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Analysis of the dynamic postural control during jump landing and subsequent lateral jump by means of the Heidelberg Jump Test, before and after a treadmill exercise load at the anaerobic threshold. Comparing high performance athletes with amateur ones.

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The objectives of the Doctoral study were to develop a test for the dynamic postural control with athletic similitude employing force plate measurements. It should be capable of detecting changes due to an exercise load. It should also be reliable, as confirmed by the Interclass Correlation Coefficient (ICC). Two main groups of young and healthy athletes (21.7 ± 4.1 years old) were included, one group of Recreationally Active Subjects [(RAS), 16 women, 8 men] and one group of female High Performance Athletes [(HPA) 10 handball, 8 volleyball players]. An exercise tolerance test with lactate measurement was performed to identify the Individual Anaerobic Threshold (AT) and heart rate level at anaerobic threshold (HR AT). The new test, called Heidelberg Jump Test (HD-JT), consisted of a jump onto a force plate from a distance of 70 cm. Each subject was required, in one fluid movement, to perform a two-legged barefoot jump in order to reach and with one hand hit the Ball-Switch. The Ball-Switch was placed above the force plate at a position equivalent to 50% of the subject's maximum vertical jump. Then lastly, the subject had to land on the force plate on the dominant leg. A Ball-Switch was developed which turns on 2 lamp indicators placed on the floor, in front of the force plate. The light signals indicated to the athlete the next action to be performed after the first jump, which could be either to stay 3 seconds motionless in single-leg stance on the force plate (for measuring "Time to stabilization") or to jump again to the right or to the left. The subjects performed 8 trials, each trial consisted of 9 jumps (3 per each possibility in random order. [Only the first trial had not random]). 3 trials were performed before the exercise load, and then 5 afterwards at the first minute and then every 5 minutes until 20 after the end of the exercise. The standardized and fatiguing exercise load consisted of running on treadmill with the objective of increasing and maintaining the subject's HR AT throughout 30 minutes and 1.5% inclination. HR was checked by a heart rate monitor every 5 min. in order to adjust the treadmill velocity according to the subject's HR AT. A new

analysis method was introduced: the dynamic postural control was studied by means of describing the ground reaction forces (GRF) that were generated by the subject in order to perform the lateral 90° Second Jump (SJ). The absolute value of the ratio of the GRF (Y/X Ratio= maximal anterior-posterior force / maximal medial-lateral force) generated at SJ phase was calculated and used as a postural control variable. The performance of SJ, after the initial landing, always generated anterior-posterior force (Y), and therefore the Y/X Ratio was always presented. For analysis, the Second Jump was reorganized in 2 groups according the dominant leg: jump to the dominant side (JDS) and jump to the non-dominant side (JNDS). In the case of the JDS, the Y/X Ratio for every subject (ALL) was 0.373 (±0.13), meaning that the Y force required from every subject was 0.373 times the X force. (Y = 0.373 * X). Y/X Ratio for RAS was 0.373 (±0.13), for HPA was 0.372 (±0.14). No significant differences were found between groups in baseline, the force used for the SJ was similarly proportional in every subject, whether athlete or amateur. According to the ICC results, the HD-JT is reliable; the JDS had an ICC value of 0.85, the JNDS had 0.69. The wished fatigue condition was reached safely: the percent of the HR AT target obtained, according the HR mean during the entire exercise load, was 100.8%; HR mean during the entire exercise was 177.2 ± 9.9, and the mean of the Rate of Perceived Exertion during the entire exercise was rated as a “hard” level. In agreement with other authors, exertion adversely and temporarily affected the postural control parameter in all the subjects. Comparing the RAS and HPA groups and since no statistical significant difference was found between them in any trial, either the test could not differentiate them or having elite competition training was apparently not important for the demanded task. Concerning both types of jumps, the RAS and HPA groups were significantly affected by the exercise load. Statistically significant differences were only found at 1 and 5 minutes after the end of the exercise; this finding could be interpreted as the recovery of the dynamic postural control occurring between 5 and 10 minutes post exertion. Different subgroups were analyzed too. The random order of the jump’s direction during the trials without exercise was not relevant. The developed test with athletic similitude evaluates successfully the dynamic postural control during a lateral jump, using as parameter the Y/X ratio of a 90° jump. The jump assessment was chosen as a test because it is a complex motor task that challenges the dynamic postural control and because it is a common activity in sport. A meaningful conclusion was that similar exhausted athletes should rest 5 to 10 minutes in order to recover total postural control and to avoid related injuries. The HD-JT could support in identifying postural control deficits and could monitor lower limb injury rehabilitation.

Regarding the Time to Stabilization (TTS) test, the ICC values of the TTS on medial-lateral plane (TTS ML) and TTS anterior-posterior (TTS AP) indicated low reliability. No significant differences were found between HPA and RAS in Baseline. TTS AP and TTS ML did not present the expected significant increase in values after the exertion. At the time of the study, it was difficult to recommend the TTS ML and TTS AP with the sequential estimation analysis as a postural control measure for healthy subjects and for describing the effects of fatigue on postural control until more research has been performed.