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P-091
Effect of plyometric training on vertical jump performance and neuromuscular adaptation in volleyball players

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OBJECTIVE Successful sporting performance at elite competition levels often depends heavily on explosive leg power of the athletes involved. Volleyball players rely heavily upon anaerobic energy systems to supply energy demands. Successful participation in volleyball requires athletes be able to propel themselves into the air during both offensive and defensive maneuvers. Although, in relation to enhancing VJ performance, plyometric training has been helpful, the effects of such training on neuromuscular responses have yet received less attention. Because there is no specific research on the efficacy of plyometric training on neuromuscular responses, the purpose of this study was to examine the effects of plyometric training on vertical jump performance and neuromuscular adaptation in volleyball players.

METHODS A semi experimental research was conducted. Statistical methods were t tests and two way ANOVA. Thirty male volleyball players (Age: 17.53 ± 0.74 yrs; Height: 177.7 ± 3.1 cm; Weight: 61.31 ± 5.32 kg), who had a minimum of two-years volleyball training volunteered to participate in a 12-week plyometric training program. The subjects were divided into plyometric training (PT) (n=15) and control (C) (n=15) groups, based on vertical jump heights.

RESULTS The results showed that there were no pre-test significant differences between the two groups. Two way ANOVA showed significant differences between pre- and post-test in the PT group in M wave parameters: latency (ms), nerve conduction velocity (m/s) and vertical jump height, but there were no significant differences in IEMG (mV/ms) and amplitude (mv), also there were no significant differences between pre- and post-test in the control group in IEMG, latency, amplitude and nerve conduction velocity. But after the training period, more significant differences in latency, NCV and VJ height were observed in the PT group than in the C group, there were also no significant differences in amplitude and IEMG ($P=0.789, 2.57\%$) between the two observed groups ($P>0.05$).

DISCUSSION & CONCLUSION It is possible to conclude from this study that coaches and trainers consider PT as a strategy for increasing volleyball players' explosive performance. This may have taken place in neuromuscular responses including: optimizing motor units (MU) pattern (intra-muscular activation), optimizing MUs recruitment, augmentation in nerve conduction velocity (NCV), decrement in reflex excitability of the motor pool.

KEYWORDS Plyometric training, EMG, M-wave amplitude, vertical jump, nerve conduction velocity

P-092
Immediate and delayed effects of eccentric exercise on proprioception of the knee

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OBJECTIVE The study investigated the effects of eccentric exercise of the quadriceps on proprioception of the knee in open- and closed-chain tasks.

METHODS Fifteen healthy adults (9 men; age 25.0 ± 3.6 yrs) of 90° and 150° participated. Proprioception of the right leg was assessed at 120 knee extension before, immediately post, and 24h following eccentric

exercise of the quadriceps with 3 tests: 1. matching the position of the right knee to the left knee; 2. repositioning of the right knee after active movement (open chain); 3. repositioning after active movement in standing.

RESULTS Immediately after the exercise and 24h post exercise, maximum knee extension force was reduced with respect to baseline (percent reduction, $77.0 \pm 12.3\%$ and $82.7 \pm 16.2\%$, respectively; $P < 0.001$). For the position matching task at 120° , proprioceptive acuity of the right knee was reduced immediately following eccentric exercise (error, $12.3 \pm 5.6^\circ$) compared to baseline ($5.8 \pm 2.7^\circ$) ($P < 0.001$). 24h post exercise, the positioning error ($8.1 \pm 4.5^\circ$) was lower than immediately after the exercise ($P < 0.05$) but greater than in the baseline condition ($P < 0.05$). Proprioception of knee extension was also impaired during the open-chain repositioning task, both immediately (error 120° , $5.9 \pm 3.1^\circ$, $P < 0.05$) and 24h post exercise ($5.2 \pm 2.9^\circ$, $P < 0.05$). Conversely, the repositioning task in weight bearing was performed with similar error as in the baseline condition.

DISCUSSION & CONCLUSION In conclusion, eccentric exercise of the quadriceps impairs proprioception of the knee both immediately after and 24h after exercise, however this effect was not observed in the weight bearing task.

KEYWORDS eccentric exercise, proprioception, delayed onset muscle soreness

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Asymmetry of force fluctuation during low-intensity isometric knee extension

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OBJECTIVE Although there are few reports on the asymmetry of force fluctuation (FF) in the muscles of the upper limbs, the asymmetry of FF in the leg muscles during $< 30\%$ MVC remains unclear. The purpose of this study was to investigate the asymmetry of FF in the leg muscles during isometric knee extension at 10% MVC.

METHODS 20 healthy males (21 ± 2 years) performed unilateral isometric knee extension that was measured by a strain gauge force transducer. After obtaining the maximal voluntary contraction (MVC), the subjects performed force matching tasks; sustained isometric knee extension for 15s at levels corresponding to 10% , 20% , and 30% MVC with the visual feedback. During the force matching tasks, the mechanomyogram (MMG) signal was detected by an accelerometer arrangement placed on the vastus lateralis, midway between the greater trochanter and the lateral condyle of the femur.

RESULTS (1) a greater FF and MMG-amplitude were found in the 30% MVC task than in the 10% or 20% MVC tasks; (2) a lower mean power frequency (MPF) of MMG was found in the 10% MVC task than in the 20% or 30% MVC tasks; (3) a greater FF and MMG-amplitude were found in the stronger limb in MVC than in the weaker limb in MVC at 30% MVC task; (4) no differences were found in FF and MMG-amplitude between the stronger and weaker limbs at 10% and 20% MVC tasks; (5) no difference was found in MPF-MMG between the stronger and weaker limbs at all tasks; and (6) significant positive correlations were found between the target force values and the FF at each contraction intensity.

DISCUSSION & CONCLUSION These results suggest that (1) FF asymmetry at intensities of MVC below 20% is not due to differences between the contraction intensities and discharge rate properties; (2) FF asymmetry at intensities of 30% MVC is found by the difference of discharge rate properties; and (3) FF increases with absolute load (i.e. target force value) by increased discharge rate variability, in same relative loads (i.e. $\%$ MVC).

KEYWORDS Force fluctuation, mechanomyogram (MMG), asymmetry, isometric contraction