The Effect of Two Plyometric Training Techniques on Muscular Power and Agility in Youth Soccer Players

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Abstract

Thomas, K, French, D, and Hayes, PR. The effect of two plyometric training techniques on muscular power and agility in youth soccer players. (J Strength Cond Res 23(1): 332–335, 2009—The aim of this study was to compare the effects of two plyometric training techniques on power and agility in youth soccer players. Twelve males from a semiprofessional football club’s academy (age = 17.3 ± 0.4 years, stature = 177.9 ± 5.1 cm, mass = 68.7 ± 5.6 kg) were randomly assigned to 6 weeks of depth jump (DJ) or countermovement jump (CMJ) training twice weekly. Participants in the DJ group performed drop jumps with instructions to minimize ground-contact time while maximizing height. Participants in the CMJ group performed jumps from a standing start position with instructions to gain maximum jump height. Posttraining, both groups experienced improvements in vertical jump height (p < 0.05) and agility time (p < 0.05) and no change in sprint performance (p > 0.05). There were no differences between the treatment groups (p > 0.05). The study concludes that both DJ and CMJ plyometrics are worthwhile training activities for improving power and agility in youth soccer players.

Key Words: plyometrics, depth jump, countermovement, stretch-shortening cycle

Introduction

Plyometric training—jumping, bounding, and hopping exercises that use the stretch shortening cycle of the muscle unit—have consistently been shown to improve the production of muscle force and power (15,30). In particular, the fast force production of the trained muscle improves, coupled with smaller increases in maximum isometric force (15). These physiological adaptations have facilitated increases in vertical jump height and decreases in sprint and acceleration times (8,14,30,31) and decreases in sprint and acceleration times (10,18,26,30).

Some research in plyometrics has investigated the effect of exercise mode on performance. Countermovement jump (CMJ) and depth jump (DJ) training have both improved vertical jump height, with no significant difference between the two modalities (8,14,17). Bobbert (4) has speculated that using CMJ or DJ techniques may result in differences in training adaptations, arguing that a DJ would trigger improvement in the power output capacity of muscles, whereas repetition of the CMJ would improve coordination. Young et al. (34) attempted to investigate these assumptions, but their study was hampered by an inadequate training volume and intensity.

The potential improvements from plyometrics as measured by vertical jump and sprint performance would be beneficial to soccer (2,23). The basic movement patterns in soccer also require high levels of agility (11,24). Agility requires rapid force development and high power output, as well as the ability to efficiently utilize the stretch shortening cycle in ballistic movements (21). Plyometric training has been shown to improve these requirements (1,5,15), and Besier et al. (3) have recommended the inclusion of plyometrics in soccer training to familiarize players with unanticipated changes in direction. The aim of the present study was to compare the effectiveness of CMJ and DJ plyometric training modalities on muscular power and agility in soccer players.

Methods

Experimental Approach to the Problem

Using a randomized, between-group design, 12 soccer players were assessed for leg power, sprint speed, and agility pre and post 6 weeks of DJ or CMJ training.

Participants

After institutional ethics approval, 15 males from a semi-professional soccer academy gave written informed consent to take part in the study after completion of a screening questionnaire. Parental consent was obtained for participants under 18 years of age. The study was conducted in season, where participants attended soccer training two to four times per week and played competitive matches at least once.
a week. All participants had been involved in soccer training of this regularity for > 4 years before the study. Participants were randomly assigned to DJ and CMJ jump groups. Twelve participants (age = 17.3 ± 0.4 years, height = 177.9 ± 5.1 cm, weight = 68.7 ± 5.6 kg) successfully completed the study.

Procedures

Training. Plyometric training was undertaken twice a week for 6 weeks. Participants in the CMJ group performed exercises that always began with a countermovement, defined as a flexion of the knees. During rebound exercises, participants in this group were told to “damp” their landings each time and to gain maximum height through knee flexion. Participants in the DJ group performed exercises that always began with a drop from a height (40 cm). Participants in the DJ group were instructed to minimize ground-contact time while maximizing height. These instructions were emphasized during every session through the use of demonstrations, verbal cues, and exercise sheets.

The intensity of each program was subjectively equated using Chu’s (7) and Potach and Chu’s (22) classification of plyometric exercise intensities. The type of exercise that each group performed was matched by intensity and, where possible, by similar jumps. The height of the DJ box remained at 40 cm to ensure that intensity increased as a function of exercise and not as a function of increased eccentric load, which could not be manipulated in the CMJ condition. Sessions began at 80 foot contacts and progressed to 120 by the end of training (22). The program was incorporated into their usual twice-weekly training regime. Participants also continued their usual competitive program of matches. Participants were asked to refrain from any other form of training that could affect the variables measured.

Testing. Participants were tested pre and post the 6-week training period. Before testing, participants performed a 5-minute warm-up protocol consisting of submaximal running, active stretching, and jumping exercises. This warm-up was chosen because of its positive effects on power production (32). Table 1 shows the test-retest limits of agreement and intraclass correlations for each dependent variable.

Countermovement vertical jump height (cm) was measured using a vertical jump mat and belt (Takei Jump Meter, Japan). Participants were instructed to keep their hands on their hips at all times and were permitted two trials (> 15 seconds of recovery) to practice jumping technique followed by two recorded jumps. Light gates were used to measure sprint speed and agility (NewTest, Kiviharjuntie, Finland). Sprint speed from a standing start was assessed for 20 m with 5-m splits. Each participant completed three trials—one practice and two recorded with at least 4 minutes of recovery between each trial. The 505 agility test was employed to assess agility. The 505 agility test is designed to minimize the influence of individual differences in running velocities while accentuating the effect of acceleration immediately before, during, and after the change of direction (11). Participants completed three trials each—one practice and two recorded with at least 4 minutes of recovery between each trial.

Statistical Analyses

Descriptive statistics are represented as mean (SD). The mean of the recorded jumps was used as the score for CMJ height. The best times for 5, 10, 15, and 20 m were used as the final results (11). The fastest agility score was used in the analyses. Tests of normal distribution (Kolmogorov-Smirnov and Levene’s) were conducted on all data before analysis. All data were normally distributed (p > 0.05). A mixed-factorial ANOVA with repeated measures on one factor assessed main effects for time, group, and the time × group interaction. Effect size was calculated by training group for each outcome measure (difference between means/pooled SD). Post hoc statistical power calculations were performed using GPower software (12). Statistical significance was set at p ≤ 0.05. Data analysis was performed using SPSS (version 11.5, SPSS Inc., Chicago, Ill).

RESULTS

After 6 weeks of training, there were increases in vertical jump height (F [1, 10] = 42.22, p < 0.05, Figure 1) and decreases in agility times (F [1, 10] = 60.97, p < 0.05, Figure 2) for both

| Table 1. Limits of agreement (LOA) and intraclass correlations (ICC) for outcome measures. |
|---------------------------------|----------|----------|
|                                | LOA      | ICC      |
| 5 m (s)                        | 0.01 ± 0.12 | 0.93    |
| 10 m (s)                       | 0.01 ± 0.13 | 0.96    |
| 15 m (s)                       | 0.01 ± 0.18 | 0.94    |
| 20 m (s)                       | 0.01 ± 0.15 | 0.98    |
| Agility 505 (s)                | 0.01 ± 0.05 | 0.99    |
| CMJ (cm)                       | 1 ± 2     | 0.94    |

CMJ = countermovement jump.
groups. There were no changes in sprint speed \( F[1, 10] = 0.14, p > 0.05, \) Table 2) and no differences between the treatment groups at improving the variables measured.

For vertical jump height, DJ training resulted in a meaningful effect size of 1.1. Countermovement jump training resulted in a moderate-high effect size of 0.7. For agility, DJ and CMJ training resulted in meaningful effect sizes of 1.3 and 1.5, respectively. The post hoc statistical power for these analyses was low to moderate (23–73%).

**DISCUSSION**

The results of this study show that DJ and CMJ plyometric training can positively affect vertical jump and agility performance in soccer players, with no significant difference between modes.

Vertical jump height increased for both training groups. The improvement in jump height indicates that adaptations relating to increases in leg power have occurred. The adaptations to both forms of training are likely to be neural because these predominate in the early stages of strength and power training (29) and have been shown to be the main adaptation to plyometric exercise (15).

Time to complete the 505 agility test decreased for both groups. In contrast to straight sprinting, agility involves greater emphasis on deceleration and subsequent reactive coupling with acceleration (21). Leg muscle power has been moderately correlated with agility (19,20), as has reactive strength (33). Leg muscle power, as measured by the vertical jump, improved for both treatment groups. Neuromuscular adaptations related to firing frequencies and patterns are also likely to have occurred (15). These speculated adaptations could have improved the ability to rapidly and forcefully switch from decelerating to accelerating movements.

The magnitude of increases in strength and power after training has been shown to be dependent on how similar the test is to the actual training exercise (28), reflecting the role of learning and coordination (27). Although the participants were experienced soccer players, their previous training did not include any type of jump training or specific maximal-intensity change-of-direction exercises similar to those employed in the study. Thus, it is likely that a meaningful learning effect was present. Future studies should fully habituate participants to the testing procedures to control for this effect.

There were no differences in acceleration or sprint speed posttraining. These findings support studies showing no improvements in sprint speed after a plyometric program (13,31). Repeated ballistic exercise could potentially improve the ability to generate explosive ground-reaction forces (9,16). Ground-contact times in plyometric bounce DJ and CMJ activities have been reported from 300 milliseconds (6) to < 200 milliseconds, and > 400 milliseconds (34), respectively. In sprinting, ground-contact times decrease from < 200 milliseconds at acceleration to < 100 milliseconds at top speed (21). In terms of the velocity specificity principle of training, it is likely that the ground-contact times were not short enough to elicit an increased ability to generate explosive ground-reaction forces during sprinting.

There were no differences between the DJ and CMJ groups. There were differences in effect sizes between groups, suggesting that the two modes of training could have different magnitudes of effect on the performance variables measured. The small sample size, low statistical power, and short training period restrict any conclusions; however, this area warrants further research.

**Practical Applications**

There were no differences between treatment groups, indicating that both forms of training were effective. Depth
jump training is commonly thought to be a more effective training mode than CMJ (4,34), but no study has yet to show greater significant improvements in leg power compared with CMJ training (8,14,17). The results of this study highlight the potential of using both plyometric training techniques to improve the power-related components of soccer thought to be necessary for success (25).

REFERENCES