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REVIEW ARTICLE

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Review of Literature on Plyometric Training

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Mani Azhagu (2001) conducted a study on the effects of varied intensities and frequencies of Plyometric training on speed, stride strength, stride frequency and anaerobic power among university men sprinters. To achieve the purpose of the study, 40 men students were selected at random from St. Joseph College Trichy belonging to the age group of 18 to 21 years. They were divided into 4 equal groups of 10 subjects each and assigned to experimental group I (80 percent intensity with 3 days frequency) experimental group II (80 percent intensity with 3 days frequency), experimental group III (70 percent intensity with 5 days frequency with 5 days frequency) and experimental group IV (70 percent intensity with 3 days frequency) relatively. Analysis of covariance and Scheffe's post hoc test were used to test the significant mean differences among the experimental groups. It was found that 80 percent intensity with 5 days frequency of Plyometric training would significantly improve the selected dependent variables, such as, speed, stride length, stride frequency and anaerobic power greater than 80 percent intensity with 3 days frequency and 10 percent intensity with 3 days frequency of Plyometric training among university men sprinters. This study reveals that high intensity contribute to the improvement of speed, stride length, stride frequency and anaerobic power among university men sprinters.

Kotzamanidis (2006) conducted a study to investigate the effect of plyometric training on running velocity (RV) and squat jump (SJ) in prepubescent boys. Fifteen boys (11.1 ± 0.5 years) followed a 10-week plyometric program (JUMP group). Another group of 15 boys (10.9 ± 0.7 years) followed only the physical education program in primary school and was used as the control group (CONT group). Running distances (0-10 m, 10-20 m, 20-30 m, and 0-30 m), were selected as testing variables to evaluate the training program. The total number of jumps was initially 60 per session, which was gradually increased over a period of 10 weeks to 100 per session. Results revealed significant differences between CONT and JUMP groups in RV and SJ. In JUMP group the velocity for the running distances 0-30, 10-20, and 20-30 m increased ($p < 0.05$), but not for the distance 0-10 m ($p > 0.05$). Additionally, the SJ performance of the JUMP group increased significantly, as well ($p < 0.05$). There was no change in either RV or SJ for the CONT group. These results indicate that plyometric exercises can improve SJ and RV in prepubertal boys. More specifically, this program selectively influenced the maximum velocity phase, but not the acceleration phase.

Miller et.al (2006) conducted to determine the effect of six weeks of plyometric training on athlete's agility. Subjects were divided into two groups, a plyometric training and a control group. The plyometric training group performed in a six week plyometric training program and the control group did not perform any plyometric training techniques. All subjects participated in two agility tests: T-test and Illinois Agility Test, and a force plate test for ground reaction times both pre and post testing. Univariate ANCOVAs were conducted to analyze the change scores (post - pre) in the independent variables by group (training or control) with pre scores as covariates. The Univariate ANCOVA revealed a significant group effect $F_{2,26} = 25.42$, $p=0.0000$ for the T-test agility measure. For the Illinois Agility test, a significant group effect $F_{2,26} = 27.24$, $p = 0.000$ was also found. The plyometric training group had quicker posttest times compared to the control group for the agility tests. A significant group effect $F_{2,26} = 7.81$, $p = 0.002$ was found for the Force Plate test. The plyometric training group reduced time on the ground on the posttest compared to the control group. The results of this study show that plyometric training can be an effective training technique to improve an athlete's agility.

Retna Raj (1994) conducted a study on the effect of varied frequencies of bench step exercise on selected physical and physiological variables. To achieve the purpose of the study, ninety boys were selected randomly from State Bank Officers Administration Higher Secondary School and divided into three groups, namely experimental group I, (two days per week training) experimental group II (three days per week training) and the control group were not given treatment. The experimental group were exercise in varied frequencies of eight weeks. The score was measured before and after the treatment periods for the physical and physiological variables, such as speed, agility, explosive power, breath holding time, resting pulse rate and mean arterial pressure. To find out the significant difference between the groups, the ANCOVA were applied. It was found out that varied frequencies of bench step exercises significantly improved the explosive power, breath holding time, resting pulse rate and mean arterial pressure. However, it was also found out that the bench step exercises did not bring any significant improvement on speed and agility.

Clutch et.al. (1983) conducted a study to determine the effect of depth jump and weight training on leg strength and vertical jump. and weight training on leg strength and vertical jump. For this two experiments were conducted. In the first experiment at the beginning of the weight training classes, undergraduate students were trained with three different jumping programmes. One maximum vertical jumps, two 0.20 mts depth jumps and three 0.75 mts and 1.10 mts depth jumps, in additional, all groups lifted weight also. In experimental two, a weight training calss and the volleyball team at Brigham Young University, Hamai were divided into two groups. One group lifted weights and performed 0.75 mts and 1.10 mts depth jumps. The other group only lifted weights. In experimental one, the three training programmes resulted in increases in one repetition maximum (1 RM) squat strength, isometric knee extension strength and vertical jump. However, there is no significant difference between treatments. In experiment two, group one made significant increase in vertical jump except the group of weight lifters who did not jumping. it was considered that depth jumps were effective but not more effective than a regular jumping routine.

Nejeebullah (1997) conducted a study on the comparative effect of Plyometric training on the performance of long jump and sprinting. To achieve the purpose of the study, 50 college men students of 17- 19 years age from Sri Sarvodaya College, Nellore, Andhra Pradesh were selected randomly. After the selection of the subjects, they were divided into two equal groups called long jump groups and sprint group, consisting 25 boys (n=25) in each group. Selected Plyometric exercises were given as training to both the experimental groups, three days in a week for a period of six weeks. ANCOVA was used as statistical technique to find out the significant mean difference due to the effect of training. It was found out that Plyometric training should significantly improve performances of both long jump and sprinting but the significant improvement level was more on long jumpers when compared to sprinters.

Selvi (1998) conducted a study on the effect of Plyometric, circuit training and NBA play on selected physical, physiological, haemotological and biochemical variables of Tamil Nadu Agriculture University women students. For the purpose of the study ninety women students studying in second and third year undergraduate courses were selected as subjects. The subjects were divided into three groups, each group consisting thirty subjects. Group one underwent a treatment for Plyometric training, Group II followed circuit training and group three followed NBA plan for a period of twelve weeks. After the experimental treatment of twelve weeks final reading was taken on the above variables. ANCOVA was employed to find out the comparative effect of each training. It was found out that all the physical and physiological variables were significantly improved through circuit training.

In a study Mc Bride et.al (2002) pointed out that training with light load jump squats have an increased movement velocity capability and that velocity specific changes in muscle activity may play a key role in the adaptation.

The purpose of this study was to examine the effect of an 8-week training program with heavy- vs. light-load jump squats on various physical performance measures and electromyography (EMG). Twenty-six athletic men with varying levels of resistance training experience performed sessions of jump squats with either 30% (JS30, n = 9) or 80% (JS80, n = 10) of their one repetition maximum in the squat (1RM) or served as a control (C, n = 7). An agility test, 20-m sprint, and jump squats with 30% (30J), 55% (55J), and 80% (80J) of their 1RM were performed before and after training. Peak force, peak velocity (PV), peak power (PP), jump height, and average EMG (concentric phase) were calculated for the jumps. There were significant increases in PP and PV in the 30J, 55J, and 80J for the JS30 group ($p \le 0.05$). The JS30 group also significantly increased in the 1RM with a trend towards improved 20-m sprint times. In contrast, the JS80 group significantly increased both PF and PP in the 55J and 80J and significantly increased in the 1RM but ran significantly slower in the 20-m sprint. In the 30J the JS30 group's percentage increase in EMG activity was significantly different from the C group. In the 80J the JS80 group's percentage increase in EMG activity was significantly different from the Control group.

Marcovic (2007) conducted a study to determine the precise effect of plyometric training (PT) on vertical jump height in healthy individuals. Meta-analyses of randomised and non-randomised controlled trials that evaluated the effect of PT on four typical vertical jump height tests were carried out: squat jump (SJ); countermovement jump (CMJ); countermovement jump with the arm swing (CMJA); and drop jump (DJ). Studies were identified by computerised and manual searches of the literature. Data on changes in jump height for the plyometric and control groups were extracted and statistically pooled in a meta-analysis, separately for each type of jump. A total of 26 studies yielding 13 data points for SJ, 19 data points for CMJ, 14 data points for CMJA and 7 data points for DJ met the initial inclusion criteria. The pooled estimate of the effect of PT on vertical jump height was 4.7% (95% CI 1.8 to 7.6%), 8.7% (95% CI 7.0 to 10.4%), 7.5% (95% CI 4.2 to 10.8%) and 4.7% (95% CI 0.8 to 8.6%) for the SJ, CMJ, CMJA and DJ, respectively. When expressed in standardised units (ie, effect sizes), the effect of PT on vertical jump height was 0.44 (95% CI 0.15 to

0.72), 0.88 (95% CI 0.64 to 1.11), 0.74 (95% CI 0.47 to 1.02) and 0.62 (95% CI 0.18 to 1.05) for the SJ, CMJ, CMJA and DJ, respectively. PT provides a statistically significant and practically relevant improvement in vertical jump height with the mean effect ranging from 4.7% (SJ and DJ), over 7.5% (CMJA) to 8.7% (CMJ). These results justify the application of PT for the purpose of development of vertical jump performance in healthy individuals.

Mikkola et.al (2007) conducted a study to investigate concurrent endurance and explosive strength training on electromyography (EMG) and force production of leg extensors, sport-specific rapid force production, aerobic capacity, and work economy in cross-country skiers. Nineteen male cross-country skiers were assigned to an experimental group (E, n = 8) or a control group (C, n = 11). The E group trained for 8 weeks with the same total training volume as C, but 27% of endurance training in E was replaced by explosive strength training. The skiers were measured at pre- and post training for concentric and isometric force-time parameters of leg extensors and EMG activity from the vastus lateralis (VL) and medialis (VM) muscles. Sport-specific rapid force production was measured by performing a 30-m double poling test with the maximal velocity (V(30DP)) and sport-specific endurance economy by constant velocity 2-km double poling test (CVDP) and performance (V(2K)) by 2-km maximal double poling test with roller skis on an indoor track. Maximal oxygen uptake (Vo(2)max) was determined during the maximal treadmill walking test with the poles. The early absolute forces (0-100 ms) in the force-time curve in isometric action increased in E by 18 +/- 22% ($p < 0.05$), with concomitant increases in the average integrated EMG (IEMG) (0-100 ms) of VL by 21 +/- 21% ($p < 0.05$). These individual changes in the average IEMG of VL correlated with the changes in early force ($r = 0.86$, $p < 0.01$) in E. V(30DP) increased in E (1.4 +/- 1.6%) ($p < 0.05$) but not in C. The V(2K) increased in C by 2.9 +/- 2.8% ($p < 0.01$) but not significantly in E (5.5 +/- 5.8%, $p < 0.1$). However, the steady-state oxygen consumption in CVDP decreased in E by 7 +/- 6% ($p < 0.05$). No significant changes occurred in Vo(2)max either in E or in C. The present concurrent explosive strength and endurance training in endurance athletes produced improvements in explosive force associated with increased rapid activation of trained leg muscles.

Kubok et.al (2007) conducted a study on the effects of Plyometric and weight training on muscle tendon complex and jump performance on 10 subjects who completed 12 wk of a unilateral training programme for planter flexors. They performed Plyometric training on one side and weight training on the other side. The tendon stiffness of the subjects was measured by using ultrasonography during isometric planter flexion. Three kind of unilateral jump heights using only ankle point on lady apparatus were measured. It was found relative increases in jump heights where significantly greater for PT that for WT. However, there were no significant differences between PT and WT in the changes in the electromyography activities of measured muscles during jumping. The researcher concluded that the jump performance gains after Plyometric training are attributed to changes in the mechanical properties of muscle tendon complex, rather than to the muscle activation strategies.

Luebbers et.al (2003) conducted a study on “Effects of Plyometric training and recovery on vertical jump performance and anaerobic power”. They examined the effects of 2 plyometric training programs, equalized for training volume, followed by a 4-week recovery period of no plyometric training on anaerobic power and vertical jump performance. Physically active, college-aged men were randomly assigned to either a 4-week (*n* = 19, weight = 73.4 ± 7.5 kg) or a 7-week (*n* = 19, weight = 80.1 ± 12.5 kg) program. Vertical jump height, vertical jump power, and anaerobic power via the Margaria staircase test were measured pretraining (PRE), immediately posttraining (POST), and 4 weeks posttraining (POST-4). Vertical jump height decreased in the 4-week group PRE (67.8 ± 7.9 cm) to POST (65.4 ± 7.8 cm). Vertical jump height increased from PRE to POST-4 in 4-week (67.8 ± 7.9 to 69.7 ± 7.6 cm) and 7-week (64.6 ± 6.2 to 67.2 ± 7.6 cm) training programs. Vertical jump power decreased in the 4-week group from PRE (8,660.0 ± 546.5 W) to POST (8,541.6 ± 557.4 W) with no change in the 7-week group. Vertical jump power increased PRE to POST-4 in 4-week (8,660.0 ± 546.5 W to 8,793.6 ± 541.4 W) and 7-week (8,702.8 ± 527.4 W to 8,931.5 ± 537.6 W) training programs. Anaerobic power improved in the 7-week group from PRE (1,121.9 ± 174.7 W) to POST (1,192.2 ± 189.1 W) but not the 4-week group. Anaerobic power significantly improved PRE to POST-4 in both groups. There were no significant differences between the 2 training groups. Four-week and 7-week plyometric programs are equally effective for improving vertical jump height, vertical jump power, and anaerobic power when followed by a 4-week recovery period. However, a 4-week program may not be as effective as a 7-week program if the recovery period is not employed.

DISCUSSION

The investigator in this study has reviewed twelve related literature on the effect of Plyometric training and nine related literatures on effects of yogic practices. There were researches on the effects of combined training groups also. The investigator also reviewed the effect of yoga asanas and other training methods on selected physiological, psychological and motor variables in this paper.

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