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Body posture and selected stabilometric parameters among patients with depression

Postawa ciała a wybrane zmienne stabilometryczne u chorych na depresję

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Key words
balance, depression, stability

Abstract
Introduction: A vertical posture distinguishes humans from other living beings. It also determines the specific conditions for movement. The element which connects body posture and movement is stability. It is based on the static and dynamic balancing of the destabilising forces of gravity and inertia through stimulating the appropriate muscle groups. A disruption of postural control may be conditioned by various factors, among which the literature mentions mental health. The purpose of this study wasa comparative analysis of selected variables characterising the postural stability of persons with depression.
Material and methods: The study involved fifty-four persons who were divided into two groups. The first group comprised 28 patients diagnosed with depression. The mean age of the participants was 37.25 +/- 3.88. The second group consisted of 26 completely healthy persons who were recruited from the general population, excluding persons with depression ora low mood. The mean age of the participants was 33.31 +/- 5.19 years. The postural stability was assessed usinga PEL 38 posturographic platform and TWIN 99 computer software.
Results: The results differed significantly between the two groups with regard to five variables: oscillations of the centre of gravity in the frontal and the sagittal planes, average deviation in the frontal plane, and deviations in the parameters of instability (the surface area and the ratio of length to the surface area). It was observed that the group witha diagnosis of depression displayed higher values in 4 out of 5 the evaluated parameters when compared to the control group.
Conclusions: Persons with depression are characterised bya reduced body stability compared to those who do not suffer from depression.

Słowa kluczowe
równowaga, depresja, stabilność

Streszczenie
Wstęp: Pionowa postawa ciała wyróżnia człowieka spośród innych istot żywych. Wyznacza również specyficzne warunki dla ruchu. Elementem łączącym zarówno postawę, jak i ruch jest stabilność. Polega ona na statycznym i dynamicznym równoważeniu destabilizujących sił grawitacji oraz bezwładności przez pobudzenie odpowiednich grup mięśniowych. Zakłócenia kontroli posturalnej mogą być uwarunkowane różnymi czynnikami. Wśród nich wymieniany jest udział czynnika psychicznego. Celem przeprowadzonych badań była analiza wybranych zmiennych charakteryzujących stabilność posturalną osób z depresją.
Materiał i metody: W badaniach wzięło udział 54 osoby, które przydzielono do dwóch grup. Do pierwszej grupy zakwalifikowano 28 pacjentów ze zdiagnozowaną depresją. Średnia wieku badanych wynosiła 37,25 +/- 3,88 lat. Do drugiej grupy zakwalifikowano 26 osób. Osoby te były w pełni zdrowe, rekrutowane z ogólnej populacji, u których wykluczono depresję i obniżenie nastroju. Średnia

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wieku badanych wynosiła 33,31 +/- 5,19 lat. Do badań oceniających stabilność wykorzystano platformę PEL 38 i oprogramowanie komputerowe TWIN 99.
Wyniki: Uzyskane wyniki różniły się istotnie między grupami w zakresie pięciu zmiennych: zmian oscylacji środka ciężkości w płaszczyźnie czołowej i strzałkowej, średniego odchylenia w płaszczyźnie czołowej oraz w parametrach niestabilności: pola powierzchni i stosunku długości do powierzchni. Grupa z depresją w porównaniu z grupą kontrolną uzyskała wyższe wartości 4 z 5 ocenianych parametrów.
Wnioski: Osoby z depresją cechuje zmniejszenie stabilności ciała w porównaniu do osób bez depresji.

INTRODUCTION

The ability to maintain the vertical body posture isa habitual action, which is shaped individually and changes throughouta person's entire life. The maintenance of stable vertical body posture is conditioned by many structures of the nervous system working in collaboration with one another, such as: the properly functioning bony labyrinth, cerebellum and the sense organs of hearing and sight. The positioning of the body's centre of gravity (COG) and the range of its displacements are considered to be the indicators ofa stable posture under the assumption thata lower amplitude and velocity of COG displacements indicatea more stable posture[1]. Disturbances in the control ofa stable body position, which increase the risk of falling, may be conditioned by various factors, among which the most commonly mentioned ones are age[2], sex[3], cerebellum disorders[4], and disorders of the basal ganglia including Parkinson's disease[5]. Many authors[6-8] indicate the significant role of mental health factors in the control of balance. Authors such as Kao et al.[9] and Kwan et al.[10] have mentioned depression as one of the predictors of the higher risk of falling, which especially occurs in elderly persons. Considering the increasing incidence of depression[11] and the visible lack of reports concerning the effect of depression on body stability, the aim of our study was to determine whether there are differences in the values of the stability parameters between healthy persons and persons with depression.

MATERIAL AND METHODS

The study encompassed 54 persons, who were divided into two groups. The first group comprised 28 patients with diagnoses of depression in the stage of partial reemission, who were being treated at the psychiatric ward of the 5th Military Hospital in Krakow. The mean age of the participants was 37.25 +/- 3.88 years. These patients were taking antidepressants from the SSRI[1] group and, according to reports, these medications do not affect the balance function[12-14]. The second group comprised 26 persons. These persons were entirely healthy, were recruited from the general population, and did not suffer from depression ora low mood. The mean age of the studied persons was 33.31 +/- 5.19 years. No comorbidities that could affect the body balance were noted in the participants. The research protocol was approved by the Bioethics Committee (No. 36/KBL/OIL/2011). Also, tests were conducted after obtaining the written consent of each study participant.

The tests evaluated stability usinga PEL 38 platform and TWIN 99 computer software. The conducted research yielded results in the form ofa stabilogram. The graphs presented the displacements of the centre of foot pressure (COP), which isa projection of the centre of gravity (COG) onto the support plane. Separate displacements were presented for the coronal axis (lateral) and sagittal axis (AP), as well as the speed of these displacements. During the test, the patients walked ontoa platform without shoes and adopteda relaxed stance, with their arms positioned alongside the body and their eyes looking straight ahead. Each participant was subjected toa single 30-second trial. During the measurements, the patients were provided with an appropriate atmosphere to eliminate the effects of such factors as visual stimuli, tactile stimuli and sounds on the displacements.

The results of the posturographic examinations were in the form of the following variables obtained both in the AP plane and the lateral plane:

- Width – range of oscillations (in mm);
- Average deviation (in mm);
- Average speed of oscillations (in mm/s);
- and the graph of the postural instability was described with the following variables:
- Path length – length of the trajectory of the centre of pressure (in mm);
- Path area – surface area of the geometrical figure created by connecting the extreme points ofa statokinesiogram (in $mm^{2)}$;
- Avg. Q. Speed – average squared speed of the centre of pressure in the AP and the lateral plane (in mm/s).

Canales et al.[8] reports that persons with depression are generally characterised bya forward bend of the body. This fact could affect the initial positioning and displacements of the centre of gravity during the measurements. For this reason, the study also included an evaluation of the trunk tilt in the sagittal and coronal planes, based ona photogrammetric examination (*Photogrammetrical Body Explorer* – PBE). The PBE isa positioning system for selected points on the entire human body, which allows for determining the spatial coordinates of those selected points[15,16]. The measurements were taken with the participants standing ina relaxed position. The conducted research and calculations yielded results ina graphical form that shows the projections of the measurement points, connected with specific line segments, on three refer-

[1] SSRI: Selective Serotonin Reuptake Inhibitor

ence planes, and tables presenting the values of the angles between the selected line segments. The values for the trunk tilt in the sagittal plane (*YZ*) and coronal plane (*XY*), measured in degrees, were used in the study. This was the angle between the line connecting the spinous process of the 7th cervical vertebrae (C7) with the sacrum (S) and the median line of the body. In order to eliminate the effect of tiredness on the body posture, the tests were conducted between 9 am and 10 am.

RESULTS

The statistical analysis was conducted with Statistica 10.0 software. A statistical significance was assumed at $p = 0.05$. The data was analysed with the Mann-Whitney *U* non-parametrical test, because the data distribution in the studied samples diverged from the normal distribution. Furthermore, the correlations between the person's age and the parameters were investigated with the Spearman's rank correlation coefficient. The average values of the studied parameters for the control and the experimental groups are presented below.

The study investigated the significance of differences between the average results of the stabilographic variables in both groups (Table 2). The results obtained with the posturography method differed significantly between the groups with regard to five variables: changes of oscillations of the centre of gravity in the coronal and the sagittal planes, average deviation

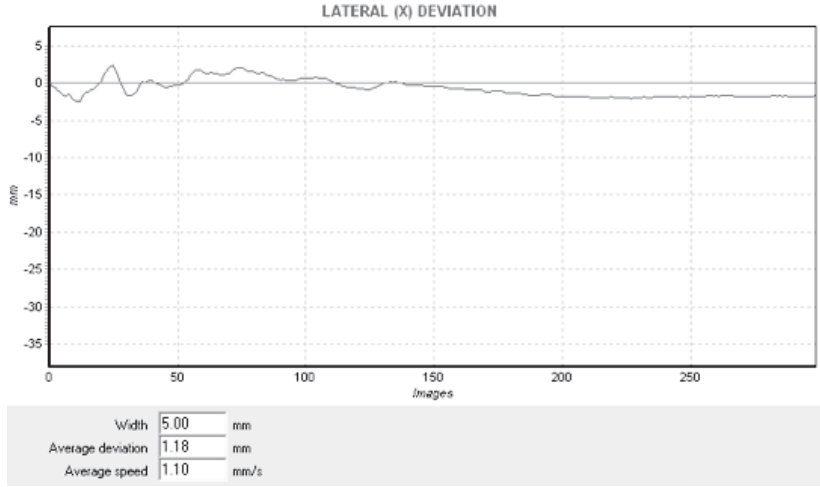

Figure 1

A sample record of COP displacements of the participants from the control group – frontal plane

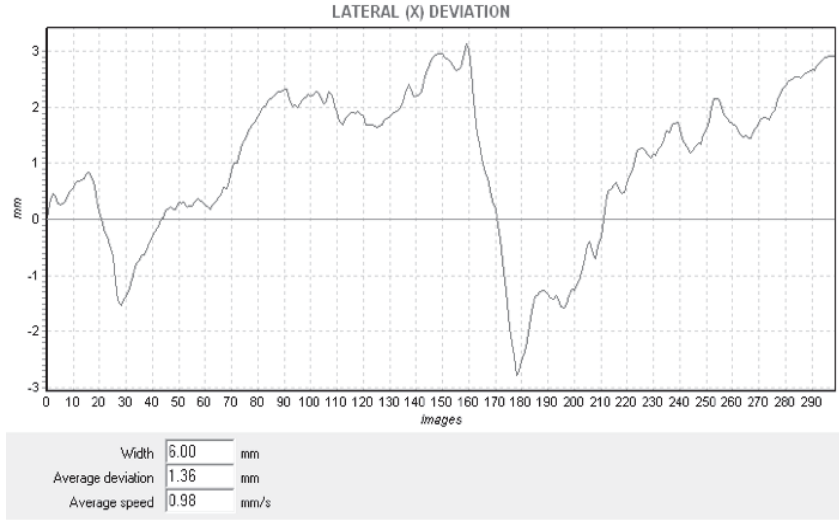

Figure 2

A sample record of COP displacements of the participants from the experimental group – frontal plane

Table 1

Descriptive statistics of the studied parameters

	Control group			Experimental group		
Studied parameters	**Average ± *SD***	**Min.**	**Max.**	**Average ± *SD***	**Min.**	**Max.**
Width AP [mm]	3.5 ±2.1	1.0	9.0	4.6 ±2.2	2.0	10.0
Average deviation AP [mm]	1.0 ±0.9	0.2	2.0	1.5 ±1.7	0.4	2.2
Average speed AP [mm/s]	0.9 ±1.43	0.3	1.5	0.6 ±0.3	0.2	1.7
Width lateral [mm]	2.7 ±1.7	1.0	7.0	4.0 ±2.7	1.0	12.0
Average deviation lateral [mm]	0.6 ±0.4	0.1	1.4	0.9 ±0.6	0.2	2.5
Average speed lateral [mm/s]	0.6 ±0.2	0.3	1.2	0.7 ±0.3	0.3	1.9
Body tilt in the sagittal plane [°]	178 ±1.8	175.3	182.6	175 ±3.3	165.1	181.0
Body tilt in the coronal plane [°]	179.4 ±1.1	177.9	182.5	179.1 ±1.0	177.4	180.8

Width – range of oscillations; Average deviation AP – average value of deviations in the sagittal plane; Average speed AP - average speed of oscillations in the sagittal plane ; Width lateral – range of oscillations in the lateral plane; Average deviation lateral – average value of deviations in the lateral plane; Average speed lateral – average speed of oscillations in the lateral plane; SD – standard deviation

in the coronal plane, and the parameters of instability (the surface area and the ratio of the length to the surface area). It was observed that the group diagnosed with depression displayed higher values in four out of the five evaluated parameters, when compared to the control group (Table 2).

The analysis of the photogrammetric values revealed differences between the groups with regard to the degree of trunk tilt. It was established that the group with depression obtained significantly lower values, indicatinga greater body tilt in the sagittal plane (*YZ*), in comparison to the group without depression. However, such differences between the groups were not observed in the case of the coronal plane (*XY*) (Table 3, Figure 3).

The obtained stabilographic and photogrammetric results were compared with the use of the Spearman's rank correlation coefficient. Calculations were performed separately for the control group and the experimental group (where the level of statistical significance was assumed at $p < 0.05$). No statistically significant correlation was found between the variables describing the posture and the variables describing the stability. Also, the *R* coefficients in both groups were close to 0, which indicatesa lack of covariance between the parameters.

DISCUSSION

Mental states affect the human body. Furthermore, whata given person looks like, and how they behave and walk is strongly connected to the person's emotional state[17]. It has been observed that there are significant

Table 2

Significance of the differences between the values of the stabilometric variables obtained in the control and the experimental groups (Mann-Whitney U Test)

	Control group	Experimental group	U	Z	*p*
Average deviation AP [mm]	701	952.5	294.5	-1.77	0.076
Average deviation lateral [mm]	632	908.0	254.0	-2.08	0.038
Average speed AP [mm/s]	819	834.5	399.5	0.10	0.924
Width lateral [mm]	636	904.0	258.0	-2.01	0.044
Average speed lateral [mm/s]	775	765.0	359.0	0.31	0.755
Path length postural instability [mm]	769	771.0	365.0	0.21	0.833
Path area postural instability [mm^2]	573	912.5	221.5	-2.46	0.014
L/A postural instability [1/mm]	1001	652.0	217.0	3.01	0.003
Avg. Q. speed postural instability [mm/s]	826	827.0	392.0	0.22	0.829
Width AP [mm]	599	886.5	247.5	-2.01	0.045

Average deviation AP – average value of the deviations in the sagittal plane; Average deviation lateral – average value of the deviations in the lateral plane; Average speed AP – average speed of oscillations in sagittal plane; Width lateral – range of oscillations in the coronal plane; Average speed lateral – average speed of oscillations in the coronal plane; Path length postural instability – length of statikinesiogram; Path area postural instability – surface area ofa geometrical figure created by connecting the extreme points ofa statokinesiogram with lines; L/A postural instability – ratio of length to the surface area; Avg. Q. speed – average squared speed of the forward, backward and sideways motions of the centre of pressure; Width AP – range of oscillations in the sagittal plane; U – value of the test fora small sample size < 20; Z – value of the test fora large sample size > 20; p – p-value for the Z-test

Table 3

Values of the photogrammetric variables in the XY and YZ planes for the control and the experimental groups

	Rank sum in the control group	Rank sum in the group with depression	U	Z	*p*
Body tilt in the XY plane (lateral)	714	772	362.5	-0.017	0.986
Body tilt in the YZ plane (AP)	918	567	161.0	3.506	0.000

U – value of the test fora small sample size < 20; Z – value of the test fora large sample size > 20; p – p-value for the Z-test; lateral – coronal plane; AP – sagittal plane

Table 4

Spearman's rank correlation coefficients for the stabilometric and photogrammetric variables examined in the control and the experimental groups

	Control group			Experimental group		
	N	R	*p*	N	R	*p*
Average deviation and body posture in the coronal plane (XY)	26	-0.15	0.470	28	-0.10	0.628
Average deviation AP and body posture in the sagittal plane (YZ)	26	0.09	0.655	28	0.15	0.440
Width lateral and body posture in the coronal plane (XY)	26	-0.11	0.603	28	0.04	0.859
Width AP and body posture in the sagittal plane (YZ)	26	0.16	0.448	28	0.13	0.515

Width lateral – range of oscillations in the lateral plane; Width AP – range of oscillations in the sagittal plane

changes in the body posture of persons suffering from depression. They often bend their bodies forward, which is manifest as an increased head flexion, increased thoracic kyphosis[8] and protruding shoulders[18]. The results obtained in this study confirm that depression involves changes in the body posture. The examined persons with depression were characterised bya greater degree of body tilt in the sagittal plane in comparison to the healthy persons. These results are similar to the observations made by Canales et al.[8]. However, such differences were not observed with regard to body posture in the coronal plane.

There is evidence that depression can also affect the body's stability. Hausdorff et al.[18] suggest that there isa greater risk of falling in this group of patients; while Whooley et al.[19] point outa higher frequency of hip fractures. Also, Lemke et al.[20] observeda lot of gait disorders when analysing the gait of persons with depression. The gait patterns of the persons they studied were characterised bya lower speed, anda prolonged swing and double support phases[20].

The above-mentioned changes accompanying persons with depression were an incentive for undertaking this study of the stability in this group of people. The obtained results confirmeda difference in the postural stability betweena group of healthy persons anda group of persons with depression. Statistically significant differences were registered in the stabilometric variables concerning the coronal plane, where the values of these changes were higher in those persons suffering from depression. Also, in the sagittal plane the study revealed greater deviations in the body's centre of gravity in the group of persons diagnosed with depression; however, the observed differences were not statistically significant. Baloh et al.[21] suggest that the assessment of instability in the coronal plane isa better indicator of balance disorders than the assessment of instability in the sagittal plane. This phenomenon may be justified by the anatomical structure of the foot, tarsus and hip joint. For this reason, even though the observed differences in the displacements in the sagittal plane were not statistically significant in the experimental group, taking into account the obtained results indicatinga statistically significantly lower stability in the coronal plane, it can be assumed that the persons with depression were characterised bya weakened postural control.

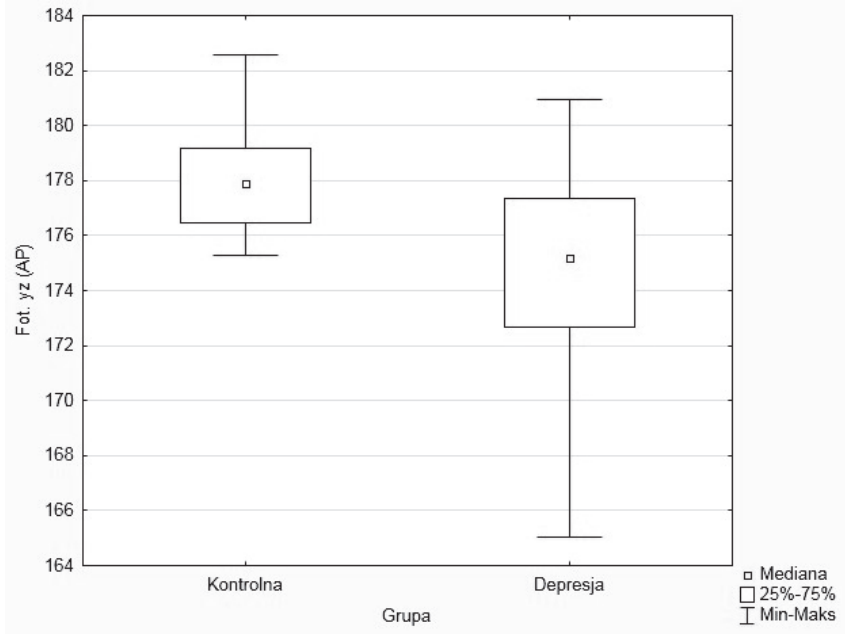

Figure 3

Values of the angle of the trunk tilt in the sagittal plane for the control group (Median = 177.875; Min. = 175.3; Max. = 182.6) and the experimental group (Median = 174.83; Min. = 165.1; Max. = 181.0)

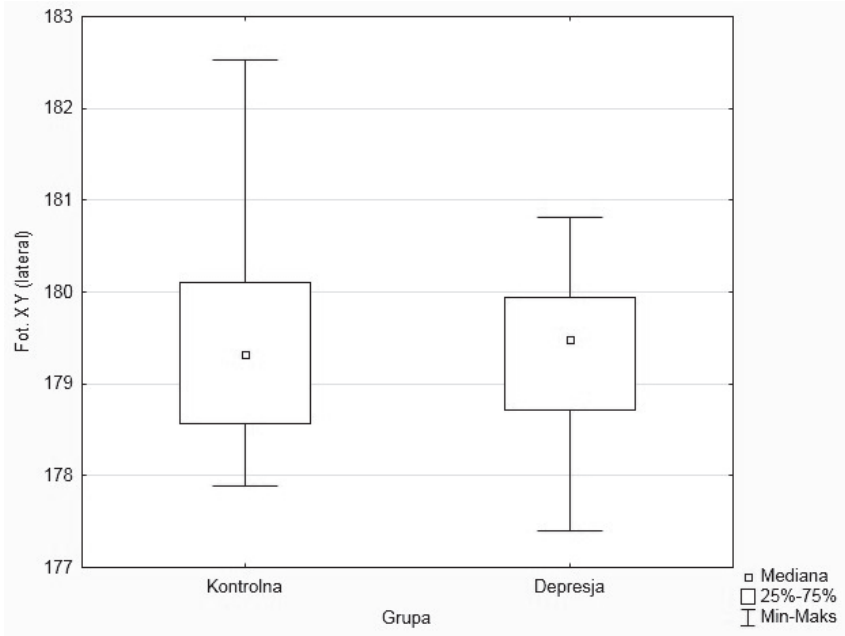

Figure 4

Values of the angle of the trunk tilt in the frontal plane of the control group (Median = 179.33; Min. = 177.9; Max. = 182.5) and the experimental group (Median = 179.55; Min. = 177.4; Max. = 180.8)

When analysing the stabilograms of persons with bipolar affective disorder, Bolbecker et al.[7] observeda higher value of the 'sway area' parameter that describes postural instability. The results of our study have confirmed this phenomenon, as the values of the variables characterising pos-

tural instability were almost twice as high in the persons with depression (Table 2).

Furthermore, the body tilt observed in our study suggests that the centre of gravity in persons with depression had moved forwards. It is possible that this phenomenon observed in the experimental group is related to the disturbed posture stability. Although the results of our study did not confirm the existence ofa statistically significant correlation between the stabilometric and the photogrammetric variables, surely this phenomenon requires further research witha larger group of participants.

CONCLUSIONS

Persons with depression are characterised bya decreased body stability. There were statistically significant differences concerning the values of the stabilographic variables, describing displacements in the coronal plane, although no greater displacements in the sagittal plane in the group with depression were observed.

Conflicts of interest: none

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