Relation between postural control and physical activity

PhD Theses

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2008

1. Introduction

Postural control is the ability to maintain the body's centre of mass over the base of support during quiet standing and movement. It is a perceptual-motor process that includes the sensation of position and motion from the visual, somatosensory and vestibular systems, the processing of the sensory information to determine orientation and movement, and the selection of motor responses that maintains or brings the body into equilibrium.

2. Review of literature

Only a few studies have reported the postural control of sportsmen, and most of these studied sportsmen who needed special skills in balance control. Ironman training does not require special practice in balance, and therefore it might be supposed that ironmen do not differ significantly in postural control compared with healthy, physically active subjects. It is well known that the ironman triathlon is an ultra-endurance race, which causes significant changes in various physiological parameters.

The vestibular, visual and somatosensory systems, which all undergo changes with aging, may provide a diminished or inappropriate feedback to the postural control centres. Similarly, the muscle effectors may lack the capacity to respond appropriately to disturbances in postural stability. The age-related alterations in postural control strategies are also well known. A considerable number of studies have reported on the increase in postural sway with advancing age.

3. Objectives

1. Our investigation in one hand focused on the postural control of ironmen in comparison with that of healthy subjects who took part in regular physical activity. Furthermore, the second aim of this part was to examine postural control after an ironman triathlon race.

Since ironman training does not require special practice in balance, and therefore it might be supposed that ironmen do not differ significantly in postural control compared with healthy, physically active subjects.

2. On the other hand our aim was to investigate differences in postural control parameters between young and elderly people, and to explore how a combined aerob, balance

training can influence the balance parameters (AP, ML sway and frequency power), and functional performance in this specific age group.

We hypothesized that the participants would demonstrate better balance control, i.e. smaller postural sway than those who did not take part in the programme.

4. Method

4.1. Subjects

50 healthy subjects, with different age and physical condition took part int he study. Group 1: young adults, who do physical activity regularly (10), Group 2 Ironmen (10), Group 3 Students (11), Group 4 Elderly training (9), Group 5 Elderly control (10).

	Group 1 (Adult control)	**Group 2 (Ironmen)**	**Group 3 (Students)**	**Group 4 (Elderly, training)**	**Group 5 (Elderly control)**
Age (years)	33 ± 1.3	33 ± 2.4	22 ± 0.4	79 ± 1.6	76 ± 1.9
Weight (kg)	78 ± 2.8	74 ± 2.3	58 ± 2.9	73 ± 4.5	69 ± 5.1
Hight (cm)	175 ± 1.5	175 ± 2.2	163 ± 0.025	157 ± 0.023	159 ± 0.029
BMI index (kg/m^2)	25,47	24,17	21,83	29,62	27,29

4.2 Investigations

Static postural stability was measured during standing on a single force platform (Stabilometer, ZWE-PII) recording the Centre of Pressure (COP) displacement. Subjects stood barefoot ont he platform, posturography was performed in first with the eyes open (EO) and then with the eyes closed (EC) in a quiet room. After the initial balance testing (pretest), the athletes took part in an ironman triathlon (3.8 km swimming, 180 km cycling and 42.195 km running; duration, 9–12 h). The after-exercise series of trials on the stabilometric platform began about 15 min from the end of the exercise (post-test 1) and was repeated 5 min later (post-test 2).

The elderly training group took part in an 8-week course of combined training, then posturographic measurements were repeated. To assess the functional mobility of the training participants, the Timed Up & Go (TUG) test was also applied, which means the time it takes

for a seated subject to stand, walk 10 ft (3 m), pass around an object, walk back to the chair and sit down again was recorded in seconds.

4.3 Ironman triathlon

The group 2, the athletes took part in an ironman triathlon (3.8 km swimming, 180 km cycling and 42.195 km running; duration, 9–12 h.

4.4 Combined balance training in the elderly

The Group 4, elderly subjects participated in combined training twice a week for 8 weeks in 45-min sessions. The exercise programme included combinations of lower extremity strength and flexibility exercises, static and dynamic balance exercises, and walking as an aerobic activity.

4.5 Data analysis

The sway path was calculated from data in AP and ML directions. The sway in both directions was subjected to spectral analysis. The frequency spectrum of the platform oscillations was calculated in the intervals of 0.1–0.3, 0.3–1, 1–3 Hz by fast Fourier transformation. All of the data were subjected to analysis of variance in order to make comparisons between the groups and the experimental situations, which constituted the independent variables. The post hoc test was the LSD multiple comparisons test. As concerns the TUG test, the Student t test was used to determine the level of difference. A level of significance of $P < 0.05$ was adopted throughout the data analysis.

5. Results

5.1. General effects of various physical activity on postural control

The main findings of the first part of the study study were that the ironmen were significantly more stable and less dependent on vision for postural control than subjects who partook in regular physical activity.

5.2. Effects of extreme physical load on postural control

Furthermore, the endurance race caused significant increases in both the sway path in the A/P direction with EC. The second post-exercise trials indicated a trend in the decrease of postural changes. The frequency analysis also revealed some new findings, which were not significant in swaypath analysis. Thus at the low-frequency band, there were significant differences between the A/P and M/L power in ironmen in both visual conditions, but not in the control group, suggesting that this band might not be linked only with visual control. This

difference could be observed in this group at all frequency bands with EC, indicating a higher level of motor control in the M/L direction.

5.3. Age-related changes in postural control

The sway paths in both directions were significantly higher in the elderly subjects than in the young control group.

5.4. Influence of training on postural control of the elderly

The main findings were that the elderly who took part in the special training course exhibited a significant improvement in the functional performance test, and significant changes in the posturographic parameters. Thus, the training significantly increased the sway path in the ML direction without visual input. The frequency analysis revealed that the training increased the frequency power without visual control in the ML direction in both the low- and middle- frequency bands.

6. Discussion, Implementations

We have demonstrated that the exhaustive race significantly affects the ability of ironmen to maintain balance. Further studies of muscular activity, heart and breathing rates, and degree of dehydration, in parallel with posturography, are needed for a better understanding of the changes in postural control observed following the ironman triathlon.

In agreement with our hypothesis, our results indicated that the combined training exerted a positive effect on the balance performance of the participants, even at this advanced age and it is especially noteworthy that the improvement was in the risky ML direction and without visual control; however, these results may be specific to this type of population.

In both part of the study we emphasised the static balance investigation – form dynamic tests only the TUG test was used – we focused on the spectral analysis of frequency power, which proved to be a useful tool to understand the nature of postural control and the delicate effect of different type of physical activities on postural control.

The second part of the study is very important fronm the point of view of physicaltherapy profession, our method enables to measure objectively the positive effects of a balance training, providing scientific evidence for physiotherapists' work.

8. References

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