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Human body posture as a source of information about selected diseases

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Abstract: The aim of the study is to present the differences between the human body posture (HBP) of healthy people and those suffering from specific disorders – both those clearly connected with HBP (scoliosis, coxarthrosis) and those seemingly unrelated (e.g. depression). The study was conducted based on the results of photogrammetric measurements of patients standing in a relaxed posture, scanned with a PBE system (Photogrammetrical Body Explorer). Research was conducted over a group of 190 people. Patients were divided into six subgroups based on diagnosed disease entity: coxarthrosis, discopathy, scoliosis, depression, and chronic fatigue syndrome. A control group constituted of 36 healthy volunteers aged 19–29 years, with no identified defects of body posture. To evaluate the differences between the HBP of healthy and sick people, an HBP model based on 29 parameters describing the HBP in three anatomical planes was created. The research showed significant differences in the HBP of healthy and sick people. The results of the analysis indicate that an objective assessment of the HBP can be a source of relevant information on the general health of the patient and may be a useful tool in the diagnosis of selected diseases.

Keywords: anatomy trains; human body posture; photogrammetry; Photogrammetrical Body Explorer (PBE).

Introduction

Human body posture (HBP) is described by different domains experts (physicians, physical therapists, and others) in several ways. One is to use the concept of myofascial chains, which are involved in a variety of body functions, including maintaining a proper posture. Many injuries or pains in motor organs arise as a result of malfunction of some myofascial chains or their fragments [1]. There are reports indicating the existence of links between abnormalities in the myofascial system and functional disorders of internal organs [2] and other disease entities, e.g. depression [3] or mandible disorders [4, 5].

Myofascial chains are described by many different concepts [1, 6–8]. This study is based on the anatomy trains (AT) conception by Myers [8]. The idea of AT, due to its comprehensive nature, allows to analyze the static of the whole body.

The aim of the present article is to demonstrate the differences of HBP of healthy and unwell people.

Materials and methods

The research was conducted on results of photogrammetric measurements of 190 people aged 13–88 years. The patients were scanned in a relaxed standing posture with a PBE system (Photogrammetrical Body Explorer) [9]. Patients' data were selected from a database of Rehabilitation Center "Health." Patients were divided into six subgroups based on diagnosed disease entity:

- Chronic fatigue syndrome (CFS)
- Scoliosis
- Coxarthrosis (arthrosis of the hip)
- Discopathy
- Depression
- The healthy subgroup is a control group, constituted of 36 volunteers aged 19–29 years, with no identified diseases and defects of body posture.

The size of these groups is shown in Figure 1.

To evaluate the differences between the HBP of healthy and sick people, a HBP model was created. This model is built on 29 angular parameters describing the HBP in three anatomical planes. These parameters are based on anthropometric points measured by PBE. They were chosen to match the skeletal points included in the four main ATs as closely as possible; the superficial back line (SBL), the superficial front line (SFL), the lateral line

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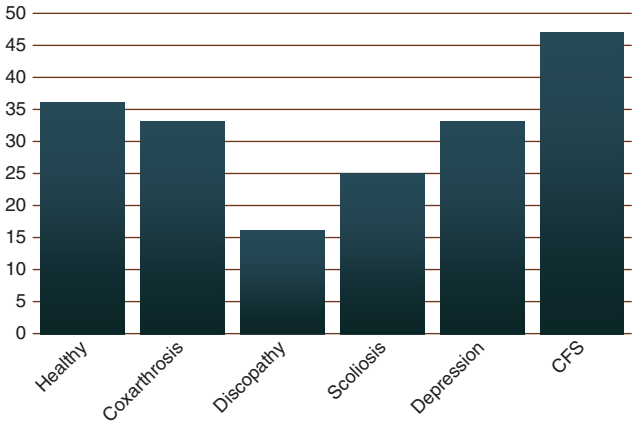

Figure 1: The size of patient groups according to diagnosed disease.

(LL), and the spiral line (SL). The positions of the measuring points assigned to the analyzed ATs are shown schematically in Figure 2.

Tables 1–3 list the parameters of the HBP model and its values for healthy people in three anatomical planes. To find differences between the HBP of healthy people and those

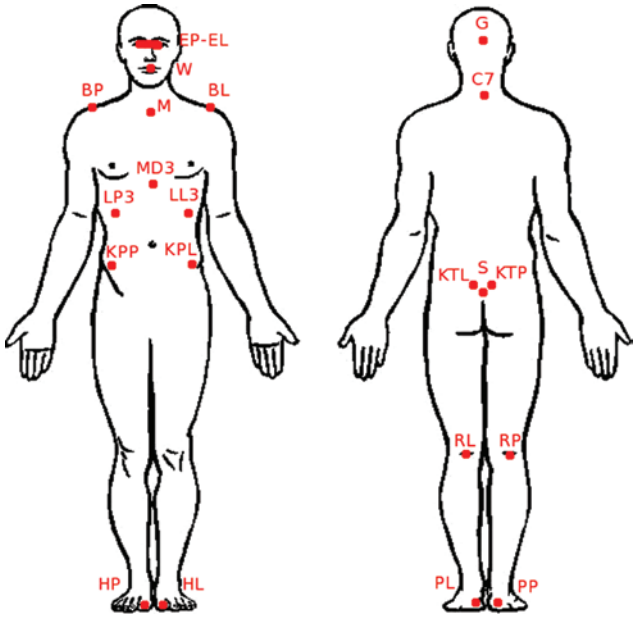

Figure 2: Anthropometric points measured using the PBE system, designating the four main anatomy trains.
EP-EL, Line joining the centers of the right and left eyes; W, center of the upper lip; BP/BL, right/left acromion; M, suprasternal notch; MD3, xiphoid process; LP3/LL3, costal margin right/left; KPP/KPL, anterior superior iliac spine right/left; HP/HL, front surface of the hallux right/left; G, occipital protuberance; C7, vertebra prominens; S, sacrum; KTP/KTL, posterior superior iliac spine right/left; RP/RL, right/left popliteal fossa; PP/PL, right/left calcaneus.

Table 1: HBP model parameters in the sagittal plane.

Parameter	Value, °
HP_PP & y_YZ	88
HL_PL & y_YZ	88
RP_PP & P_HP_YZ	267
RL_PL & PL_HL_YZ	268
KTP_RP & RP_PP_YZ-1	365
KTL_RL & RL_PL_YZ-1	364
KPP_KTP & y_YZ	86
KPL_KTL & y_YZ	85
S_PP & y_YZ	177
S_PL & y_YZ	178
MD3_LP3 & y_YZ	177
MD3_LL3 & y_YZ	176
M_C7 & y_YZ	59
G_C7 & y_YZ	185
C7_S & y_YZ	178
W_G & y_YZ	71

Table 2: HBP model parameters in the coronal plane.

Parameter	Value, °
RP_KPP & RP_PP_XY	178
RL_KPL & RL_PL_XY	179
S_PP & y_XY	176
S_PL & y_XY	183
MD3_LP3 & y_XY	141
y & MD3_LL3_XY	142
BL_BP & y_XY	90
G_C7 & y_XY	180

Table 3: HBP model parameters in the transverse plane.

Parameter	Value, °
C7_M & PP_HP_XZ-1	360
PL_HL & C7_M_XZ-1	365
BP_BL & KPP_KPL_XZ-1	360
G_EP-EL & C7_M_XZ-1	359
C7_M & BL_BP_XZ	90

suffering from specific disorders, we analyzed the correlation matrices of the parameters in each anatomical plane for the control group and the above-mentioned disease entities. Furthermore, we also examined the relationship between the parameters describing the HBP in all three planes of the body. For this purpose, we use the cluster analysis.

Results

The statistical analysis of the data indicated a strong correlation between the right and left sides of the body

in all anatomical planes for healthy people. For groups of patients with diagnosed disease entities, these relationships are considerably reduced. The values of some parameters describing the HBP in each group are significantly different. These differences, for selected parameters, are illustrated on interaction plots in Figures 3–9.

Values of the C7_S & y_YZ parameter, which describes the inclination angle of the torso in sagittal plane, are completely different for the control group than for other patients (Figure 3).

Figures 4–7 show the parameters describing the lower part of the body in sagittal and coronal planes. These parameters also have different values for healthy and sick people. However, for angles in the sagittal plane (Figures 4 and 5), results obtained for the control group were similar to a group of people with depression.

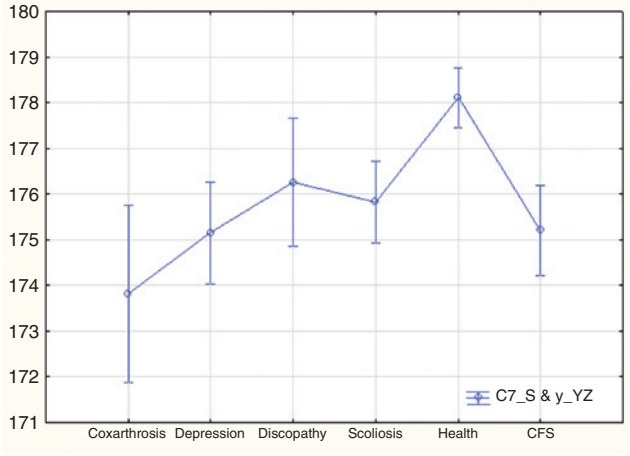

Figure 3: The average values (°) of the inclination angle of the torso in the sagittal plane, relative to disease entities.

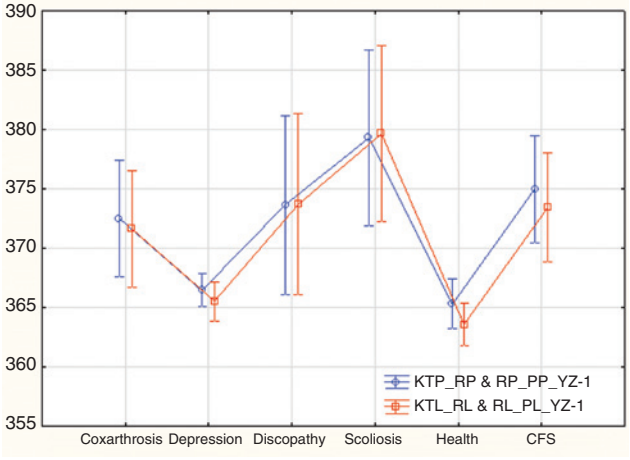

Figure 4: The average values (°) of the angle between thigh and lower thigh in the sagittal plane, at the left and right sides of the body, relative to disease entities.

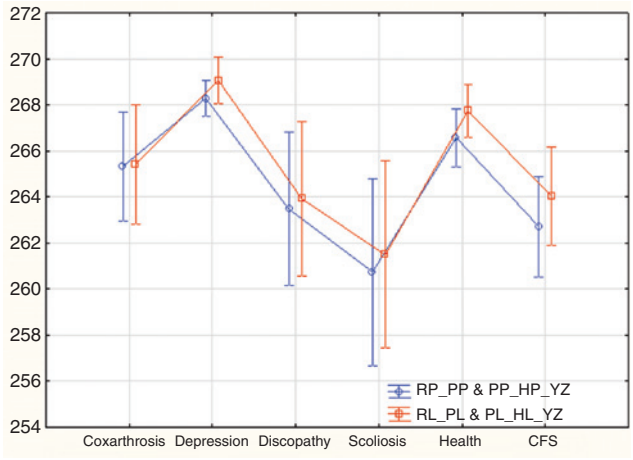

Figure 5: The average values (°) of the angle between lower thigh and foot at the left and right sides of the body in the sagittal plane, relative to disease entities.

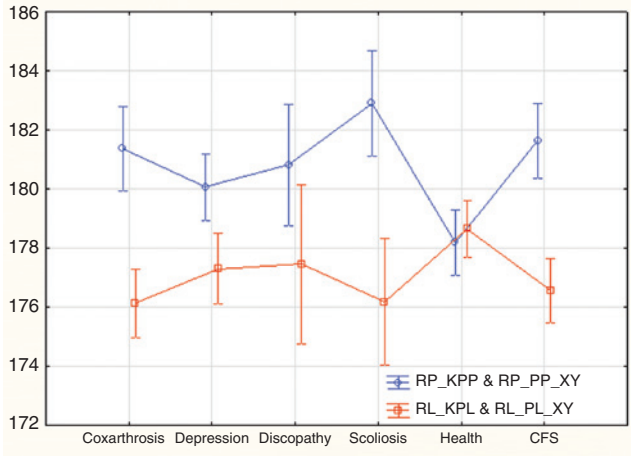

Figure 6: The average values (°) of the inclination angle between thigh and lower thigh in the coronal plane at the left and right sides of the body, relative to disease entities.

Differences between healthy people and other groups also occur in the upper part of the body, as shown in Figures 8 (in sagittal plane) and 9 (coronal plane).

For more information about the differences between the HBP of healthy people and those suffering from specific disorders, in addition we performed hierarchical agglomerative clustering. In forming clusters, we used Euclidean distance as a measure of distance between objects. For the calculation of distances between clusters, we used the weighted pair-group method using arithmetic averages [10], due to suspected significant differences in cardinality of the respective clusters.

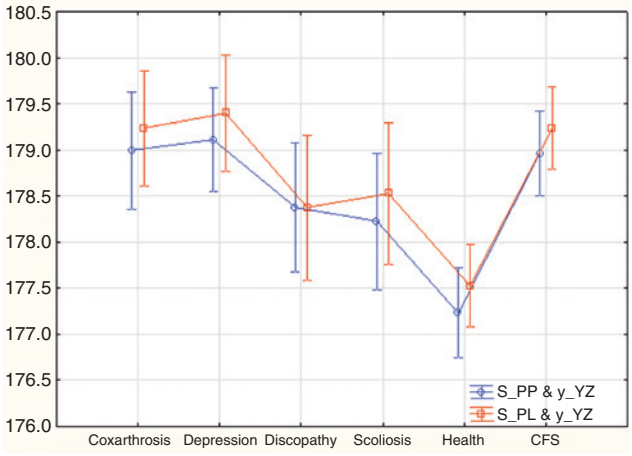

Figure 7: The average values (°) of the inclination angle between thigh and lower thigh in the coronal plane at the left and right sides of the body, relative to disease entities.

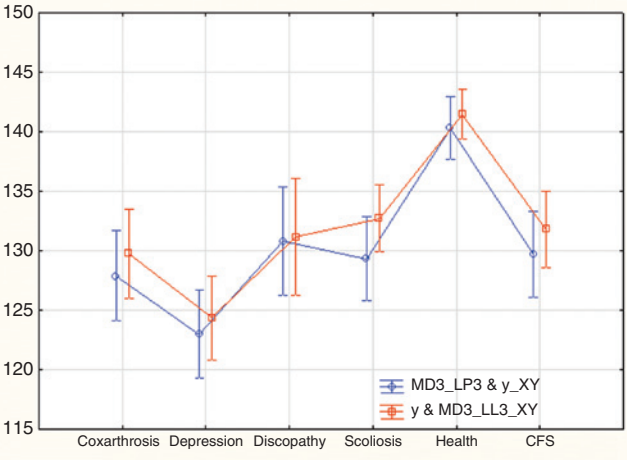

Figure 9: The average values (°) of the inclination angle of the chest in the coronal plane at the left and right sides of the body, relative to disease entities.

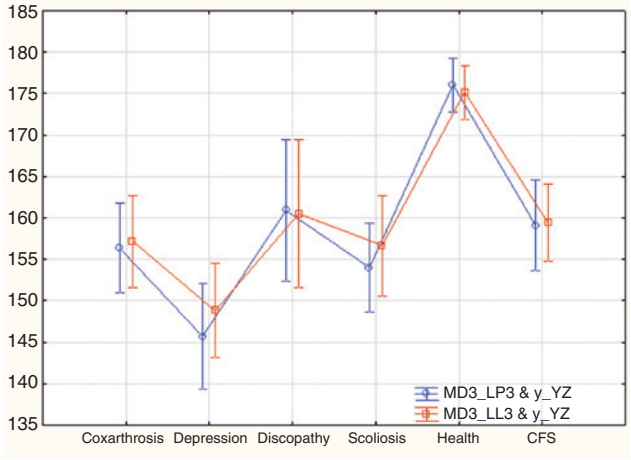

Figure 8: The average values (°) of the inclination angle of the chest in the sagittal plane at the left and right sides of the body, relative to disease entities.

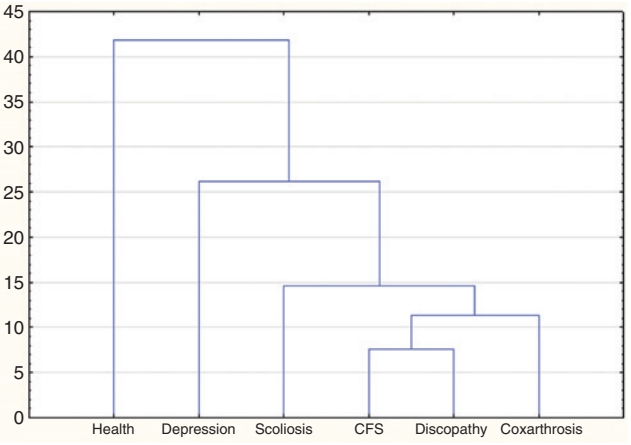

Figure 10: Classification of patient groups' dendrogram.

The results of clustering are shown in a dendrogram in Figure 10. To determine the cutoff point, we used the chart of linkage distances (Figure 11). It was observed that a clear flattening of the graph occurs at a linkage distance equal to 8, which divides the group of patients into three clusters. With this division, results obtained for the control group are clearly outliers from the other analyzed groups.

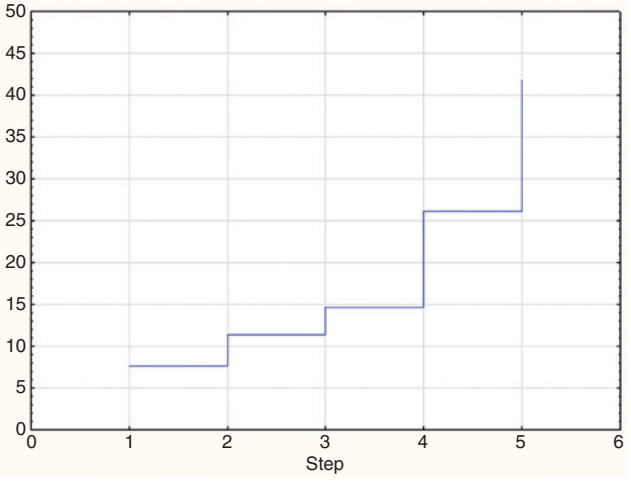

Figure 11: Plot of linkage distances across steps.

Discussion and conclusions

The results of the analysis showed significant differences between the posture of healthy people and those suffering from specific disorders – including those seemingly

unrelated with HBP, like depression or CFS. It means that an objective assessment of the HBP can be a source of relevant information on the general patients' health. It can also be a useful tool in the diagnosis of various diseases – and results presented in this paper form the basis for further research on this topic.

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