EFFECTS OF A THREE WEEK SPORT SPECIFIC PLYOMETRICS TRAINING PROGRAM ON LEG PERFORMANCE OF MALE UNIVERSITY SOCCER PLAYERS

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The purpose of the study was to evaluate the effects of a plyometrics program (twice weekly) of leg performance on male university soccer players. Thirteen subjects were divided into two groups. Group 1 served as a control group and participated in normal soccer training only. Group 2 served as a plyometrics training group and participated in both regular soccer training and a plyometrics training program. Pre- and post-training data was collected from subjects on a force plate performing counter-movement jumps. After three-weeks of training, both the control group and the plyometrics group showed improved velocity of center of mass ($p<0.05$), however, the plyometrics group showed a greater improvement ($p<0.05$) than the control group. It was concluded that an appropriate short-term plyometrics training program could enhance leg performance.

KEY WORDS: soccer, plyometrics, jump training, sport-specific training

INTRODUCTION: The goal of plyometrics exercises is to train the nervous system so that the muscles, when lengthened, will react with maximal speed and rapidly shorten with maximal force (Chu, 1986). These exercises are characterized by the rapid pairing of eccentric to concentric muscle contractions, referred to as the stretch-shorten cycle. Stimulation of the stretch-shorten cycle triggers a neural response, which increases the force generation ability of the muscles (Lundin, 1985; Wilk et al., 1993). Past research has shown that 8-9 minutes of plyometrics training, for 6-weeks, can lead to neuromuscular improvements for university athletes (Polhemus et al., 1980; Polhemus & Burkhardt, 1980). The question from many sports specialists concerns the minimal number of weeks required to generate neuromuscular improvements using plyometrics. In regards to short-term studies, only low-limb protocols have been tested over 3-weeks (Fowler et al., 1995) or 4-weeks of training (Dean et al., 1998; Hutchinson et al., 1998). These studies have shown plyometrics to improve maximum power (Fowler et al., 1995); increase reaction time, leap height and power (Hutchinson et al., 1998); and improve time-based drills measuring acceleration, speed, and power (Dean et al. 1998). Given the limited number of short-term protocols, the purpose of this study was to examine the effects of a short-term, sport-specific plyometrics program on the velocity of the center of mass by male university soccer players.

METHODS: Thirteen athletes (mean age = 21 $\pm$ 2 years) volunteered to participate in 3-weeks of jump training. One group consisted of players (N=4) who participated in normal soccer training alone (control group). Another group consisted of players (N=9), who participated in normal soccer training combined with a plyometrics training program (experimental group). No base leg strength was mandatory for participation in the study since players had no injuries and were in competitive shape for in-season competition. Two common plyometrics exercises were used: a Two-Leg Alternate-Leg Bound and a Single-Leg Hop as described by Dintiman et al., 1998. Subjects performed sets of jumps over either half the soccer field (35-45 jumps) or over the full soccer field (70-90 jumps), followed by a hand-timed 1.5-2.0 minute rest interval. Session 1 included 1 set of 35-45 bounds and 2 sets of 35-45 hops (1 set of hops per leg). Session 2 included 1 set of 35-45 bounds, 1 set of 70-90 bounds, and 2 sets of 35-45 bounds (1 set per leg). Sessions 3, 4 and 5 involved 2 sets of 70-90 bounds and 2 sets of 35-45 hops (1 set per leg). Session 6 used 3 sets of 70-90 bounds and 2 sets of 35-45 hops (1 set per leg). Subjects were encouraged to jump with maximal intensity for height and distance. Proper technique was taught a week before training and emphasized during training. While the experimental group performed jump training, the control group participated in a self-directed, extended warm-up including light jogging, stretching, and some shooting and passing to keep warm for the main session of practice.

Lower-limb performance was evaluated using a model AMTI OR6-5-1 Force Plate with associated BioSoft (Version 1.0) software. A manual trigger was used to give a 3-second countdown before data was collected at a rate of 500 Hz, for 4 seconds by a 400 MHz Pentium computer. Three trials were collected for a counter-movement jump, which required subjects to assume an upright position, feet slightly apart and near the edges of the force plate. When cued, subjects performed a rapid knee flexion, dropping their body mass into a squat position. This action was immediately followed by an explosive knee extension so that the subject would explode upwards and forwards off the force plate. No height restriction was placed on the depth of the squat. During all jumps, subjects were required to hold their hands on their hips, to control for differences in jumping technique between trials, as recommended by Bobbert et al. (1987) and Kibele (1999). All subjects were verbally encouraged to jump with maximal effort, followed by a 10-20 second recovery. Only the maximal velocity of center of mass was used for statistical analysis for each subject.

RESULTS AND DISCUSSION: Analysis using a 2-way ANOVA with repeated measures on testing (pre- vs. post-testing) was performed to evaluate statistical improvements. The mean velocity of center of mass for the control group, produced during pre-testing was 256.792 $\pm$ 2.756 cm/s. During post-testing, the mean velocity for the control group increased to 262.337 $\pm$ 17.865 cm/s. This 2.16% improvement was statistically significant (p=0.02). The mean velocity for the experimental group during pre-testing was 245.407 $\pm$ 19.020 cm/s. For post-testing the mean velocity for the experimental group increased to 275.884 $\pm$ 15.856 cm/s. This 12.42% improvement was also statistically significant (p=0.02). A statistical interaction was found (p=0.017) between group (experimental vs. control) and testing (pre- vs. post-testing). Velocity data was validated by Lees and Fahmi (1994). The gains observed during this study may be attributed to neural adaptations as a result of plyometrics training. EMG studies on the stretch-shorten cycle have shown increased EMG activity in the leg extensors during the eccentric phase (loading period), which is argued to improve muscle performance during the concentric stage (Aura & Komi, 1986). Other studies involving low-limb stretch-shorten tasks, also support the explanation that improved muscle performance is due to neural adaptations, particularly involving neural reflex potentiation, as a result of a pre-stretch (Viitasalo & Bosco, 1982). During a pre-stretch the neural reflex is potentiated, causing an increase in muscle stiffness. The stiffened muscle thereby increases the return of elastic energy during the concentric contraction to improve performance (Aura & Komi, 1986; Bosco & Komi, 1979; Bosco et al., 1981; Bosco et al., 1982a; Bosco et al., 1982b). Thus, plyometric training may have trained the neural reflex to increase muscle stiffness when stretched. A factor that may have contributed to effectiveness of this study may have been the rest period allowed before post-testing. At the completion of training, all players received 5 days of full rest before post-testing commenced. Since plyometrics focuses on neural training, this rest period may have facilitated greater neural adaptations in the plyometrics group than the control group. Research by Hakkinen et al. (1991) showed significant increases (p<0.05) in neural activation (averaged integrated EMG) and maximal voluntary isometric force for competitive athletes who performed a typical 2-week strength training program, followed by a 1-week period of reduced training. In fact, neural adaptations have been shown to occur in as little as 2 days (Prevost et al., 1999). In essence, the competitive soccer players, who directly trained the neuromuscular system, may have facilitated greater recovery during the 5-day reduced training period (rest).

Practical applications: This study indicates that plyometrics training improved leg performance to increase the velocity of center of gravity on a force plate. Consequently, soccer players may be able to run faster or jump higher after an appropriate training regime. The plyometrics program in this study was very practical since training was easily incorporated into a warm-up routine and lasted approximately 10-15 minutes at the beginning of practice. Plyometrics are also inexpensive, since they do not require any specialized equipment. Given the results of this study, coaches may consider incorporating plyometrics into a pre-season or tryout situation, to gain rapid improvements during pre-season preparations. It appears that an appropriate short-term plyometrics training program can enhance leg performance in as little as three weeks.

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