

**ABSTRACT OF THE DOCTORAL THESIS BY MS. CARMEN-LILIANA
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Thesis Title: **ASPECTS OF THE DYNAMIC BALANCE IN YOUTH
PRACTICING ORGANIZED SPORTS ACTIVITIES**

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Modern approaches argue that the real balance, in the sense of a deviation equal to zero, as compared to a fix point, can't exist in the biological systems. This paper is focused on the possibility of establishing the tendency presented by the recorded data, in order to label postural stability and dynamic balance in more than three value classes.

While measuring them, some pertinent questions about the reference point, the deviation and the scaling modality may arise. Previous studies on top sporting shooters show that postural balance can be approached as a relative dimension, asymptotically tending to reach the perfect stability, which is supposed to be the gravity center immovability, as compared to the ground.

By convention, the measurable parameters of oscillations may label the instability in many categories. It is known that the null instability is the equivalent of perfect balance, and the most unfavorable category of instability is represented by the unstable balance. There were identified five categories of instability, starting with the very great one, in the pathological zone, then passing by the habitual normal man's hyper-, mean and hypo-instability and ending with the very small instability, specific to performance shooting.

This research is based on findings and on their interpreting, with the aim of trying to determine how the regulation systems work and what tendencies have the data distribution, in order to subsequently identify the value deviation and the labels specific to the main parameters of dynamic stability and balance. In this sense, we shall analyze aspects related to the postural stability, namely the pressure center and the mass center oscillations, and to the dynamic balance, namely the stride width and length and the walking speed, pressure and duration.

The work hypotheses were formulated as follows:

- Physiological systems of the dynamic balance regulation can be approached as cybernetic instances with multiple feed-back loops, acting in a differentiated way. Their scientific knowledge might provide the deciding factors supplemental information for the improvement of some sports performances.
- Dynamic records of the static-kinetic (dynamic) balance tend to group around a central value, which might represent a reference deviation for diagnosis and selection.

Within the study, we complexly investigated, under lab conditions, 62 subjects divided into 2 groups:

- a non-randomized sample, made up of 31 subjects belonging to the statistical population called “healthy youth, practicing sports moderately, on a regular basis” (but not at the performance level);
- a sample made up of 31 “shooters” (performance athletes), with a rich experience in sports training and competitions.

The testing was made by means of a POSTUROTEST software. This testing type is included into the category of tests oriented towards the sensorial organization (SOT); the method is also known under the name of “posturography”.

Computerized posturography is a postural stability test providing information about the motor control or the balance function, under different environmental conditions.

The test consists in keeping the body position on a platform, the eyes staring at a given target. The platform pressure sensors register the body weight movements (balance), while the tested person keeps his balance.

Posturography informs about how well the balance is kept during some situations created on purpose.

The experiment protocol

Having in view the above-mentioned assertions about the measurands’ labeling, the main objective of our research is to identify some systematical and significant differences in a sample apriorically considered as being composed of different categories, from the postural

stability and the dynamic balance standpoints. Consequently, we established an experiment protocol on stages.

In the first stage, we tested 62 young people by means of the POSTUROTEST software.

Subjects were submitted to a questionnaire that aimed at collecting their identification data and some physiological data about their nervous, endocrine and metabolic activity.

In the second stage, we made the anthropometric measurements of the subjects' height and body weight.

For the investigation, subjects were informed and instructed, and the testing optimum conditions were respected.

The first aimed element was the postural stability investigation that started with the subjects' informing about the testing conditions. In this stage, a primary aspect consisted in the pressure center analysis in the orthostatic position. In the course of time, this analysis can provide information about the postural system control mechanism. The pressure center results from the combinations between the descendent motor commands and the ankle mechanical properties.

The next aspect referred to the analysis of weight center oscillations, under the existence of visual control conditions.

The testing took place under conditions almost similar to those used by the previous testing, with little differences related to the duration of position maintaining.

Oscillations are measured from the initial balance position to the final balance position and, after having eliminated one of the sensors, the information provided by the visual analyzer are modified (the patient closes his eyes).

The mass center is considered to be a controllable variable in the analysis of postural oscillations.

The second aimed element was the dynamic balance. In this sense, we tested the normal walking, respectively four successive steps. Subjects were instructed to perform a walking with a usual stride speed and length. They made a trial course and then each subject performed the test twice.

The data referring to the walking parameters, namely the path width, the stride length and the striding cycle length were recorded and put down.

The analysis of graphs for the momentary speeds, from the maximal similitude and amplitude, represented another aspect important to this study.

Other aimed aspects related to the walking balance referred to the distribution of sole pressure on the ground, to the support and balance durations and to the walking total duration.

To conclude, by means of POSTUROTEST, we managed, on the one hand, to visualize the pressures exerted by the sole, by indicating the body weight centers, the pressure shift while walking, the image of the “charged” foot, and, on the other hand, to completely examine the balance, by visualizing the body weight center shift, and to measure the balance under different conditions - closed eyes/ opened eyes.

Conclusions referring to the theoretical aspects of the study

- the specialty literature and other information sources emphasize the existence of a great number of anatomical structures involved in the dynamic balance achievement, from the analyzers, that bring information about the body position, to the spinal marrow, where the muscle movements are initiated for the locomotion and the posture maintaining, and, last but not least, to the higher nervous structures, where the data are processed and the responses necessary to balance keeping are elaborated;
- the balance maintaining in the orthostatic position is a motor activity important to a person’s autonomy keeping. From our documentation, we concluded there are four main control mechanisms that permanently adjust the postural stability in the orthostatic position. These mechanisms are represented by: the instantaneous reaction of the muscles and joints, depending on their properties, which is modulated from the spinal level, the muscular activity initiated by the detecting of body oscillations on the basis of information received from the periphery, the muscular anticipatory activity, determined by the existent internal model and by the cognitive intervention of the nervous system higher centers. Our opinion about this problem is different, because we think there are at least five feed-back loops that regulate the balance keeping and that are represented by the vestibular analyzer, the peripheral proprioception (mainly, the tactile analyzer, but some others, too), telereception (the visual analyzer) and the central nervous system structures.

Conclusions referring to the experimental research

- It is well-known that the volume of scientific information about this subject, as well as the interpretation of results, can generate different points of view, specific to this field. According to our aim, this research was limited to the parameters able to emphasize the tendency of data central grouping, which finally might represent a starting point for the dynamic balance labeling and normalizing.
- Balance, understood as the keeping of balance and of the movement direction, is an important element of walking. Starting from this desideratum, we considered that walking is the simplest

and the most accessible way to evaluate the dynamic balance. In this research, we analyzed walking both through its parameters (the stride width and length) and its characteristics, evaluated by means of the computerized platform (the pressure center imaginary trace, the momentary duration and speed). The analysis of the pressure center imaginary trace provides us important data related to the pressure center oscillations in the sagittal and frontal plans. Momentary speed is a characteristics of movement, from the biomechanical standpoint, which might be useful when trying to define and to label the dynamic balance.

- The Anderson-Darling Normality Test, for the category represented by the pressure center in the anterior, posterior, lateral-left and lateral-right plans, shows a normal data distribution (P-value>0.05) in both of the groups. Having in view the composition of the groups made up of young healthy people, the results come to reinforce our finding that the pressure center may be considered a controllable variable of the nervous system and that the analysis, in the course of time, may provide information about the postural system control mechanism. The Standard Deviation for the anterior and posterior plans emphasize a difference, which shows that the performance athletes' responses were properly adjusted for the balance keeping in the orthostatic position and that they were continuously refined by practice and learning.
- For the category of mass center oscillations with a visual control, the statistic analysis emphasizes a significant difference among the results, it being noticed in the anterior plan, which can be explained by the fact that the athletes, in their search for performances, appeal to solutions for the position stability improvement in the vestibular and visual analyzers' zone, by developing, at the phenotype level, the subjects' ability of maintaining their balance in positions specific to the sports event.
- For the walking parameters represented by the 1st stride length and the 2nd stride length, the Anderson-Darling Normality Test shows a result distribution allowing us to consider that these categories are not relevant for the dynamic balance study, they being individual anthropometric parameters.
- For the category represented by the momentary speed, the Anderson-Darling Normality Test shows a normal data distribution (P-value>0.05) of the 2nd stride, in both of the groups; the 1st and the 3rd strides have also a normal data distribution (P-value>0.05), in the performance athletes' group. The Standard Deviation for the momentary speed of the 1st, 2nd and 3rd strides and of the movement average speed shows a difference that can be explained when the

physiological indices involved into the respective mechanisms are compensated by the stability and the dynamic balance components, in particular situations.

- Din analiza comparativă a rezultatelor celor două loturi, prelucrate statistic cu ajutorul metodei ONE WAY ANOVA și a testului MANN - WITHNEY, se evidențiază o diferență semnificativă statistic referitoare la o caracteristică măsurată. Astfel din totalul de 22 categorii analizate pentru echilibru static la 3 categorii s-au înregistrat diferențe semnificative statistic. Rezultatele confirmă ideea potrivit căreia diferențele individuale ale echilibrului postural sunt nesemnificative raportate la aspectul somatic, fiziologic al omului sănătos (statistic habitual), în privința variațiilor semnificative acestea sunt raportate domeniului patologic, ceea ce nu face obiectul studiului de față.
- Considerăm oportun acordarea unei atenții deosebite categoriilor echilibrului dinamic – viteza momentală și medie, presiunea repartizată în mers, durata și fazele mersului (sprijin, balans), deoarece rezultatele obținute evidențiază faptul că acești indicatori sintetici sunt cei mai relevanți pentru etichetarea echilibrului dinamic.
- Datele analizate de majoritatea autorilor, în general, sunt legate de aspectele geometrice și proiecția centrului de greutate. În studiul de față noi am analizat și alte aspecte ale echilibrului static și dinamic. Rezultatele obținute în urma prelucrărilor statistice argumentează prin diferențele identificate la unele categorii, confirmarea ipotezelor studiului.