Original Article

Effects of a soccer training session fatigue on balance ability

ASIMENIA GIOFTSIDOU , PARASKEVI MALLIOU, GEORGE PAFIS, ANASTASIA BENEKA, GEORGE GODOLIAS

Department of Physical Education and Sports Science, Democritus University of Thrace, Greece

ABSTRACT

Gioftsidou A, Malliou P, Pafis G, Beneka A, Godolias G. Effects of a soccer training session fatigue on balance ability. *J. Hum. Sport Exerc.* Vol. 6, No. 3, pp. 521-527, 2011. The purpose of the present study was to investigate the effects of a soccer training session on the balance ability of the young soccer players. Participants were twenty-six young soccer players. Standard testing balance boards and Biodex Stability System were used to assess balance ability before (pre-training) and immediately after (post-training) the completion of a soccer training session. Also, Isokinetic knee joint moment measurements (60°/sec and 180°/sec) were carried out pre- and post-soccer training. The results revealed that no differences ($p>0.05$) were found in balance ability and knee joint moment production between pre- and post-soccer training. Result is in contrast to the notion of a link between fatigue induced by a soccer training session or game and injury caused by impaired balance. **Key words**: PROPRIOCEPTION, BALANCE BOARDS, BALANCE TEST.

Corresponding author. Department of Physical Education and Sports Science. Democritus University of Thrace. Campus, 69100 Komotini, Greece.
E-mail: agioftsi@phyed.duth.gr
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INTRODUCTION

Soccer is a contact sport associated with an increased preponderance of injuries (Inklaar et al., 1996; Dvorak, 2000; Morgan & Oberlander, 2001; Junge & Dvorak, 2004). Epidemiological research into soccer injuries has consistently reported joint sprains to be a primary injury type, with approximately 20% of all injuries attributed to joint sprains (Hagglund et al., 2004; Hawkins et al., 2001). In particular, the knee and ankle joints accounted for 34% of all injuries in the Football Association audit, with the most common type being a joint sprain injury.

Hawkins et al. (2001) reported significantly more injuries to the dominant leg, which has previously been attributed to greater exposure to forced inversion and eversion in jumping and kicking activities (Ekstrand & Gillquist, 1982). Moreover, Woods et al. (2003) suggested that the high incidence of joint sprains might also be attributed to the specific running requirements in soccer. The above mentioned injury causes are related to the activity profile of soccer match-play which is multi-directional and irregular in both intensity and duration.

In addition to highlighting the primary injury types and sites, epidemiological research has also examined the time pattern of injury incidence during soccer matchplay. Most injuries occur in the second half of a game (Hoy et al., 1992; Hawkins & Fuller 1996, 1999), indicating that the higher intensity at the second half lead to injury. Similarly, Woods et al. (2003) reported that 48% of ankle sprain injuries were sustained in the last third of each half during matches. Aetiological risk factors associated with joint sprain injury incidence and severity (Barrack et al., 1989) include impaired proprioceptive capacity (Renstrom & Kannus, 2000) and postural stability (Murphy et al., 2003), suggesting that in the fatigued state the joint may fail to produce the appropriate muscular responses which have a protective function in maintaining joint stability (Rozzi et al., 2000).

Similar research has been carried out in experimental studies showing that muscular fatigue induced in the laboratory environment in sedentary individuals may adversely affect several motor performance indicators of their balance ability (Nardone et al., 1997; Johnston et al., 1998; Vuillerme et al., 2002; Yaggie & McGregor, 2002; Greig & Walker-Johnson, 2007). However, it is unknown whether the same applies to soccer players (who are accustomed to regular exposure to muscle fatigue), when fatigued in real conditions, as a result of a soccer game or training. Thus, the aim of the present study was to investigate whether a soccer training session with similar intensity to a real match, affects the players' balance ability.

MATERIAL AND METHODS

Subjects and protocol

The study was conducted on 26 young male soccer players (age 16±3 years; body mass 67±4 kg; body height 175±7 cm; mean ± SD) participating in the young championship of the first Greek division. All the participants were informed about the study, and they gave their written informed consent. They were free of injuries in the lower limbs for the past 1 year. The experimental procedures complied with the Helsinki declaration of 1975 and were approved by the Ethical Committee of the Democritus University of Thrace.

Training session

In the present study, fatigue was induced by a soccer-training session in an attempt to more directly relate to the mechanisms mediating the well-established high incidence of injuries towards the end of a match or a training session (Hoy et al., 1992; Hawkins and Fuller, 1996; Hawkins and Fuller, 1999; Hiemstra et al., 2001).

Balance assessment

Balance ability was assessed before and immediately after a high-intensity (at the middle of the week) soccer training session (pre-training and post-training, respectively). The balance ability assessment was performed with three different balance boards (boards 1a, 1b, and 2) and the Biodex Stability System (Biodex Medical Systems, USA; Arnold & Schmitz 1998; Testerman & van der Griend, 1999; Paterno et al., 2004). Board 1a restricted movement in the anteroposterior direction only, board 1b restricted movement in the medio-lateral direction only, and board 2 allowed movement in both antero-posterior and mediolateral directions. In the balance board tests, the subjects maintained single-limb stance for as long as possible. Three test trials were timed on each balance board and the best trial was considered for further analysis. In the Biodex test, the participants maintained single-limb stance for 20 s, with the Biodex platform set to freely move by up to 20° from level in any direction. From the variance of the platform displacement (°) in the antero-posterior and medio-lateral directions from level during the test (Figure 1). The Biodex system provided three different indices according to the direction of the deviations from the horizontal plane; the total stability index (SI), the anterior -posterior index (API) and the medial-lateral index (MLI) (Rozzi et al, 1999). Three test trials were carried out and the one with the lowest Ii (best performance) was further processed.

Figure 1. *The platform of the Biodex stability system.*

Dynamometric assessment

Measurements of peak isokinetic moment in the knee flexors and extensors were performed pre-training and post-training to quantify the degree of muscle fatigue induced by the soccer training session. The subjects were secured with straps on the seated position on the chair of an isokinetic dynamometer (Cybex 6000, USA) at a hip joint angle of 110° (180° is the supine position), with the dynamometer lever and knee joint axes being visually aligned. After a standardized warm-up, three successive cycles of maximal effort knee extension–flexion concentric contractions were performed at two different angular velocities, first at 60°/s and then at 180°/s. More than one angular velocity was examined to assess whether the soccer training session would affect the production of muscular force similarly in slower and faster contractions. The two tests were performed ~2 min apart, and the two legs were tested ~5 min apart. Visual feedback of the recorded joint moment values was provided. For each angular velocity, muscle group and leg, the contraction with the highest peak moment value was considered for further analysis.

Statistics

Two-way repeated measures ANOVA was used to test for differences in (a) isokinetic performance at the velocities examined between pre-training and post-training (2·2), (b) balance ability between pre-training and post-training (2·2). The level of statistical significance was set at $p<0.05$.

RESULTS

The isokinetic joint moment measurements post-training were lower by 8-11% than pre-training ($p>0.05$; Table 1). This had no effect ($p>0.05$) on any of the balance performance indicators examined (Table 2). In agreement with previous reports (Pincivero et al., 1995; Johnson et al., 2005), intraclass correlation coefficient values for two measurements taken in the same day ($p>0.05$, Student's t-test) were 0.74 for the Biodex test, 0.72 for the board 1a test, 0.78 for the board 1b test, and 0.67 for the board 2 test.

Table 1. *Isokinetic knee joint moment measurements.*

	Before soccer training		**After soccer training**	
Knee	**Right**	**Left**	**Right**	**Left**
Extensors at 60 deg/s (Nm)	195±33	195±41	178±37	179±38
Extensors at 180 deg/s (Nm)	128±21‡	125±16‡	113±11‡	109±19‡
Flexors at 60 deg/s (Nm)	112±26	109±25	103±25	98±25
Flexors at 180 deg/s (Nm)	85 ±17†	78±24†	76±15†	69±23†

Data are presented as the mean±SD. ‡ Indicates lower joint moments (p<0.001) than at 60°/s (for any given leg pre-training and post-training). † Indicates lower joint moments (p<0.01) than at 60°/s (for any given leg pre-training and post-training).

Table 2. *Balance assessment.*

	Before soccer training		**After soccer training**	
Leg	**Right**	**Left**	**Right**	**Left**
Total SI (°)	7.63 ± 3.57	7.54 ± 2.59	7.73 ± 3.72	7.65 ± 2.46
A/P SI (°)	5.65 ± 3.23	5.62 ± 3.02	5.78 ± 3.22	5.82 ± 3.03
ML SI (°)	4.08 ± 1.77	4.12 ± 1.34	4.15 ± 1.78	4.24 ± 1.31
Board 1a (sec)	5.38 ± 1.45	5.42 ± 2.23	5.26 ± 2.41	5.31 ± 2.48
Board 1b (sec)	6.42 ± 1.22	6.43 ± 2.31	6.31 ± 2.17	6.36 ± 2.25
Board 2 (sec)	4.36 ± 1.26	4.41 ± 2.72	4.27 ± 2.24	4.31 ± 2.65

DISCUSSION AND CONCLUSIONS

The main objective of this study was to investigate whether a soccer training session influences the players' balance ability. We found that there was no statistically significant effect of a soccer training session on the balance ability of the players. Similarly, Greig & Walker-Johnson (2007), found no significant effect on single limb balance ability after the completion of 90min treadmill protocol replicating the activity profile of soccer match-play. No other exercise protocols- which caused fatigue- have succeeded in replicating the physical demands of soccer match-play. For example, Adlerton et al. (2003) observed impaired balance after localised calf fatigue. Similarly, deterioration of balance ability in sedentary individuals as a result of fatigue was found after controlled, repeated ankle muscle contractions leading to complete exhaustion or joint moment reduction by at least 50% (Lundin et al., 1993; Nardone et al., 1997; Johnston et al., 1998; Yaggie & McGregor, 2002). In the present study, however, the extent and role of fatigue induced by a soccer training session in soccer players was studied in an attempt to more directly relate it to the mechanisms mediating the well-established high incidence of injuries toward the end of a match or a training session (Hoy et al., 1992; Hawkins & Fuller, 1996, 1999; Hiemstra et al., 2001).

As far as fatigue effect on muscle strenght is concerned, in contrast to the above experimental conditions, our dynamometric measurements in the knee extensor and flexor muscles revealed that soccer training reduced the contractile joint moment by only ~10%. Similar levels of knee muscle fatigue have recently been reported in response to exercise simulating the work rate of competitive soccer (Ranhama et al., 2003). Moreover, Small et al. (2010) reported that the performance of an exercise protocol designed to replicate the physiological and mechanical demands of soccer match-play (SAFT) did not change the concentric hamstring or quadriceps peak torque. Similarly, Greig (2008) reported no effect of the simulated soccer match-play protocol on either concentric hamstring or quadriceps peak torque.

The absence of substantial muscle fatigue following a soccer training session may justify the present finding of maintenance of balance ability. This latter result indicates that the function of relevant systems mediating postural control, including the muscular and proprioceptive systems (Nelson & Hutton, 1985; Skinner et al., 1986; Hagbarth & Macefield, 1995; Hiemstra et al., 2001; Vuillerme et al., 2002), is not compromised as a result of a soccer training session or game in trained individuals. Further tests are required to assess the applicability of our findings to additional muscles and balance performance indicators, but the present results suggest that the cause-and-effect hypothesis between fatigue-induced instability and high injury incidence in soccer may be unsustainable. The role of other factors that may need to be within certain ‘‘safety’’ limits in order to avoid an injury, e.g., explosive muscle power and reaction time, merits further investigation. To conclude, the present finding show that a soccer training session does not deteriorate the balance ability of the players, indicating that the hypothesis for a link between fatigue-induced instability and high injury incidence in soccer may be unsustainable.

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