deviation. **P* < 0.05, significantly different from Pre.

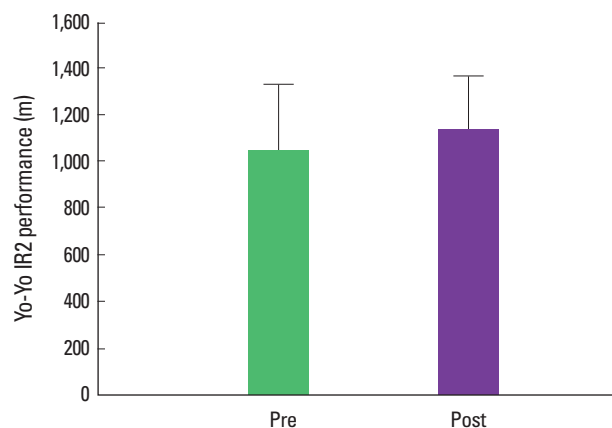


Fig. 5. Yo-Yo intermittent recover level 2 (Yo-Yo IR2) before and after the 1-week detraining period (n = 11). Values are presented as mean ± standard deviation.

P = 0.01) and higher SFI (5.8% ± 2.8% vs 7.8% ± 3.2%, *P* = 0.04) were observed after the detraining period.

Yo-Yo IR2 test

The changes in the Yo-Yo IR2 performances before and after the detraining period were 1,040.0 ± 291.8 and 1,134.5 ± 232.7

Table 3. Peak torques (Nm) during concentric knee flexion and extension before and after the 1-week detraining period (n = 11)

Variable	Pre	Post
DL-PT-E-60	207.3 ± 27.8	203.4 ± 27.3
DL-PT-F-60	127.9 ± 26.5	131.0 ± 25.6
NL-PT-E-60	198.1 ± 28.0	188.7 ± 23.3
NL-PT-F-60	121.9 ± 39.7	132.3 ± 23.5
DL-PT-E-180	145.2 ± 23.6	144.7 ± 12.3
DL-PT-F-180	101.5 ± 21.7	101.5 ± 23.6
NL-PT-E-180	138.1 ± 16.5	137.1 ± 15.6
NL-PT-F-180	102.7 ± 16.6	104.8 ± 21.8
DL-PT-E-240	116.2 ± 16.2	119.3 ± 12.1
DL-PT-F-240	86.1 ± 14.5	88.7 ± 16.1
NL-PT-E-240	115.2 ± 10.8	108.7 ± 16.8
NL-PT-F-240	86.9 ± 16.2	91.2 ± 19.3

Values are presented as mean ± standard deviation. DL, dominant leg; NL, nondominant leg; PT, peak torque; E, extensors; F, flexors; 60, 180, 240; angular velocities (°·s⁻¹)

m, respectively (Fig. 5). There was no significant difference in the Yo-Yo IR2 performance (*P* = 0.08).

Isokinetic strength

Peak torques for the flexion and extension of the dominant and nondominant lower legs measured at two occasions are presented in Table 3. No changes in the knee extensors and flexors peak torques at all applied angular velocities were observed after the detraining period (*P* < 0.05).

DISCUSSION

The findings from the present study indicated that 1 week of detraining improved performances in the 5- and 10-m sprints, impaired performance in RST, and no changes in Yo-Yo IR2 and isokinetic strength. Furthermore, 1 week of detraining resulted in an increase in body weight.

The present study shows that Yo-Yo IR2 performance was not changed during the 1-week detraining period. These results are inconsistent with previous findings where 2 and 3 weeks of training cessation led to decrease in Yo-Yo IR2 performance in the soccer players (Nakamura et al., 2012; Thomassen et al., 2010), even if the total distances (845 ± 48 and 860 ± 120 m) before the cessation training were lower compared with current study (1,040 ± 291 m). Theoretically, Yo-Yo IR2 performance should be reduced after a period of training cessation since the magnitude of decrease in the fitness level was greater in highly trained athletes compared with untrained by inadequate training intensity and

detraining (Krustrup et al., 2006; Mujika and Padilla, 2000). The reasons for the disparate results are not clear, but differences are likely to be related to the detraining period after season. Indeed, Thomassen et al. (2010) indicated that 3 days of a short-term detraining did not significantly reduce Yo-Yo IR2 performance. Similarly, the flexion and extension peak torques for the dominant and nondominant lower legs did not change in current study. Such results can be supported by the observations that the isokinetic concentric knee flexion and extension force did not significantly reduce after 2 weeks and 3 weeks without training (Lehnert et al., 2014; Mujika and Padilla, 2000).

Repeated high-intensity exercise performance is associated with energy generation through the aerobic energy system (Bangsbo et al., 2001). Tomlin and Wenger (2002) reported that there was a significant relationship between maximal oxygen uptake and performance in RST. The RST performance (total sprint time and SFI) was reduced after the 1-week detraining period in the present study. Consistent with present study, Christensen et al. (2011) observed longer total sprint time after a 2-week detraining period although the fastest sprints (3.14 ± 0.08 and 3.15 ± 0.14 sec) remain the same. However, SFI did not change as in the previous study. The reasons for such discrepancy are unclear but could be associated with difference in the test method (10 maximal 20-m sprints vs 7 maximal 34.2-m sprints). Decrease in the RST performance with short-term detraining is thought to be related to the detraining-induced changes for the adaptation on the cellular and molecular level. For example, 2 weeks of cessation of training led to a decrease in the resting phosphorylation status of the $\text{Na}^+ - \text{K}^+$ pump, which may play an important role in the repeated high-intensity exercise performance (Thomassen et al., 2010). Further research is needed to examine the relationship between exercise performance and cellular and molecular adaptation responses to short-term detraining in trained athletes.

Unlike the reduced RST performance responses to a 1-week detraining period, performances in sprint, agility, and coordination did not decrease after the detraining period. These results were similar with several previous studies which have indicated that short duration and high-intensity exercise performances did not change after a short-term training cessation (<4 weeks) (Herrero et al., 2006; Nakamura et al., 2012). These results indicate that anaerobic exercise performance may not be sensitive to short-term detraining in the trained soccer players. However, short-term detraining improved performance of the 5- and 10-m sprints in the present study. Several possibilities may explain these findings in the trained athletes. It is possible that the reason for the increase

in sprint performance could be related to recovery from accumulated fatigue through the soccer season. Indeed, several participants expressed better physical condition to complete the sprint performance after the 1-week training cessation period. Another possible mechanism for increased sprint performance after detraining is likely to be related to the adaptation in the anaerobic enzyme activities in human skeletal muscle. Limited work to date has been undertaken to determine the impact of short-term detraining on the anaerobic exercise performance and anaerobic enzyme activities in human skeletal muscle. Future studies are, therefore, required.

In summary, our results show that 1 week of detraining of well-trained soccer players did improve sprint performance (5 and 10 m), whereas, RST performance was reduced after the short-term detraining period. On the other hand, isokinetic concentric knee flexion and extension torques and Yo-Yo IR2 performance did not change. These findings suggest that 1 week of training cessation can reduce speed endurance in well-trained soccer players. Therefore, the players and their coaches should plan suitable and appropriate training program to maintain exercise performance during the off-season.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ACKNOWLEDGMENTS

This study was supported by research fund from Honam University, 2015.

REFERENCES

- Bangsbo J, Krustrup P, González-Alonso J, Saltin B. ATP production and efficiency of human skeletal muscle during intense exercise: effect of previous exercise. *Am J Physiol Endocrinol Metab* 2001;280:E956-964.
- Burgomaster KA, Cermak NM, Phillips SM, Benton CR, Bonen A, Gibala MJ. Divergent response of metabolite transport proteins in human skeletal muscle after sprint interval training and detraining. *Am J Physiol Regul Integr Comp Physiol* 2007;292:R1970-1976.
- Christensen PM, Krustrup P, Gunnarsson TP, Küllerich K, Nybo L, Bangsbo J. VO₂ kinetics and performance in soccer players after intense training and inactivity. *Med Sci Sports Exerc* 2011;43:1716-1724.
- Herrero JA, Izquierdo M, Maffiuletti NA, García-López J. Electromyo-

- stimulation and plyometric training effects on jumping and sprint time. *Int J Sports Med* 2006;27:533-539.
- Kılınç BE, Kara A, Camur S, Oc Y, Celik H. Isokinetic dynamometer evaluation of the effects of early thigh diameter difference on thigh muscle strength in patients undergoing anterior cruciate ligament reconstruction with hamstring tendon graft. *J Exerc Rehabil* 2015;11:95-100.
- Krustrup P, Mohr M, Nybo L, Jensen JM, Nielsen JJ, Bangsbo J. The Yo-Yo IR2 test: physiological response, reliability, and application to elite soccer. *Med Sci Sports Exerc* 2006;38:1666-1673.
- Lehnert M, Psotta R, Chvojka P, Ste Croix MD. Seasonal variation in isokinetic peak torque in youth soccer players. *Kinesiology* 2014;46:79-87.
- Melchiorri G, Ronconi M, Triossi T, Viero V, De Sanctis D, Tancredi V, Salvati A, Padua E, Alvero Cruz JR. Detraining in young soccer players. *J Sports Med Phys Fitness* 2014;54:27-33.
- Morton JP, Croft L, Bartlett JD, Maclaren DP, Reilly T, Evans L, McArdle A, Drust B. Reduced carbohydrate availability does not modulate training-induced heat shock protein adaptations but does upregulate oxidative enzyme activity in human skeletal muscle. *J Appl Physiol* (1985) 2009;106:1513-1521.
- Mujika I, Padilla S. Detraining: loss of training-induced physiological and performance adaptations. Part I: short term insufficient training stimulus. *Sports Med* 2000;30:79-87.
- Nakamura D, Suzuki T, Yasumatsu M, Akimoto T. Moderate running and plyometric training during off-season did not show a significant difference on soccer-related high-intensity performances compared with no-training controls. *J Strength Cond Res* 2012;26:3392-3397.
- Thomassen M, Christensen PM, Gunnarsson TP, Nybo L, Bangsbo J. Effect of 2-wk intensified training and inactivity on muscle Na⁺-K⁺ pump expression, phospholemman (FXD1) phosphorylation, and performance in soccer players. *J Appl Physiol* (1985) 2010;108:898-905.
- Tomlin DL, Wenger HA. The relationships between aerobic fitness, power maintenance and oxygen consumption during intense intermittent exercise. *J Sci Med Sport* 2002;5:194-203.