Biology of Sport, Vol. 23 N°2, 2006

BODY BALANCE PARAMETERS ESTABLISHED WITH CLOSED AND OPEN EYES IN YOUNG AND ELDERLY MEN

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Abstract. The aim of the study was to check whether there are any differences in the level of body balance between younger and elderly men. Body balance was measurements by computer posturographic system in two variants, i.e. a) with open eyes, b) with closed eyes. The measurement of the body balance was used also for analysis importance of the sight organ for maintaining a stable standing position in young physically active men and in elderly men. It was examined: 22 students of physical education ($\overline{X}$=22.2 years) – group A and 23 elderly men ($\overline{X}$=70.5 years) – group B. Balance was measured with use of a computer posturographic system PE 90 (a platform with four tensometric force transducers). The following parameters were analysed: a) mean radius (MR), b) sway area (SA), c) total length (TL), d) length of left-right sways (LDL-R), e) mean speed left-right sway (MSL-R), f) number of sways in left-right movements (NDL-R), g) length of back-front sways (LDB-F), h) mean speed of back to front movements (MSB-F), i) number of sways in back to front movements (NDB-F). In both studied groups a significant increase in the value of individual posturographic parameters was noted when the subjects were to maintain a stable standing position with eyes closed in compare to the result of the tests with their eyes open. It demonstrates a lower stability of the posture with closed eyes. In the majority of cases, the increase in the posturographic parameters (except MR) in the test with closed eyes is much higher in elderly men (B) than in younger ones (A). The results of the study indicate that the increased difficulty of the conditions of the task (closed eyes) leads to significantly greater disturbances in static body balance in elderly men.

(Biol.Sport 23:185-193, 2006)

Key words: Body balance - Male sex – Students - Elderly

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Introduction

Maintaining body balance is a complex function which includes sensory integration, processing in the nervous system and muscular strength [5]. With increasing age these functions may deteriorate, for example as a result of chronic diseases [9,15]. Deterioration of the ability to keep body balance by elderly people is often related to the weakening of sense organs, in particular sight [6]. Wolfson *et al.* [14] comparing groups of elderly men and women (mean age 76 years) with a group of adults (mean age 34 years) observed slight – although statistically significant – differentiation in body balance between adults and elderly individuals. According to these authors, the noted diversification results mainly from the disturbance in the functioning of prioreceptors and sight in elderly people. In the same study an increase was noted in the difference between the level of body balance in adults and in elderly people with the increase in the difficulty of the task (e.g. change in the position of a posturographic platform). It was observed that irregularities in the functioning of senses affect elderly people to a larger extent than younger ones [13]. Thus, reducing of the ability to see (e.g. inadequate lighting) may increase the difficulty of keeping body balance particularly in elderly people. Borger *et al.* [4] observed moreover that moving pictures during the measurement additionally increases difficulty of keeping balance. A greater effect of these moving images on keeping balance is noted in elderly people in comparison to younger people. Some works indicate that a typical posturogram for elderly people is characterised in number of length of sways of the body centre of gravity [1, 7]. Individual basic parameters of body balance can be established using a computer posturographic system and the need to carry out separate analyses for individual parameters of statokinesiogram and stabilogram is indicated [8].

The aim of the study was to check whether there are any differences in the level of body balance between young and elderly men. Body balance was measurements by computer posturographic system in two variants, i.e. a) with open eyes, b) with closed eyes. The measurement of the body balance was used also for analysis importance of the sight organ for maintaining a stable standing position in young physically active men and in elderly men.

Materials and Methods

There were 55 men examined in this study:
22 men studying physical education – group A, mean age 22.2 (20-25 years)
23 elderly men – group B, mean age 70.5 (64-81 years)

The estimation of balance level was carried out with the use of a computer posturographic system PE 90 produced by the Military Institute of Aviation Medicine (Wojskowy Instytut Medycyny Lotniczej) in Warsaw (a platform with four tensometric force transducers). Every subject had been precisely informed about the kind and performance of the test prior to the experiment. Every men was subjected to 2 trials, differing in difficulty and performance conditions. Both trials consisted of sustaining a sill, relaxed, upright position, the arms hanging down: first – with eyes open, second – with eyes closed. Everybody subject declared good function of their sight organ. They don't suffer from any eyes diseases.

The following parameters were analysed: a) mean radius (MR) – mean momentary sway from the centre of the vertical projection of the centre of gravity on the support place (COP), b) sway area (SA) – sum of areas generated by consecutive points of momentary sway from the COP base, c) total length (TL) – sum of distances between consecutive sway points in the Cartesian system, d) length of left-right sways (LDL-R) – length of the sway line, e) mean speed left-right sway (MSL-R) – mean velocity of transitions between the sway points, f) number of sways in left-right movements (NDL-R), g) length of back-front sways (LDB-F), h) mean speed of back to front movements (MSB-F), i) number of sways in back to front movements (NDB-F) [8]. For each parameter a mean and standard deviation were established. In order to check the significance of differences between groups a t-test for dependent and independent trials was used.

Results

Firstly the analyses of variance in the study of body balance with open eyes and closed eyes among young and elderly men was used (Table 1). All value of F test were statistically significant so trials were different.

The second step, differentiation of individual parameters of body balances level of maintaining a stable standing posture was analysed (Table 2).

Similar results in both groups were noted only for MR (mean value in group A=5.5 mm, in group B=7.4 mm) and NDL-R (mean value in group A=16.8 mm, in group B=20.2 mm). In case of both parameters, the differences were statistically non-significant. For the other parameters higher values were noted in group (B) in relation to values reached by students (A). All analysed differences were statistically significant at the level $p \leq 0.01$.

The analysis of the differentiation of the balance level in the test with eyes closed (Table 3) indicates that all posturographic parameters were statistically different (for MR $p \leq 0.05$, for the others $p \leq 0.01$) between groups A and B.

Table 1
Value of F test (analysis of variances for four trials) in the study of body balance with open eyes and closed eyes among young and elderly men

Posturographic parameters	TEST F
Mean radius (MR)	5.01**
Sway area (SA)	12.99**
Total length (TL)	19.03**
Length of left-right sways (LDL-R)	12.63**
Mean speed left-right sway (MSL-R)	13.18**
Number of sways in left-right movements (NDL-R)	13.37**
Length of back-front sways (LDB-F)	21.28**
Mean speed of back to front movements (MSB-F)	22.66**
Number of sways in back to front movements (NDB-F)	25.40**

**p≤0.01

Table 2
Values of posturographic parameters in the study of body balance with open eyes and their differences depending on the age of the subjects

Body balance parameters	Group A $\bar{x}$±SD	Group B $\bar{x}$±SD	Difference (A-B)	Value t
MR (mm)	5.5±2.6	7.4±4.2	-1.9	1.9
SA (mm^2)	329.7±184.0	655.1±509.9	-325.4	2.8**
TL (mm)	193.8±44.7	282.2±79.5	-88.4	4.6**
LDL-R (mm)	66.1±30.5	107.3±51.4	-41.2	3.3**
MSL-R (mm/s)	2.9±1.3	4.5±2.5	-1.6	2.6**
NDL-R	16.8±6.4	20.2±5.6	-3.4	1.9
LDB-F (mm)	92.7±30.4	169.4±62.2	-76.7	5.2**
MSB-F (mm/s)	3.7±1.2	6.6±3.1	-2.9	4.1**
NDB-F	17.7±5.7	27.1±9.6	-9.4	4.0**

*p≤0.05, **p≤ 0.01

Table 3
Values of posturographic parameters for a balance test with closed eyes and their differences depending on the age of subjects

Body balance parameters	Group A $\bar{x}$±SD	Group B $\bar{x}$±SD	Difference (A-B)	Value t
MR (mm)	6.3±4.1	9.4±3.9	-3.1	2.5*
SA (mm^2)	474.9±371.9	1892.5±1845.7	-1417.1	3.5**
TL (mm)	260.9±72.5	662.9±452.4	-402.0	4.1**
LDL-R (mm)	96.1±53.3	261.7±227.9	-165.6	3.3**
MSL-R (mm/s)	4.0±1.9	10.0±7.8	-6.0	3.5**
NDL-R	21.6±8.8	33.8±15.7	-12.2	3.2**
LDB-F (mm)	156.2±53.1	495.8±366.2	-339.6	4.3**
MSB-F (mm/s)	6.3±1.9	17.7±11.8	-11.4	4.4**
NDB-F	27.2±8.0	52.4±23.7	-25.2	4.7**

*$p \leq 0.05$, **$p \leq 0.01$

In both groups much higher values of individual posturographic parameters were noted when the subjects had to maintain a stable standing posture with eyes closed in relation to the results of the test with eyes open (Table 4, Fig. 1). Greater differences were noted in the group (B). The increase in values of posturographic parameters in group B often exceed of 200% (for SA change=288.9%, TL=234.9%, LDL-R=243.9%, MSL-R=222.2%, LDB-F=292.7%, MSB-F=268.2%). In group (A) the increase in values of individual parameters was from 114.5% for MR to 170.3% for MSB-F.

It was checked whether the changes in the values of analysed parameters in the test with eyes closed compared to the test with eyes open were statistically different in two age groups. Only in one case (MR) statistically significant changes of results depending on age were not observed. In the case of all other posturographic parameters, higher increases in values (greater disturbances in body balance) in the test with eyes closed were noted in the group of elderly men $p \leq 0.01$ and $p \leq 0.05$.

Table 4

Differences between the results of the body balance test with open eyes (o) in relation to the test with closed eyes (c)
in two age groups

	Group A			Group B			A – B
Parameters of body balance	Difference (o-c)	Percentage difference (o-c)	Value t	Difference (o-c)	Percentage difference (o-c)	Value t	A(o-c) – B(o-c)
	$\bar{x}$ ±SD	(%)		$\bar{x}$ ±SD	(%)		Value t
MR (mm)	-0.8±5.2	114.5	0.7	-2.0±4.3	127.0	1.62*	0.8
SA (mm^2)	-145.2±392.1	144.0	1.7	-1237.4±1805.0	288.9	3.1**	2.8**
TL (mm)	-67.1±46.8	134.6	6.7**	-380.7±432.7	234.9	4.0**	3.4**
LDL-R (mm)	-30.0±33.4	145.4	4.2**	-154.4±220.9	243.9	3.2**	2.6*
MSL-R (mm/s)	-1.1±1.2	137.9	4.5**	-5.5±7.2	222.2	3.2**	2.8**
NDL-R	-4.8±5.4	128.6	4.2**	-13.6±14.5	167.3	3.9**	2.7*
LDB-F (mm)	-63.5±38.2	168.7	7.8**	-326.4±349.2	292.7	4.2**	3.5**
MSB-F (mm/s)	-2.6±1.3	170.3	9.3**	-11.1±11.3	268.2	4.4**	3.5**
NDB-F	-9.5±6.8	153.7	6.5**	-25.3±20.4	193.4	4.7**	3.5**

*p≤0.05, **p≤ 0.01
(o-c) – difference in result between tests with open and closed eyes

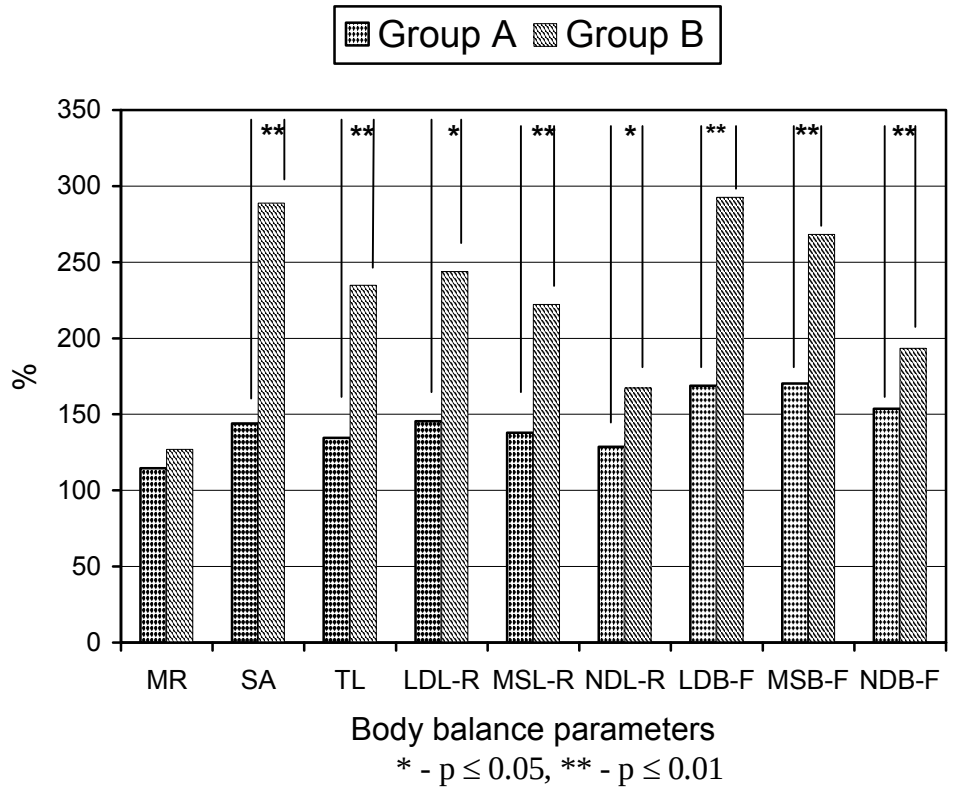

Fig. 1
Differences (%) and statistical signification of the differences in value of individual body balance parameters in the test with eyes open (o) and closed © in two age groups

Discussion

The results of the study indicate differences between men of various ages in the processes of body balance control. Some earlier studies noted no or slight differentiation in the level of body balance of young and elderly people. These differences were particularly small in case of relatively easy balancing tasks [14]. In our study in a test that did not require any special skills, i.e. standing on immobile posturographic platform with eyes open, statistically significant differentiation of most posturographic parameters was noted ($p \leq 0.01$).

On the basis of the analysis of previous literature concerning maintaining body balance in which a mobile posturographic platform or moving pictures were used

[4], a greater differentiation of results depending on the age was expected in tests in which the difficulty of conditions of the task was greatly increased, i.e. with eyes closed. Also in the study statistically significant differences ($p \leq 0.01$ and $p \leq 0.05$) were noted between the groups of younger and elderly men for all posturographic parameters. The picture of posturogram for elderly men is characterised by higher values of parameters, which describe the process of maintaining balance indicating significant disturbance.

Błaszczyk *et al.* [3] indicate that at elderly age many functions of human body are disturbed. Thus, with age the body balance control system works in more and more difficult conditions, possibilities of adjusting to new situations are limited and balancing movements slower. The changes taking place in central and peripheral nervous system with ageing result in slower reaction time [12]. Thus, age strongly influences the value of individual posturographic parameters. The demonstrated differentiation may also result from e.g. muscular strength of lower limbs [5] and use of medication [11] of which elderly people take more than the younger. Significant influence on the level of balance is also exerted by diseases related to ageing processes [14]. Particular significance in the processes of maintaining body balance is ascribed to the functioning of the sight organ [2,15] and its relative efficiency until very old age [13].

It was observed that in tests with eyes closed compared to tests with eyes open in both groups of age, a significant increase in the values of parameters associated with wide range of movements of the vertical projection of the centre of gravity on the support place. In the test with eyes closed, an increase in the speed of movements compared to the test with eyes open MSL-S and MSB-F ($p \leq 0.01$) was observed in both age groups. In each case greater changes of balance parameters were noted for eyes closed in elderly men.

Somatosensoric system with the sight and vestibular systems make it possible for the central nervous system to feel the complex body position and thus, contribute to maintaining of the stability of posture [12]. Changes taking place in the central and peripheral nervous system with ageing processes result in changes in the ability to integrate incoming sensory information [10]. The studies demonstrated that switching off of one of the systems, sight in this case, results in a greater disturbance in maintaining balance in elderly men.

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Accepted for publication 28.07.2003