

**ABSTRACT OF THE DOCTORAL THESIS  
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**TITLE THESIS: Manifestation of Balance  
at Puberty Depending on Cerebral Hemisphere Dominance  
with a view to Orientation in Athletic Events**

*Key words:* athletics, balance, puberty, technical events, hemispheric dominance

The analysis of movements in sports, justified by the desire for increased sports performance, has arisen the interest of many specialists in various sciences, precisely because of the complexity and specificity of motor acts.

According to interdisciplinary approaches, any analysis of movement aims at finding those clear, systematic differences which involve two aspects: observation and interpretation.

Movement, through its dynamic features (direction, amplitude, rhythm, etc.), leads to many oscillations which put at risk the permanent state of balance. These oscillations, depending on their intensity, produce instability or disordered balance.

Effects of oscillations are subject to nervous control and analyzer action involving entry into a vast set of reflexes, which cause contraction of many muscle groups. These contractions help maintaining and controlling balance and posture during various motor acts and actions.

Maintaining balance involves the interaction of two centres for movement essential for human environmental integration (centre of pressure exerted by humans on the ground at the sole level and centre of gravity where gravity acts on humans). This interaction requires an optimum capacity of controlling the forces of human contact with external environmental forces, moving the centre of pressure below its projection of the centre of gravity, and not moving one's centre of gravity above the centre of pressure (an extremely risky action resulting in possible balance disorder).

In this thesis, we have conducted a functional experiment in order to detect differences in the expression of balance in teenagers with different cerebral hemispheric dominance. The possibility of comparing these differences to those of athletes of the same age, athletes oriented towards specific technical sports, was part of this research, which aimed at setting possible landmarks in the selection and orientation towards and in athletics, in terms of balance capacity.

Knowing that human beings manifest and best educate balance from 6 to 13 years of age, and human behaviour is also influenced by the different control of the central nervous system on psycho-motor activity, we found that establishing the possible differences in regulating balance at the age of puberty, when nervous activity is dominant, is both an interesting and innovative attempt.

For the practice of athletics performance, we consider it necessary and beneficial to approach the manifestation of balance at the age at which the bases of future performance in the sports field are being laid.

In terms of its structure, our thesis is divided into three parts, each with original questions:

- The first part highlights interesting aspects of the various studies and researches in specialized literature with reference to the subject matter of our analysis. The five chapters present issues related to psychomotor activity issues, to the relationship between puberty and specific psychomotor activity, physiological aspects of cerebral hemispheric dominance and different approaches to the concept of balance (delimitations of the notions of balance, equilibrium and stability, forms of manifestation, anatomical physiological bases, disturbance factors, description of various methods of education and assessment of this human capacity, etc.).
- Part 2 outlines the general organization of the research (hypotheses and research tasks, group of subjects, location, duration and methods used, tests applied to equipment and software used) and preliminary research results.
- Part 3 emphasizes the experiment applied in the basic research corpus, personal contributions, results and conclusions of the research, as well as bibliographic sources.

### ***Research hypotheses***

Because our research involved a preliminary observation stage and applied research, we considered it appropriate to treat assumptions separately, as they imposed the selection of different approaches to confirm or rule out certain aspects. We thus made two groups of hypotheses, preliminary research (described in Part 2 of the thesis) and for applicative intervention (exposed in Part 3 of the thesis).

#### ***Preliminary research hypotheses***

1. application of specific tests and events will highlight different aspects of cerebral hemisphere dominance for eleven and thirteen-year old children;
2. there are differences in balance manifestation caused by cerebral hemisphere dominance in children aged 11 to 13;

#### ***Applied research hypotheses***

1. cerebral hemisphere activity is involved differently in balance manifestation and control in children of 11-13 years of age;

2. balance manifestation among teenagers practicing athletic events shows significant differences in some indicators that are involved in postural control;
3. taking into account the positive transfer between some athletic events, balance manifestation analysis outlines insignificant differences between pubertal hurdling and long jump-oriented athletes.
4. balance manifestation for children aged 11-13 with different hemispheric dominance can be a criterion for driving them towards practicing specific athletic events.

In our research, we submitted a number of 80 subjects, children aged 11 to 13, divided into two groups, to a complex investigation under reproducible laboratory conditions, according to their **hemispheric dominance** and their **practicing athletics**:

- **GROUP A**: 40 subjects, children aged 11-13 years, showing different hemispheric dominance and practicing different sports activities in their leisure time, but not consistently and not at the level of performance. This group is the one which became subject to applied intervention;
- **GROUP B**: 40 children aged 11-13 years, practitioners of athletics and selected into performance groups (with a period of at least 20 months in athletic training and coach/trainer-oriented towards specializing in hurdling (B1) or long jump (B2). No intervention in the performance of daily activities was made.

Applied intervention and testing were conducted in the counties of Bacau, Argeş and in Bucharest.

To the purpose of evaluating balance in the subjects, we used static and dynamic *posturographic evaluation* by means of the SYNOPSIS posturographic system. This type of test is part of the tests which aim at determining sensory organisation.



This posturographic system has allowed a real-time display of results and allowed detection of minor changes in subjects' ability to maintain balance and adjust the static and dynamic conditions both in the presence and in the absence of visual information. There were highlighted two diagrams for the two planes of movement (antero-posterior and medio-lateral).

Posturographic evaluation included five samples. Based on data obtained from the fixed platform and, subsequently, from both platforms (Bessou mobile platform applied over the static plate for data acquisition), we could determine

the contribution of visual, vestibular and proprioceptive systems to the balance maintenance strategy.

Out of the multitude of data collected by the posturographic system, our research has aimed to identify systematic and significant differences on 30 variables analysed in the subjects (the limit of stability, the length of pressure centre oscillations on the ground, the scope of these oscillations, the Romberg coefficient, sensory organization, the involvement of loops in reflex regulation of body posture on three areas: visual vestibular area, upper nervous structures area and proprioception and skin sensitivity area).

**The synthesis of our approach** is as follows:

- determining cerebral hemispheric dominance of children at 11-13 years for composition of group A and of its subgroups (A1-children with left hemispheric dominance and A2 - children with right hemispheric dominance) – an aspect outlined in part 2 of our thesis, preliminary research;
- analysis of balance manifestation at group A level and of the significant differences between children with different cerebral hemispheric dominance – aspect outlined in part 2 of our thesis, preliminary research;
- implementation of the experiment. This experiment, conducted over 3 months, was aimed to implement a specific training program, consisting of both exercises of adaptation to the specific athletic effort and of a complex of 7 groups of 6 balance-educating exercises. Applicative intervention was conducted in training type lessons (of three parts), lasting for 60 minutes. Within a week, there were two lessons, which resulted in a total of 8 lessons per month – aspect detailed in Part 3 of our thesis;
- final testing at group A and determination of statistically significant differences between the two groups of children with different hemispheric dominance (A1 and A2). The calculation of the differences concerned the issues arising between preliminary and final testing in each group A of children, and highlighted differences between the two groups A1 and A2 - aspect detailed in Part 3 of our thesis;
- analysis of static vs. dynamic balance in group B. The calculation of the significant differences concerned the issues arising between preliminary and final testing in each group A of children highlighted the differences between the two groups B1 (hurdling-oriented children) and B2 (long jump-oriented children) – an aspect of Part 3 of our thesis. Note that work on batches B1 and B2 did not intervene with anything;
- comparative analysis of balance manifestation in both groups of subjects – presented in part 3. Existing data have imposed a statistical comparative analysis performed on the 4 smaller groups (A1, A2, B1, B2) and an overall comparative analysis between the large groups of subjects (A and B).

Comparisons were made as follows:

- Group A1 (right-handed) with group B1 (hurdlers);
- Group A1 (right-handed) with group B2 (long jumper);
- Group A2 (left-handed) with group B1 (hurdlers);
- Group A2 (left-handed) with group B2 (long jumper);
- A group (40 children 11-13 years) with group B (40 athletes from 11-13 years).

The data recorded have been transcribed into tables, sorted and processed by means of statistical mathematical methods using Office programs – Microsoft Excel for Windows and SPSS for Windows, version 10.0.

There have been calculated the following statistical indicators of trend and dispersion: the arithmetic mean, standard deviation, coefficient of variance, obliqueness (Skewness) and vaulting indicators (Kurtosis) the threshold of significance and confidence interval (Student's "T" test) equality of variances (Levenne' "F" test).

The existence of significant differences between children with either right or left hemispheric dominance (A group), on the one hand, and performance athletes oriented toward technical events (group B), on the other hand, in terms of various parameters involved in static and dynamic balance control, has been shown by running the "T" test for independent samples with group as independent variable and parameters which maintain balance as dependent variables.

### ***Contributions to the determination of balance manifestation in children of 11-13 years with a view to youngsters' orientation towards specific athletic events***

The formulation of certain conclusions referring to balance manifestation at children and the applicability of these research results into practice is a difficult target, but not impossible to achieve.

Through the present research we were able to, even if partially, elucidate certain aspects concerning the possible similarities or differences of adjustment and balance control of children and athletes of the same age (11-13 years) while aiming to discover the means by which sports performance can be improved, in an attempt to identify young athletes with special aptitudes for the practice of a successful sporting event.

Comparative analysis of the values recorded by the two groups of children with different abilities, as regards the manifestation of balance was a challenge which helped conducting an original research, new to the sports field in our country.

Those stated above are based on the following aspects of practical work in our research:

- Taking into account the existence of only 2, respectively, 3 differences between left-handed children and groups of athletes, but also the fact that there were 12 and 13 significant differences between right-handed children and athletes, we consider that the 15 reported significant differences between groups A and B were largely due to the values highlighted by children with left cerebral hemispheric dominance (right-handed);
- Compared with the athletes, group A children with different hemispheric dominance, have shown higher values in all variables which have assumed the involvement of visual information in regulating and maintaining static and dynamic balance. Thus, they emphasized the importance of the visual analyser that has a manifestation in their movements, when such movements involve stability and control of balance disorders;
- All the children of 11-13 years, who do not practice any sport at the level of performance compared with athletes of the same age, have also registered increases in values in zone 3 on the FFT graph, meaning an increased involvement of proprioceptive and cutaneous involvement at the lower limbs, when trying to maintain static and dynamic balance, both in the presence and in the absence of visual information;
- Involvement of reflex regulating loops at proprioceptive and cutaneous levels is much more active for children who do not practice any high-performance sports, compared with athletes of the same age. This involvement is interpreted by the increase in the number of additional rapid movements of high intensity, which the children must execute in order to maintain static and dynamic balance.

The review and processing of statistical data for this chapter have shown that the limit of stability (LS mm<sup>2</sup>) of athletes at the age of puberty is much higher than the one recorded by the children of the same age with different hemispheric dominance, the difference determined exceeding 2000 mm<sup>2</sup>. We believe that this difference is due to the ability of the athletes to perform much ampler rotation movements, compared with the other children under survey, without jeopardizing their body balance.

## **CONCLUSIONS**

The interdisciplinary study of the different fields with which the sporting activity is related, as well as the statistical processing of data recorded as a result of a complex balance assessment at the age of 11 to 13 has led us to synthesize the following conclusions on the issues being discussed in this research:

- Due to the complexity proven by daily activity and in particular in sports activities, balance is a capacity that allows the individual to be aware of his body and of its segments in space, to maintain or modify its position, depending on the motor tasks imposed at a specific time and in a given situation and in relation to the presence or absence of the support surface;

- Maintaining balance involves the interaction of two centres of movement, essential for human integration in the environment (centre of pressure exerted by humans on the ground at the feet level and centre of gravity, where gravity acts on humans). This interaction requires an optimum capacity to control the forces of human contact with external environmental forces and to move its centre of pressure below its projection of the centre of gravity, not to move his centre of gravity above the centre of pressure (risky action resulting in losing one's balance);
- Balance is a result of the sensorial-motor potential of the individual, which depends on the genetic dowry and the motor experience accumulated during morpho-functional and psychic development and ageing;
- Posturographic evaluation of balance can emphasize the existence of some functional asymmetries in posture control, particularly at the age of explosive pubertal changes. These incongruities can be corrected by different exercises, aiming at making these movements more efficient and using less energy for balance control leads to better performance;
- The forces acting on the body in athletics, the various tasks (to be completed in time, space), and the environment in which the task is done – all these have more or less serious impact on our balance capacity, which is permanently regulated by different compensations. Adjusting balance can be best achieved only when the athlete's biological, physiological and mental integrity allows it to happen;
- The analysis of statistical data from our research, at the level of 11-13 year-old children has outlined that *the activity of cerebral hemispheres is differently involved in balance manifestation and control* in children. This confirms the first hypothesis from which we have started our research;
- Another conclusion that we have reached during this research is that there have been noticed statistically significant differences in balance for each group of athletes under certain test conditions. This conclusion confirms the hypothesis that *balance manifestation in pubertal athletes oriented towards a certain technical event shows significant differences in some indicators that are involved in postural control*;
- From a comparative perspective between the two groups of athletes (B1 and B2), there have not been determined statistically significant differences in terms of the parameters involved in balance manifestation. This conclusion confirms the assumption that, taking into account the positive transfer between certain technical athletic events, the analysis of balance manifestation for pubertal athletes specializing in hurdling and long jump highlights lack of significant differences between them;
- In terms of the practical applicability of this research results, we can say that, as regards the manifestation of balance, 11-13 year-old children with right hemisphere dominance (left-handed) have obtained results much closer to the two groups of athletes surveyed;

- At 11-13 years, children with right cerebral hemispheric dominance (left-handed) can be easily oriented towards practicing technical sports (hurdling and long jump), having very high chances to adapt much better than the "right-handed" at motor structures imposed by these technical events;
- However, this does not mean that the "right-handed" (children with left cerebral hemispheric dominance) may not be oriented towards practicing these technical sports. Data recorded on these children, on their balance manifestations could also be reference points for their future training, so that obtaining performance can be more easily achievable, with less effort and energy saving;
- Balance manifestation in children aged 11-13 years with different hemispheric dominance can be a criterion for their orientation towards practicing technical athletic events, helping practitioners in the detection of skills which favour performance in some athletic competitions. This conclusion confirms the last hypothesis of our applied research.

### **Recommendations**

As a result of the above findings, we believe that initial selection and sports orientation should contain criteria to detect those children with increased efficiency in maintaining and regulating static and dynamic balance, criteria related to the specific event or sports field.

Taking into account that genetic dowry can not be modified to obtain superior indices for balance manifestation, practical sports activities should set as an important objective the development of a more varied motor experience under particular balance conditions, with effect upon technique correctness and upon future performances.

# Curriculum vitae

## Personal information

Date of birth: 8 March 1979, Marital status: married, Nationality: Romanian

## Professional experience

- Assistant lecturer, Ph.D candidate, University of Bacau
- Main activities and responsibilities: Athletics, Tourism and Sport Orientation

## Studies:

- National Highschool with Athletic Program, Cîmpulung, Argeş
- Bachelor of Physical Education and Sports, third category trainer in Athletics;
- Master of Physical Education and Sports (2004), specialisation „Recreative and leisure sporting bodily activities”;
- Master of Physical Therapy (2004), specialisation „Recovery from post-traumatic injuries of subcutaneous tissue” – 2007;
- Ph.D candidate at the National Academy of Physical Education and Sport, Bucharest (2005-2009);

## Personal aptitudes and competences

- First category of sport classification; third category in athletic training

## Foreign languages English and French

## Artistic aptitudes and competencies

- winner of medals at international athletics competitions, junior category; multiple national champion in athletics - 110 mg, 4 x 1 tur, multiple university champion – 60mg, 110mg (1999 - 2002), 3 years included in the Junior Olympic Centre from Cîmpulung Muscel, Argeş;

**Managerial and coordinator competencies:** coordinator and editor of student journals („Bacau Students”, „Physical Education and Sport at teh University of Bacau”, „Education through Sports”); academic coordinator, promotion 2004-2008.

## Mmembershhip in different organisions and committees

- Member of the Council of Sport Science from Romania (since 2004);
- Member of the Romanian Olympic Academy (since 1999);
- President of the „Sports for Everybody” Bacau County Association (since 2007);
- Member of the Algesiology Association from Romania (since 2004);
- Member of the Romanian Association of Posturology (since 2008);

## Scientific activity:

- author of books: „Athletics.Practical and methodological guide”, Ed. PIM, Iaşi, 2007, 147 pages, ISBN 978-973-716-548-0; 29 scientific papers published in the scientific journals of International Sessions and Conferences at which I participated in 2001 – 2008; scientific advisor for "Athletics. Specialisation" / Alin Larion, Ovidius University Press, Constanta, 2007, ISBN 978-973-614-405-9; member of different research projects at national and international level.