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THE EFFECTS OF NEUROMUSCULAR TRAINING ON POSTURAL STABILITY IN FEMALE INDIVIDUALS

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SUMMARY
The aim of this study was to evaluate the effects of neuromuscular training (NT) on postural stability in female individuals. Twenty female basketball amateurs were assigned into NT experimental group or control group by volunteer. All the players were underwent regular basketball practice, 90 minutes, 3 times per week for 6 weeks, but the NT experimental group underwent extra NT with plyometric and core training, 50 minutes, 3 times per week for 6 weeks during this period. The postural stability was evaluated by the 8-direction limits of stability (LOS) test. One factor ANCOVA was used to examine the differences between groups after training. The significant level for statistic was set at $p<.05$. Results showed that the right direction LOS scores at level 3 indicated a significant interaction between the trained/untrained groups × pre/post repeated measures with post-training scores higher than pre-training scores in the NT experimental group. The study demonstrated that Six weeks NT can improve the postural stability in young female individuals.

INTRODUCTION
Basketball is a high-intensity, aggressive body contact game of an intermittent nature, requiring frequent changes in movement, and it includes sprints, jumps, and quick stops. Plyometric training (PT) is a training technique used by athletes in sports such as football, basketball and soccer to increase muscle strength and explosiveness. PT typically includes bounding, hopping, and various jumps executed by one or two legs. PT are characterized by stretch shortening cycle (SSC) actions, which consists of the rapid stretching of a muscle (eccentric phase) immediately followed by the shortening of the same muscle and connective tissue (concentric phase). Studies demonstrated that the sports injury rate in female athletes was higher that male athletes, therefore, it is meaningful to find out a efficiency way to improve the female athlete's lower extremity musculature and the stability.

METHODS
Twenty female basketball amateurs volunteered to participate in the study and were randomly assigned to the NT experimental group (EG, age: 19.9 ± 1.2 yrs, height: 162.3 ± 3.5 cm, weight: 56.4 ± 5.4 kg,) or control group (CG, age: 20.0 ± 1.6 yrs, height: 162.4 ± 8.6 cm, weight: 55.7 ± 8.7 kg,). All participants completed a self-report health history questionnaire and signed a written informed consent before testing. All participants were screened for lower-extremity (ankle, knee, hips) bone and joint injuries and abnormalities as well as for conditions (i.e., concussion, inner-ear disorders, upper-respiratory infection, etc.) that may influence balance. Any participant self-reporting the presence of any injury or condition within the last 6 months was excluded from the study.

The NT program used in this study was adapted from previous studies included plyometrics and core strength training. The training program was conducted on Monday, Wednesday, and Thursday. Each training session lasted for approximately 50 minutes. Before each training session, an active warm-up that included jogging, backwards running, lateral shuffling, and carioca was used. At the end of each training session, the subjects performed self-selected stretching exercises for 10 minutes. The training period lasted a total of 6 weeks.

The plyometrics training component progressively emphasized double- then single leg movements through training sessions. The majority of the initial exercises involved both legs to safely introduce the subjects to the training movements. Early training emphasis was on sound athletic positioning that may help create dynamic control of the subject's center of gravity. The core strengthening component of the protocol followed an organized exercise selection specifically directed at strengthening the core stabilizing muscles. This component focused on providing an appropriate balance between developing the proprioceptive abilities of the subject and exposing the subject to inadequate joint control. The training progression took the subject through a combination of low- to higher-risk maneuvers in a controlled situation. The intensity of the exercises were modified by changing the arm position, opening and closing eyes, changing support stance, increasing or decreasing surface stability with balance training device (BOSU Balance Trainer, DW Fitness LLC, Madison, NJ), increasing or decreasing speed, adding unanticipated movements or perturbations, and adding sports-specific skills. Each NT exercise was demonstrated

by the instructor, with feedback given to the subject both during and after training. The NT stressed performance of athletic maneuvers in a powerful, efficient, and safe manner. The progressive nature of the NT was important to achieve successful outcomes from the training. The goal of the next training session was to continue to improve technique while increasing duration, volume, or intensity of the exercise.

The postural stability was evaluated by the 8-direction limits of stability (LOS) test. Subjects were tested bilaterally at two levels of difficulty: 3 and 6. To control for the learning effect and fatigue, the order of the tests was randomly assigned. The subject was instructed to start moving the cursor which accurately moves the display toward the flashing target at eight different directions. The LOS score was calculated for each direction according to the percentage between the straight line distance to target and the number of samples. Therefore, more direct the path to the target and back to center, the higher score will be achieved.

All statistical procedures were performed by using SPSS version for Windows 12 (Chicago, IL, USA). A mixed design, one-way ANCOVA was used to evaluate the difference between groups after training for each parameter. The statistic significance was set at $p < .05$.

RESULTS AND DISCUSSION

After six weeks of neuromuscular training, the overall LOS scores for the EG at levels 3 and 6 in pre- and post-training changed from 22.1±10.0 % to 27.2±12.9% and 26.5±8.6% to 35.6±12.0%, respectively. The overall LOS score for the CG at levels 3 and 6 in pre- and post-training changed from 25.2±12.4% to 23.8±7.5% and 31.3±10.2% to 31.1±10.9%, respectively. The results of the ANOVA for the right direction LOS scores at level 3 (Figure 1) indicated a significant interaction between the trained/untrained groups × pre/post repeated measures with post-training scores higher than pre-training scores in the EG (F=8.56, $p < .05$).

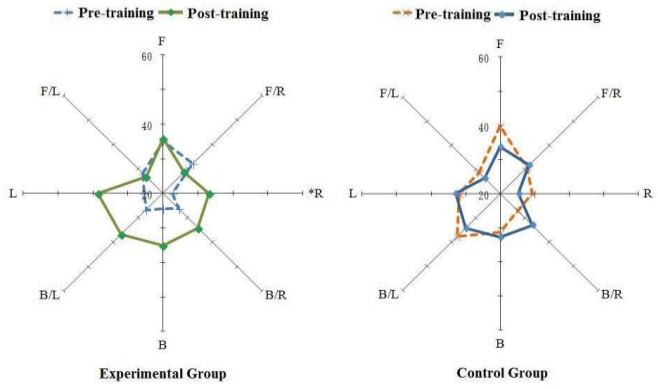

Figure 1: LOS scores in each direction between groups at level 3 before and after training.

Comprehensive neuromuscular training can lead to improvements in athletic performance and movement biomechanics. The main purpose of the present study was to evaluate the effects of six weeks of NT on LOS in female collegiate basketball athletes. The main findings of this study suggest that this kind of NT can improve LOS performance, as shown by the improvement in the dynamic LOS test, especially in the right directions during unstable situations.

The finding of a significant improvement in the right-direction performance on the unstable, level 3 LOS test indicates that a 6-week period of NT can improve postural stability in specific direction. This improvement could be due to enhanced neuromuscular coordination and neural adaptations between the CNS signal and proprioceptive feedback, or to better facilitation of neural impulses to the spinal cord. A previous study demonstrated that after PT, athletes had significant improvements in lower-extremity coronal plane mechanics parameters during both the drop vertical jump and medial drop landing movements, and suggested that this improvement could be related to awareness, feedback and adjustments made during the dynamic and fast-paced nature of the PT [2,3]. It is commonly assumed that core strengthening, PT, and jumping exercises can alter the movement patterns of athletes and lower the incidence of injury [1]. Our study provided further support for this hypothesis, since it showed that PT could facilitate voluntary active postural and lower extremity corrections during the unstable LOS test.

CONCLUSIONS

Six weeks regular NT can improve the postural stability in young female individuals. A dynamic NT program designed for the prevention of lower-extremity injuries can provide simultaneous improvements neuromuscular control, active joint stabilization, and increasing postural stability in female individuals.

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