A POSTUROGRAPHY STUDY OF BALANCE IN PHYSICALLY ACTIVE YOUNG, ADULT AND OLDER WOMEN

by

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The aim of the study was to evaluate differences in parameters of body balance between women at various ages. The body balance was measured by computer posturographic system (PE 90) in so called "feedback system". Three groups of subjects were examined: a) 33 female physical education students aged 22.4±0.7 years (group A), b) 22 women aged 43.5±6.4 years (group B), c) 19 women aged 66.5±8.5 years (group C). It was found that in the comparison of group A young physically active women with group B higher values of posturographic parameters were observed in the younger group in respect to maximum left deflection (MDL) – 5.0 mm, $p \leq 0.01$ and maximum right deflection (MDR) – 4.6 mm, $p \leq 0.01$. In the comparison of group A with group C higher values of balance parameters were observed in younger women in mean radius (MR) – 0.5 mm, $p \leq 0.05$, sway area (SA) – 205.8 mm^2, $p \leq 0.01$, total length (TL) – 47.5 mm, $p \leq 0.05$, length of left-to-right deflection (LDL-R) – 40.1, $p \leq 0.05$, mean velocity of left-to-right movement (MSL-R) – 1.3 mm/s, $p \leq 0.05$, maximum deflection in movements to the left (MDL) – 5.7 mm, $p \leq 0.01$ and to the right (MDR) – 4.6 mm, $p \leq 0.01$ and maximum back deflection (MDB) – 6.6 mm, $p \leq 0.01$. Contrary to the expectations in young and physically active women, in the studied set of conditions, movements were observed to be larger, less stable, which was indicated by a larger sway area of deflections and the scope of vertical movement of centre of gravity, than in older women.

Key words: body balance, posturography, women, age.

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Introduction

Body balance is a complex feature which includes sensory integration, processing in the nervous system and biomechanical fitness (Golema 1987). With the age these functions may deteriorate, e.g. as a result of chronic diseases (Woollacott et al. 1986, Pancer et al. 1995). The decrease of the ability to maintain the body balance by the elderly is also related to the weakening of function of sense organs, in particular sight (Matheson et al. 1998). When comparing a group of older women and men (average age 76 years) with a group of adults (average age 34 years) Wolfson et al. (1992) observed small but statistically significant, diversity in the body balance. According to the above authors the noted diversity results mainly from the disorder in functioning of proprioceptors and vision in older people. In the same study the difference between the level of body balance of adults and older people was found to increase with the increased difficulty of task (e.g. change in the position on the posturographic platform). It was observed that irregularities in functioning of senses have greater impact on older people than on young people (Whipple et al. 1993). In another study devoted to the question of body balance it was noted that with age the size of support area (placement of legs, type of footwear) has greater effect on maintaining body balance than good functioning of the visual organ (Benjuya et al. 1998). Borger at al. (1999) observed moreover, that moving pictures shown to the subjects during the measurements are an additional difficulty in the process of maintaining balance. This task is more difficult for older people. A characteristic picture of posturogram for the elderly includes a larger number and greater length of deflections of the centre of gravity of the body (Lord et al. 1992, Anacker and Di Fabio 1992). At the same time the work devoted to the analysis of the measurement of body balance using a computer posturographic system indicated the need to carry out separate analyses for individual parameters of statokinesiogram and stabilogram (Osiński et al. 1994).

The aim of the study was to establish the difference between the level of parameters of body balance, specified in so called feedback, in women at various ages. The measurement of the balance was used in particular for the analysis of the nature of women's reactions to the moving picture of vertical projection of the centre of gravity of the subject.

Material and methods

The subjects were:

1. 33 female students from the University School of Physical Education aged from 21 to 24 – mean 22.4±0.7 years (group A),

2. 22 women aged 28 to 50 – mean 43.5±6.4 years (group B)
3. 19 women aged 51 to 78 – mean 66.5±8.5 years (group C).

The sense of balance was studied using a computer posturometric system constructed by the Military Institute of Aviation Medicine (Instytut Medycyny Lotniczej) in Warsaw (a platform with four tensometric power converters).

The point which reflected the vertical projection of the centre of gravity of the subject and a fixed square with the side 1 cm long was displayed on the screen. The task of the subject was to keep stable posture and at the same time keep the point within the square. The point moving on the screen enabled the subjects to observe their movements. The following parameters were used for the analysis: a) mean radius (MR), b) sway area (SA), c) total length (TL), d) length of left-to-right deflection (LDL-R), mean velocity of left-to-right movements (MSL-R), a number of deflections in movements left-right (NDL-R) and maximum deflection in movements to the left (MDL) and to the right (MDR), e) the length of back-front movements (LDB-F), mean speed of back-front movements (MSB-F), number of deflections in back-front movements (NDB-F), maximum back (MDB) and front deflection (MDF). The above parameters and the manner of measurement have been described in the earlier study (Osiński et al. 1994).

The analysis of the results was performed with the use of basic statistics including mean value, standard deviation and the t-Student test.

Results

Table 1 presents mean values and standard deviations of the established balance parameters – separately for each group. In the majority of cases the highest mean values are obtained for the youngest women (group A). In terms of total length (TL=313.6 mm), length of left-to-right deflection (LDL-R=183.0 mm), mean velocity of left-to-right movement (MDL-R=7.1 $mm \cdot s^{-1}$), number of deflections left-to-right (NDL-R=31.0) and maximum deflection in movements to the left (MDL=15.0 mm) and to the right (MDR=14.4 mm) and maximum deflection in movement to the back (MDB=15.8 mm) and to the front (MDF=15.6 mm) the values of balance parameters of women in group A are higher than the results obtained for groups B and C. In terms of other parameters of balance the highest values were registered by women in group B, where the mean radius (MR) was 3.8 mm, sway area (SA) – 365.7 mm^2, length of back-to-front deflection (LDB-F) – 174.6 mm, mean velocity of back-to-front movement (MDB-F) – 7.0 mm. The oldest women acquired highest mean results in terms of a number of deflections in back-to-front movements (NDB-F) – 27.9. In order to perform detailed analyses

the differences between body balance parameters of subjects in different age groups were calculated. Statistical significance of the differences was calculated by the t-Student test (table 1).

Table 1. Mean values and standard deviation of posturographic parameters among three groups of women (A, B and C) and differences between the groups

Balance	Group A		Group B		Group C			Difference	
parameters	$\bar{x}$	±SD	$\bar{x}$	±SD	$\bar{x}$	±SD	A – B	A – C	B – C
MR (mm)	3.2	±0.8	3.8	±1.4	2.7	±0.9	-0.6	0.5*	1.1**
SA (mm^2)	351.8	±189.3	364.7	±227.9	146.0	±148.3	-12.9	205.8**	218.7**
TL (mm)	313.6	±63.1	310.8	±114.9	266.1	±80.2	2.8	47.5*	44.7
LDL-R (mm)	183.0	±55.7	155.1	±80.7	142.9	±70.8	27.9	40.1*	12.2
MSL-R($mm \cdot s^{-1}$)	7.1	±1.7	6.2	±3.0	5.8	±2.4	0.9	1.3*	0.4
NDL-R	31.0	±5.7	27.6	±9.8	27.5	±8.2	3.4	3.5	0.1
MDL (mm)	15.0	±7.7	10.0	±3.9	9.3	±3.7	5.0**	5.7**	0.7
MDR (mm)	14.4	±6.6	10.2	±3.7	9.8	±4.1	4.2**	4.6**	0.4
LDB-F (mm)	145.9	±51.5	174.6	±82.3	141.7	±53.7	-28.7	4.2	32.9
MSB-F($mm \cdot s^{-1}$)	6.2	±1.8	7.0	±2.9	5.9	±1.8	-0.8	0.3	1.1
NDB-F	25.0	±6.5	26.6	±7.7	27.9	±7.4	-1.6	-2.9	-1.3
MDB (mm)	15.8	±9.8	12.7	±3.8	9.2	±2.6	3.1	6.6**	3.5**
MDF (mm)	15.6	±12.0	13.8	±5.2	10.0	±3.4	1.8	5.6	3.8**

* - $p \leq 0.05$ ** - $p \leq 0.01$

The greatest diversity of balance was observed between women in the youngest group – A, and women in the oldest group – C. In case of eight of thirteen established parameters statistically significant differences was observed. The highest differences were obtained in terms of sway area (SA) – 205.8 mm^2, $p \leq 0.01$, maximum left deflection (MDL) – 4.7 mm, $p \leq 0.01$, maximum right deflection (MDR) – 4.6 mm, $p \leq 0.01$ and maximum back deflection (MDB) – 6.6 mm, $p \leq 0.01$. In all cases younger women acquired higher values of the balance parameters than older women.

The smallest differences were observed between women in groups A and B. Statistically significant differences were observed only in terms of maximum deflection to the left (MDL) – 5.0 mm, $p \leq 0.01$ and maximum deflections to the right (MDR) – 4.2 mm, $p \leq 0.01$, which were characteristically higher for the younger group.

Discussion

The results of this study indicate differences between women at various ages in terms of the course of control processes of body balance. The study of Wolfson et al. (1992) indicated small differences between the level of body balance in young and elderly people. However, it is visible in case of easy balancing tasks i.e. such which involve even and stable surface in unchanging conditions with open eyes. The studies were supposed to establish the differences in level of sense of balance among women at various

ages in more difficult tasks (e.g. in the feedback system). In a few cases the analysis of the collected material indicated the statistically significant differences in body balance parameters in women at various ages.

The diversity shown on the basis of the acquired results depends on many factors. The figure obtained in the posturograph is affected by the strength of legs (Golema 1987), as well as medicines taken (Thapa et al.1998). Age-related diseases also have significant effect on the level of balance (Wolfson et al. 1992). However, as the results of previous studies, the functioning of the visual organ is attributed special significance for the maintaining the sense of balance (Woollacott et al. 1986, Baloh et al. 1993). Thus in the current study, the control of the balance was conducted on the basis of the task described as the analysis in the conditions of the so called feedback.

On the basis of the previous studies of balance maintaining, in which a movable posturographic platform or moving pictures were used (Borger et al. 1999) a significant differences in the results was expected between women in three groups on average 20 and 40 years.

The measurements indicated, that the age determines the value of specified posturographic parameters. It was observed, that the level of analyzed parameters does not change in proportion to age. In terms of four parameters (mean radius MR – 3.8 mm, sway area SA – 354.7 mm^2, length of deflection back-to-front (LDB-F) – 174.6 mm, velocity of deflections in back-to-front movements (MSB-F) – 7.0 $mm \cdot s^{-1}$ the highest level of the values was achieved by women in group B. Thus, it is difficult to discuss about constant, unidirectional changes in the level of these parameters with age.

In the current study no increased number and length of deflections of vertical centre of gravity was observed in older people what is indicated in other studies (Lord et al. 1992, Anacker and Di Fabio 1992). It was not found that the number of left-to-right deflections (NDL-R) and the length of back-to-front movements (LDB-F) and the number of deflections in the back-to-front movements (NDB-F) diversified statistically significant women at various ages.

A statistically significant differentiation of velocity of back-to-front movements (MSB-F) was not either observed, and in terms of the velocity of left-to-right movements (MSL-R) women at older age reached lower results than the youngest women ($p \leq 0{,}05$). The difference in adequate reaction, by balancing the body, to the observed picture of a moving point manifested itself in the sway area (SA) and in mean radius (MR). The results of women in the oldest group are lower than those of women in group A ($p \leq 0.05$) and in group B ($p \leq 0.01$). Thus, women in group C make

slower movements than younger women, and the area marked by the moving vertical centre of gravity is smaller. So the changes in the central and peripheral nervous systems in the course of ageing results in longer reaction time (Thornby 1995). At an older age many systems are working at less than at optimal levels – thus the control system of body balance operates in worse conditions and balancing movements are slower (Błaszczyk et al. 1994). The results noted may also result from the concentration of older women on keeping still and missing the need to keep the picture of the vertical projection of the centre of gravity within the square. Lower values of posturographic parameters are also the effect of motor program execution reorganization due to declination in the postural stability in older people where movements are slower and their range is smaller (Błaszczyk et al. 1993). In another study Boloh et al. (1994) observed higher speed of balancing movements in older people (more 75 years of age) than in younger subjects (18-39 years old). It means that in posturographic study the variability of individual balance parameters is not constant with age. The own studies indicate that the process of maintaining body balance in the conditions of additional information (adjustment to the picture of moving centre of gravity) is very complex and the obtained results of measurements for subjects at all ages may be sometimes surprising as for the directions of the changes taking place.

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