Postural sway response to resistance exercises with different intensity of proprioceptive stimulation

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Introduction
Several studies have documented that various forms of exercise, e.g. running (Lepers et al., 1997; Derave et al., 2002), cycling (Seliga et al., 1991; Nardone et al., 1997), walking (Hashiba, 1998; Nardone et al., 1998) as well as repeated heel rising (Lundin et al., 1993; Yaggie, McGregor, 2002) and sustaining stance on tiptoe (Vuillerme et al., 2002) adversely affect postural stability. Fatigue has been proposed as the principal factor responsible for such an impairment of postural stability. Also level of ventilation has been found closely correlated to sway velocity in an early phase of recovery (Zemkova, Hamar, 2003) indicating that recovery hyperventilation should also be considered as an important factor in post-exercise maintenance of balance. However, the same ventilation may be induced by exercise with different intensity of muscle contractions eliciting different level of proprioceptive stimulation. Therefore, the aim of the study was to compare the parameters of balance after two forms of resistance exercise leading to the same ventilation, however with different intensity of proprioceptive stimulation.

Methods
A group of 17 physical education students (age 21.9 ± 2.1 years, height 179.3 ± 4.2 cm, weight 78.7 ± 6.4 kg) underwent in different days two lower limbs resistance exercises in form of calf rises and vertical rebound jumps. Metronome was employed to guide the frequency of repetitions at the rate of 1 Hz. Calf rises were performed for 60 seconds. Jumps were finished as soon as ventilation reached the level achieved during previously performed calf rises (on an average after 50 seconds). Ventilation was monitored by means of breath-by-breath system MMC Horizon. A level of exertion was estimated at the end of exercises using Borg's 6 to 20 Rating of Perceived Exertion Scale (1970). One minute prior to and two minutes after exercises the velocity of the centre of pressure (mean and in antero-posterior and medio-lateral directions) was registered at 100 Hz by means of the stabilography system FiTRO Sway check based on dynamometric platform. Average values of 5-second intervals were used for the evaluation.

Results
As intended, in an initial 5-seconds phase of recovery there were no significant differences in ventilation after jumps and calf rises (26.4 and 26.5 l/min, respectively). However, in the same period significantly (p < 0.01) higher increase in velocity of the centre of pressure after jumps (from 8.9 to 24.1 mm/s) as compared to calf rises (from 9.1 to 18.8 mm/s) has been registered. In addition, its values after jumping remained temporarily elevated with slight tendency to increase and only after about 25 seconds a gradual decrease back to the resting level set in. On the other hand, velocity of the centre of pressure after calf rises started to decrease within 5 seconds of recovery. In addition, higher increase in medio-lateral (8.4 and 5.8 mm/s, respectively) than in antero-posterior direction (5.0 and 3.9 mm/s, respectively) has been found. All subjects perceived both exercises as very hard, corresponding to a rate of 18 on the Borg's RPE scale.

Discussion/Conclusion
As known from biomechanical analyses substantially higher vertical ground forces are produced during jumps as compared to calf rises. It may be assumed that more profound stimulation of muscle spindles, tendon organs, joint receptors and cutaneous mechanoreceptors on the sole during jumps has been provided leading to impairment of their sensitivity. It may be assumed that resulting partial reduction of afferent impulses leading to deterioration in proprioceptive feedback control of balance after jumping contributed some 60% to the approximately double increase in sway velocity relative to pre-exercise values already registered after calf rises. It may be concluded that intensity of proprioceptive stimulation during resistance exercise have an important influence on feedback mechanisms involved in control of balance.

References