“BABEŞ-BOLYAI” UNIVERSITY

CLUJ-NAPOCA

FACULTY OF PHYSICAL EDUCATION AND SPORT

DOCTORAL SCHOOL OF PHYSICAL EDUCATION AND SPORT

DOCTORAL THESIS

- ABSTRACT -

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Correction of scoliotic type trunk asymmetry using exercises from basic gymnastics

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Table of content

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Introduction

Many people (especially young women and mothers of 4-14 year olds) are looking for treatment options for a common illness in the younger generation, called scoliosis. For many, the internet is the first source of information about the disease, so many are unaware of the possibilities of treatment of scoliosis and the seriousness of the illness. With a simple search on Google, you can see how many people suffer from scoliosis. There are dozens of Romanian sites where you can find useful information about scoliosis, and the comments on these articles show us that tens or even hundreds of people are looking for answers, advice, guidance, share experiences (negative and positive) and healing stories . One of the purposes of this research has been to provide current and structured information on this subject to anyone interested in this topic, whoever will browse this thesis.

Decades ago schools were the places where students and youngsters gained reliable and necessary information. Nowadays, access to information has become much easier due to the emergence and spread of the Internet. Gradually, schools and teachers will no longer be the first sources of information. Although to a certain extent the role of the teacher has changed, its presence in the proper education of the younger generation is undoubtedly important. In our country, some people in society see the profession of physical education teachers as a lower didactic occupation and the discipline as a less valuable and important component of school education, but physical education is a component of general education alongside intellectual education, moral education, aesthetic education and technical-professional education. There is interdependence between these components, forming a whole, a system.

Learning to speak for a human being is as important as learning the basic motor skills (walking, running, throwing, jumping), without which we can say that solving daily activities would be impossible. Both speech and motor skills can also be learned outside of school programs, but the learning process provided by the education system can be planned, coordinated, accelerated, evaluated, and tailored to students' needs. Although many believe that the normal posture of the body develops by itself, being an elementary function of the human body, it is related to certain conditions that will be presented in this research.

A physical education teacher must be able to grasp the difference between a healthy body and one with physical deficiencies, to observe the illness in the early stages. For this reason, he / she

needs to be properly trained during university studies, but continuous training and self-training are equally important.

At the moment, being a teacher of physical education and sports in a state school is a lifetime experience, but also a huge challenge. Since the teaching of physical education classes in primary school has been carried out by physical education teachers, their work has become harder. The lessons in primary classes differ from the lesson in secondary school or high school. Lesson in primary school consists of dynamic games, stacks, and appraisal paths (especially in the preparatory, first and second class). The exercises chosen must be as attractive as possible, otherwise they do not capture the students' attention. A teacher must prepare for a lesson in a thorough, precise and thoughtful way. Achieving the objectives of lessons is sometimes difficult, because:

- they cannot pay attention for a long time,
- the cognitive development of the students is ongoing,
- the success of child education, however, is largely conditioned by the experience, firmness and the qualification level of the teacher

Another great advantage of teaching physical education in the primary cycle too is that the teacher can see and supervise the somatic and motoric evolution of children during the years of study (6-19 years).

The school curriculum of physical education emphasizes the acquisition of specific sports skills and the development of motor skills, as well as the harmonious development of the body and the transmission of theoretical knowledge. We consider that some of the means used in physical education in schools are appropriate for correcting and removing the deficiencies, provided they are applied in an appropriate way (methodologically) and systematically.

Surveys report the increasing frequency of physical deficiencies in school-aged children. Some states (especially the western ones) have taken action to solve the problem by pulling the alarm signal to doctors and researchers.

The interest in the physical deficiencies of the spine led us to the initiation of this research, which consists in detecting the students with the thoracic asymmetry of scoliosis, following which we will carry out an experiment aimed at diminishing the asymmetry of the trunk by applying physical exercises of basic gymnastics. Having been a teacher at a school in the center of Cluj-Napoca, all the arrangements and access to all the teaching materials necessary to carry out this research were assured. The chosen theme falls into the field of sport science and physical education research. Some competencies needed to solve the chosen problem were acquired in the undergraduate studies of the

author, being part of the curriculum, but the major part was acquired during the doctoral studies. The approach of the chosen theme will not be made from a medical point of view, but from the perspective of the study of human motricity.

The first purpose of the research was to identify the TA frequency in a group of subjects, and the second purpose to analyze through statistical tests the relationship between the torso rotation angle and other dependent variables. The angle of rotation of the trunk determines the size of TA. Values ranging from 1-4 degrees are minor asymmetries of the trunk, values between 5-6 degrees are major asymmetries of the thorax and values equal to or greater than 7 degrees are severe asymmetries of the thorax.

Another purpose of the research was to investigate the possibility of treating this physical deficiency in scholar physical education lessons by using exercises from basic gymnastics. In the planning of the intervention we started from the assumption that some physical deficiencies, in our case posterior thoracic wall asymmetry, can be treated using basic gymnastics exercises in physical education lessons.

The premises of this research are the following:

• the large number of pupils with scoliosis,

• the lack of a unified screening network in Romania,

• the sedentary lifestyle of the young generation today,

• lowering the level of physical activity of society in general and of pupils in particular.

The research approach starts with the theoretical foundation by consulting the specialized literature in order to understand the problem that needs to be solved. For this reason, in the first part of the research, we dealt with the physical and psychic peculiarities of adolescent children (10-15 years), which can contribute to the physical deficiencies typical of adolescents or favor their appearance, development or aggravation, even if these particularities are not the main contributing causes of scoliosis.

At the same time, it is important to know the anatomical structure of the parts of the body and their functioning, so we will briefly discuss aspects related to the anatomy of the spine and the vertebrae. We will continue with the column biodynamics to know both the possible movements of this segment and the anatomical components involved in motor acts and actions (bones, muscles, ligaments, joints).

The second part of the research presents a pilot study on the verification of working tools and measuring equipment. All the tools and methods expected to be used were tested in a trial

screening with a class of students from the Báthory István Theoretical High School. The results of the tests and measurements were interpreted and considered as starting points for the next screening.

In the third part of the thesis are presented the personal research contributions on the AT correction program to the students of the secondary level by applying the basic gymnastics. Basic gymnastics has a wide variety of means, of which only a part is used in this program.

This part of the research began with the identification of students with AT by screening at some municipal and rural schools. After identifying subjects with this asymmetry, an experiment was run to test the effect of the intervention program, its goal being to reduce asymmetry. The experiment was conducted in the sport hall of a high school during a school year. By applying the means selected in the experiment, it has been attempted to reduce or eliminate asymmetry. The effect of the intervention was tested in several ways. The most important results were obtained by direct measurement of TA with an appropriate instrument, called the scoliometer.

The level of development of the strength of some trunk muscles and the mobility of the spine in the frontal and sagittal plane was also evaluated. We used motor tests which measure the level of development to motor skills, because AT treatment is done through exercise. These, if practiced regularly and scientifically, will exert an influence not only on AT, but also on the level of development of motor skills. In fact, AT or the value of asymmetry is somehow dependent on the physical development of a person. Several studies have shown that those subjects who practice physical exercise regularly are better developed physically and motorically. In case of these people, despite having a predisposition to the appearance of scoliosis, the disease cannot evolve as easily as in case of other predisposed people. Starting from this premise, we intend to measure not just the modifying of the asymmetry value, but also the changing values of the motor quality level.

Gymnastics is a complex sporting branch that has and uses a great number of physical exercises. Through the basic gymnastics we can influence the most important muscle groups in the human body, respecting the particularities of each individual. It is not a coincidence that in scholar physical education the selective influence of the locomotor apparatus is accomplished through the means of basic gymnastics.

My love and commitment to physical education (more exactly gymnastics) has gradually developed since the years of my studies, then during the teaching of this discipline. One after the other, the scientific papers that looked at the benefits of physical education for health have emerged; moreover, it has turned out that a lot of illnesses can be treated by practicing physical exercise. In case of physical deficiencies, the treatment applied in many cases is kinetic or orthopedic / surgical

completed by the kinetic. As a consequence, for several decades a new profession appeared, that of kinetotherapists. In general, we can say that prevention is the best way to fight disease. However, if we have not been able to prevent a disease, we have a lot better chances if we diagnose it in the initial stage of development. Screening tests help us in early recognition of diseases or signs.

Unfortunately, there are no mandatory screenings in our country. However, screening is recommended for many diseases, fortunately we have many medical examination centers, but these are not mandatory and are not supported by the Health Insurance House. Some diseases can be easily recognized from symptoms, others from clinical signs. Scoliosis is a disease of the locomotor system (spinal deviation), whose clinical signs can be recognized in the initial stage of the disease, at the same time it is a complex disease with serious consequences requiring complex treatment.

The appearance of scoliosis involves a number of problems: it changes the structure of the vertebrae and the ribs, it affects the spinal vertebral muscles, decreases the pulmonary and circular capacity, triggers the appearance of the lump on the back, can cause violent pain in the posterior thoracic wall. Various measurement tools and methods, including scoliometry, are used in screening. In our country, the screening test can be performed only in medical centers, but in some countries (will be presented in the theoretical grounding of the thesis) the screening of scoliosis is mandatory. School screenings are organized by doctors, nurses, or other people who have attended a training course. The advantage of these school screenings is that they target the group of people (10-15 year olds) who are in greatest danger. The examined sample is much more accessible, so doing the measurement requires less money and time.

Finding out about the high frequency of this physical deficiency, about the consequences of the disease if it remains untreated, and that screenings are not or rarely conducted in our country, we decided to undertake screening as a physical education teacher. I started to document, to purchase the measuring instruments, to obtain the necessary agreements, and then we measured almost 500 children aged 10-15 years in Cluj-Napoca and in a village in Sălaj County. Making screening was just the first step in our research. When we found out how frequent the severe asymmetries of the trunk are (this is the physical manifestation of scoliosis in the posterior thoracic wall due to the twist of the vertebrae and the prominence of the ribs) in the studied sample, we decided to include in an intervention program those subjects who had a severe trunk asymmetry.

The treatment of physical deficiencies is not the obligatory task of the physical education teacher, but if he is trained and has the necessary knowledge, then physical deficiencies can be treated either at the physical education lesson or at an activity similar to that of the physical education lesson

.There are few schools in the country where kinetotherapists are employed for the differential treatment of pupils with special needs. Taking into account the high frequency of children affected by this disease and the lack of staff who could deal with the differential treatment of these children, we considered the possibility of an intervention program aimed at diminishing TA in children age 10- 15. The presentation and results of this intervention program can be found in the third part of the thesis.

Synthesis of Chapter I. - Somatic, Physiological, Psychic, and Motric Particularities at Puberty

Puberty is defined by Moţet (2010, p.151) as "a period of life that marks the onset of adolescence and the beginning of sexual maturity by moving from biological childhood to somatic and sexual maturity; ... normally occurs between 8 and 18 years in girls and between 10 and 18 in boys."

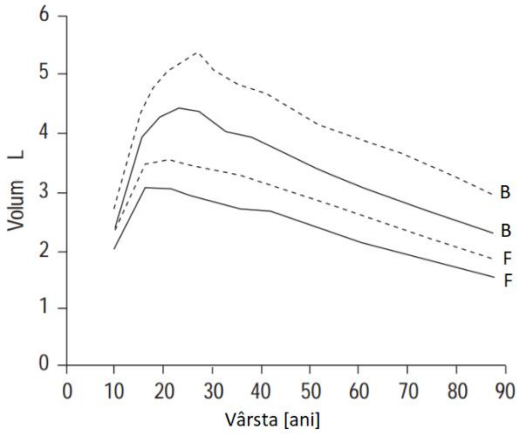
Depending on gender, puberty differs both in morphological and physiological terms. In girls, puberty is installed on average 1.5-2 years earlier than in boys, this being short and at an accelerated pace. In boys, its evolution is longer and slower. Although puberty occurs at different ages in boys and girls, both genres are accompanied by an increase of growth that significantly transforms the physical appearance of the teenager. In boys the increase in body weight is the result of increased muscle mass, and in girls more fat growth (Paul, 2015).

Since the second part of the twentieth century, there has been a phenomenon of biological acceleration in many countries, in the sense of increasing the speed of somatic growth and somatic differentiation of children. Some believe that this phenomenon in western cultures began much earlier (in the mid-nineteenth century) due to socio-economic improvements, nutrition and general health (Warren, 1983).

The volume of air that can be introduced and exhausted from the lungs varies depending on the intensity of the respiratory movements and a number of other factors such as gender, age, height, profession, training rate (Saulea and Tache, 2014, p. 20). As the age increases, the chest wall becomes stiffer, parallel to the decrease of lung distention.

Maximum pulmonary capacity is reached at age 20 in men and at age 27 in women, then decreases (Knudson, Slatin, Lebowitz and Burrows, 1976). The rate of loss of lung capacity is higher in males than in women. The annual decline in pulmonary capacity is approximately 20 ml in subjects aged 25 to 39 years, increasing to 38 ml in subjects over 65 years of age (Brandstetter and Kazemi, 1983). At this age, children's motricity is experiencing great progress. The basic motor skills and the

utilitarian-applicative skills are refined, and new ones are formed and consolidated (Mitra & Mogos, 1977). Although this period is quite disturbing, they claim that "this age is the most appropriate for the development of motor skills" (1977, p. 35). Velocity, skill, and aerobic resistance ratios are growing rapidly, but special attention must be paid to joint mobility, which, if not properly supported, may regress.



Figură 1. – Evoluția volumului expirator forțat (—) și a capacității vitale forțate (- - - -) în funcție de vârstă și gen. Notă: B - bărbați, F- femei (după Knudson, și alții, 1976)

Synthesis of Chapter II. - Morphology, biodynamics and spine function

The vertebral column consists of 33 or 34 overlapping bone pieces called vertebraes. According to the body regions at which they are found, the vertebrae bear certain zonal names:

I. Cervical vertebrae, 7 vertebrae (C1 - C7)
II. The thoracic vertebrae, 12 vertebrae (T1 - T12)
III. Lumbar vertebrae, 5 vertebrae (L1 - L5)
IV. Sacral vertebrae, 5 vertebrae (S1 - S5)
V. Vertebrele coccigiene, 4-5 vertebrae (Co1 - Co5)

If the sagittal curves are oriented with convexity before, it is called lordosis, and if the convexity is oriented back, it is called cifosis.

- cervical curvature with forward convexity (cervical lordosis);
- chest curvature with convexity back (thoracic cifosis);
- lumbar curvature with anterior convexity (lumbar lordosis);
- Sacro-coccygian curvature with back convexity (sacral cifosis).

Front curves are not as pronounced as those in the sagittal plane. Typically we encounter three curves in different regions:

- cervical curvature with convexity to the left;
- chest curvature with convexity to the right;
- lumbar curvature with left convexity (see Figure 5).

Synthesis of Chapter III. – The posture of the human body

Adolescent idiopathic scoliosis (AIS) is an abnormal deviation of the spine, which occurs in late childhood or during preadolescence (at puberty), less frequently during adolescence. Instead of spinal growth, a lateral curvature, usually in the form of an elongated "S" or "C", develops; at the same time the spinal bones are also slightly twisted or rotated around the longitudinal axis. In many cases the abnormal curvature is stable, but there is also the risk of progression because it is an evolutionary disease with a superior and inferior offset curve tendency, but without a tendency to completely reduce it by suspension. Severe and progressive curves occur more frequently in girls than in boys (Ojoga & Suciu, 2006).

Cordun (1999, p.127) defines idiopathic scoliosis as "... structural scoliosis with unknown etiology, are also called essential". A mild scoliosis generally does not cause pain, movement problems or shortness of breath, and is therefore diagnosed during a physical examination or school screening.

Scoliosis may appear as a feature of other conditions (eg, traumas, diseases of the spine), including a variety of genetic syndromes. However, AIS usually occurs without signs and symptoms that affect other parts of the body (Genetics Home Reference, 2013) (see Figure 11).

Evolution of scoliosis depends largely on the age of appearance. A scoliosis in a 4 year old girl will have a development period of about 13 years. The same scoliosis, if installed at 12 years, will have a development period of 5 years. However, the chronological and bone age will be taken into account when assessing evolution.

The link between scoliosis and thoracic asymmetry

A curvature of the spine in the frontal plane is considered a scoliotic curve if the Cobb angle value is at least ≥10º. The Cobb angle is formed by the intersection of two lines traced to a spinal radiograph of a person suspected of scoliosis (see Figure 12). The first line is drawn parallel to the

lower surface of the last affected vertebral body on the vertebral surface. The second line is drawn parallel to the upper surface of the first affected vertebral body (Sfat Medical, Keynan, et al., 2006).

The Cobb angle measurement process is presented at conceptual delimitations. To diagnose scoliosis, the clinical examination is the first and an important stage, but the complete diagnosis is made by radiographic examination, which has the role of confirming the clinical diagnosis (Nicolae, 2013). An inevitable consequence of scoliosis is the change in the physical appearance of the trunk, especially the back. It is possible to observe the protrusion of the paravertebral region on the convex part of the curvature. This prominence is called "gibbosity", and is even more pronounced as the curve is more pronounced. It is caused by the horizontal rotation of the vertebrae and the rise of the ribs (Vlad, et al., 2009).

Some authors claim that TA "can be considered as the clinical expression of scoliosis" (Nissinen, et al., 2010). TA (asymmetry of the posterior thoracic wall) - is considered by many authors as the clinical indicator of the presence of scoliosis. It can be caused by the gibbosity of the ribs and the rotation of the vertebrae (Grivas, Vasiliadis, Mihas, Maziotou, & Triandafyllopoulos, 2008). TA measurement is possible through several methods, one of which the scoliometric can be easy administered.

Tabel 1. - The risk of evolution of scoliosis in girls (Duma, 1997)

Risc de evolutivitate în funcție de vârsta scheletică °%]			
Unghiul curburii	**10-12 ani**	**13-15 ani**	**16 ani**
Sub 19º	25	10	0
20 - 29º	60	40	10
30 - 59º	90	70	30
Peste 60º	100	90	70

Synthesis of Chapter IV. - Treatment of physical deficiencies in school physical education

The physical education and sports curriculum is the official document developed by the Ministry of National Education (the current name of the institution). It provides "the content of the learning process at the different subsystems of physical education" (Cârstea, 2000, p.74). The curriculum includes the following: general and specific competences plus examples of learning activities through which specific competencies are achieved. In the current school curriculum, the notions of framework and reference objectives have been replaced by general and specific

competences. Among the framework objectives of the old curriculum was "the harmonization of their own physical development and the prevention of possible deviations from it" (Consiliul Național pentru Curriculum, 2005, p. 3). In the current curriculum, one of the general competencies refers to "The use of physical education and sport purchases for their own harmonious physical development ..." (Ministerul Educației Naționale, 2017, p.4).

The benchmarks guide us towards the expected learning outcomes at the class. One of the benchmarks that many students and adults can not achieve is "maintaining the correct posture of the body in static positions and dynamic actions" (p. 4). Learning activities provide the teacher with possible solutions to achive the objectives. The implementation of these activities during the school year is only recommended, they can be "replaced, completed or diversified, according to the concrete conditions, the experience of the didactic staff and the potential of the pupils" (p. 2). The recommended learning activities, which refer to physical deficiencies, are:

- bservation of the correct position of the body (column, segments) during the activities;
- identifying incorrect positions and actions that may lead to deviations from the correct posture;
- systematic control of the spine and body segments in static positions and dynamic activities;
- performing corrective exercises with systematic warnings and corrections (p. 4).

Synthesis of Chapter V. - School screenings for the detection of trunk asymmetry

Currently, in our country, we do not have statistically representative data on the number of subjects with the spine deviations. Jianu (2011) estimates that the number of scoliosis patients exceeds 100,000 in the whole country, starting from the fact that during the last 15 years only 14,000 patients with scoliosis have been diagnosed and treated in the clinic at "Grigore Alexandrescu" Hospital, of which 600 surgery was needed. Analyzing publications on school screening, we can see that Jianu probably underestimated the number of scoliotic persons in our country.

There were also some school screenings in Romania for the detection of scoliosis or other locomotor deficiencies, especially by various private organizations or researchers interested in the subject. Among the most significant we can mention the screenings organized by:

• Mangalia Balnear and Recovery Sanatorium - 820 children consulted (Dumba, 2013; Năstase, 2013);

• Avramescu-Opriţoiu - study done in Timişoara on a group of 308 pupils (Avramescu-Opriţoiu, 2008);

• the representatives of the Home Foundation in Zalău - 198 evaluated students (Baican, 2012);

• OrtoProfil Prod in Sibiu, Oradea, Braşov, Craiova, Târgu-Mureş - 1800 children consulted (Ortoprofil, 2009);

• a group of researchers from the Faculty of Physical Education and Sport organized an organized screening for children aged 11-12 years - 149 subjects (Câmpeanu, Vădan, Crişan, Nemeti, & Varga, 2013).

In the years 2014-2016, training programs for family doctors were announced and organized for early detection and scoliosis monitoring. "This program has the aim to bring together family doctors and orthopedic doctors for the benefit of small patients, but also to connect virtually all the geographical areas of the country so that over a year we can diagnose scoliosis among children and adolescents. " says Dr. Burnei the program initiator (apud Formare Medicală, 2016). If the promising initiative of Medical Associations in our country will be successful in the next few years or decades, we believe that they will only partially solve the problem of early detection of this disease or other deseases. The program may fail due to factors that may be the following: a) many children are not in active relationship with the family doctor; b) not all family doctors will participate in the training program; c) among those participating in the program, no one can guarantee that they will apply screening methods to patient consultations; d) Early detection of scoliosis is essential to prevent aggravation; this can only be done by periodically examining the subject.

Synthesis of Chapter VI. - Verification of working tools and intervention program

This part of the paper presents pilot research that is divided into two parts. The first part is the one in which we verified the measuring instruments. Subjects of the pilot study (N = 23) were subjected to a somatometric examination, from which we statistically analyzed the measured data. In the second part of the pilot study that includes the pilot study II, we intend to verify the intervention program will be applied to the experimental group. This study included subjects selected after the pilot study I that were eligible for the selection criteria. These were: 10 to 15 years of age, have a trunk asymmetry of at least 5 degrees, have no restrictions on exercising with medium and submaximal effort. The purpose of this study was not the representativeness of the results or the effect

of the intervention program, but only the verification of the methodology, the time allocated for the measurements, the verification of the applicability of the physical exercises within the intervention.â

Pilot study I – Verification of working tools

Objectives

To verify the work protocol, we have proposed the following goals:

• checking the measurement methodology with the working tools (scales, talimeters, scoliometers);

• calculating the working time allocated to the measurements;

• verification of the methodology for applying the questionnaire to be applied:

if the questioning is clear, unambiguous and easy to understand;

an appreciation of the time required to complete the questionnaire;

- checking the administration of the questionnaire, from distribution to receipt of the completed form and entering the replies in the database; .

• determination of the body mass index; .

• statistical analysis of the relationship between AT and other variables such as: BMI, height, gender and physical activity score.

Conclusions

The purpose of this pilot study was to verify the proposed measuring instruments for use in a subsequent study. Measurements with the caliper and the taliometer were carried out without difficulty. Measurement with the scoliometer was a bit difficult and demanding, but by exercising the measurement and applying some helpful lines to the next study, we will remove the difficulties in this study. The lines will be marked on the floor of the room or on a cardboard paper that students can step on and can guide during the assessment. We were able to perform somatic measurements and apply the questionnaire in 50 minutes to a class with a staff of 23 students. We assume that we will have no problems in conducting the measurements nor in the concluding study of the thesis.

Questions to the questionnaire were explicit, and only in a few cases we were asked questions about some phrases or notions used in the sentences. Although the questions are well formulated, we believe that the questionnaire will need to be presented in terms of how to fill it out.

No correlations were found between the ATR and the other dependent variables (BMI, SAF, genre). It is possible that we will have other results after conducting the statistical analyzes in the sample of the constatitive study which will be a much larger sample.

Pilot study II – Verify the protocols expected to be used in the experiment

ATR was the variable we wanted to work with through physical exercises borrowed from basic gymnastics. Supposed that the magnitude of the TA value will decrease until the end of this pilot study. Given that the participants in the study will practice physical exercise regularly and systematically, there will be some changes in both the TA value and the level of development of some motoring qualities. To measure these changes, we will use motor tests to measure the level of development of force and joint mobility. In many cases, physical deficiencies (especially spine deviations) depend not only on hereditary factors or the somatic development of a person, but also on the level of development of a motoric capacity. Thee low or high, possibly asymmetrical tonicity of a muscle may be a factor of the occurrence of some deviations of the spine.

Purpose and objectives

The objectives of the pilot study II were the following:

- Checking the assignment within the allocated time (50 minutes) of the exercise activities;
- verifying group work, given the large heterogeneity of the group (gender, age, level of training, type and severity of asymmetry);
- determining the optimal dosing of effort according to pupils' particularities;
- Establishing an optimal time horizon for carrying out activities;
- measuring by some motor tests the influence of physical exercises on motor abilities (force, articular mobility) in the studied group

Subjects and methods

In this pilot study, 8 subjects (5 girls and 3 boys) of the Báthory István Theoretical High School were aged between 10 and 13 years, the average age of the group being 12.07 (± 0.8) years. These subjects were selected from the first pilot study, they were part of those subjects where the major or severe asymmetry of the trunk was present. Subjects were included in Pilot Study II on the basis of the following criteria: aged between 10 and 15 years, the presence of an TA at least 5 degrees, have no restrictions on exercising with medium and submaximal exercise. In six children TA was present on the right side (four in the thoracic region, one child in the toracolombar region, one in the lumbar

region), and in two children the hump was on the left side of the trunk in the thoracic region. The mean value of TA in the evaluated group was 6.23º.

Conclusions

Restoring bone, muscle and joint balance can not be achieved without altering muscle tone and joint mobility. The results obtained at the end of the pilot study are superior to those of all the variables measured. Although these differences in the tests are remarkable, they can not be regarded as significant because of the small number of subjects.

The content of the lessons has been varied, and for this reason we have not been able to go ahead with anticipated planning. Consequently, we will reduce the number of planned exercises in the experiment sessions.

Subjects did more easily with the exercises that followed the principle of continuity, that is, an exercise, a position, or a movement that relied on some simple exercises, positions or movements that had previously been performed.

The best time to run the experiment will be after school (15 o'clock). The pilot study sample has obtained better results at final testing than at initial testing in all aplied tests. Please note that the results have not been tested statistically.

In the experiment, it will be necessary to form groups according to the gravity and the place of the asymmetry.

Synthesis of Chapter VII. - Study I - Detection of adolescence aged 10-15 years with trunk asymmetry

The present study aims to investigate a phenomenon that is very common in children, namely the trunk asymmetry. This asymmetry is caused in most cases by the uneven development of back muscles, shoulders or various developmental problems of the pelvis and lower limb inequalities. We might say that its presence is "normal," because we can hardly find adult or minor people with an absolutely symmetrical developed body from all points of view. The phenomenon is known by field specialists (physicians, orthopedists, kinetotherapists), but among ordinary people very little knows that asymmetry may have a direct link with the spinal deviation in the frontal plane, with scoliosis. Minor asymmetries are not particularly important because they can be caused by innumerable internal and external factors, so we will not insist much on them. However, accentuated asymmetries may be the first signs indicating the presence of the scoliosis or the predisposition of the person to appear or worsen.

School screening of scoliosis is in practice in some European countries as well as in other countries of the world. Periodical screenings are not made in most of the countries that are involved in screenings, but doing them with less than a yearly frequency is much more convenient. At the beginning of puberty, it is advisable to examine children (especially girls) when preventive action is still possible. The presence of some trunk asymmetries may indicate a scoliotic curvature or predisposition to the appearance of some scoliotic curves.

Structural scoliosis (true ones) have a number of clinical signs at the surface of the human body. The most obvious of these are: the asymmetric position of the scapula, the spine line is not straight (it is thrust), the uneven height of the shoulders, but all this is due to the rib cage and the rotation of the vertebrae. The rib cage appears on the back surface as a visible and palpable protrusion. This fiddiness is more noticeable when the trunk bends forward, with the relaxed muscles of the trunk and shoulders.

The difference between the right and left sides of the back is called TA. This asymmetry can be measured using several methods and tools, but these are usually not diagnostic tools. Diagnosis of scoliosis is done by radiographic examination, which makes it possible to measure the deviation by establishing the Cobb angle. An increased TRUNK asymmetry caused by the rib coziness of the ribs can be considered as the most powerful indicator of scoliosis or some structural problems of the bone or muscular system (Grivas et al., 2006). In any case, if a person has a sever asymmetry, it is advisable to consult a specialist.

Purpose - First, the purpose of this study was to identify the TA frequency in a group of subjects, and second, to analyze statistically the relationship between ATR and other dependent variables**.**

Objectives - In the design of the investigative inquiry, we considered the following general objectives of the study:

- Identification of subjects with TA by performing a school screening in some schools in Cluj-Napoca;
- Identification of subjects with TA through school screening in rural areas;
- Calculation of the BMI in order to analyze the relationship between it and ATR;
- Calculation of the SAF following the application of a questionnaire to analyze the relationship between it and ATR;
- Analysis of relationship between dependent variable (ATR) and independent variables: age and gender of subjects, home environment.

Subjects - The sample selected for this study consisted of 487 pupils aged between 10 and 15 years, 372 pupils (76.4%) of urban schools and 115 pupils (23.6%) of a rural school, (Table no.12). The percentage of pupils living in urban areas was 64.5%, while rural students were 35.5%. It should be noted that some pupils in urban schools reside in rural areas. Urban subjects were students of the Báthory István Theoretical High School (LTBI) (268 students) and Apáczai-Csere János (LTAJ) Theoretical High School (104 pupils) from Cluj-Napoca. Those in the rural area were students of Gymnasium School no. 1 from Pericei (ȘGP), Salaj County. The measurements were performed in March-June 2015.

Methods - In this study, were applied the methods used in the pilot study for checking the working tools and equipment used (Chapter VI.). Applied methods will not be presented in detail because they have already been described in a previous chapter.

The methods used were as follows:

The used desciptive methods were the following:

• questionnaire method: PAQ-C Physical Activity Questionnaire for Children

From the measurement method:

• Somatometric measurements: height measurement, body mass measurement, TA measurement.

Of the statistical methods:

• Descriptive analysis

• Significance tests

• Pearson correlation test

Rezultate - Data normality distribution testing was performed on several dependent variables, such as age, waist, body mass, BMI, and physical activity score. The test results are shown in Table 14.

Scoliotic type trunk asymmetris

In the present study, following the measurement with the scoliometer, four categories of situations were defined, depending on the severity of the asymmetry:

- 0º - symmetry
- 1º - 4º light asymmetry;
- 5º - 6º moderate asymmetry;
- ≥ 7º sever asymmetry.

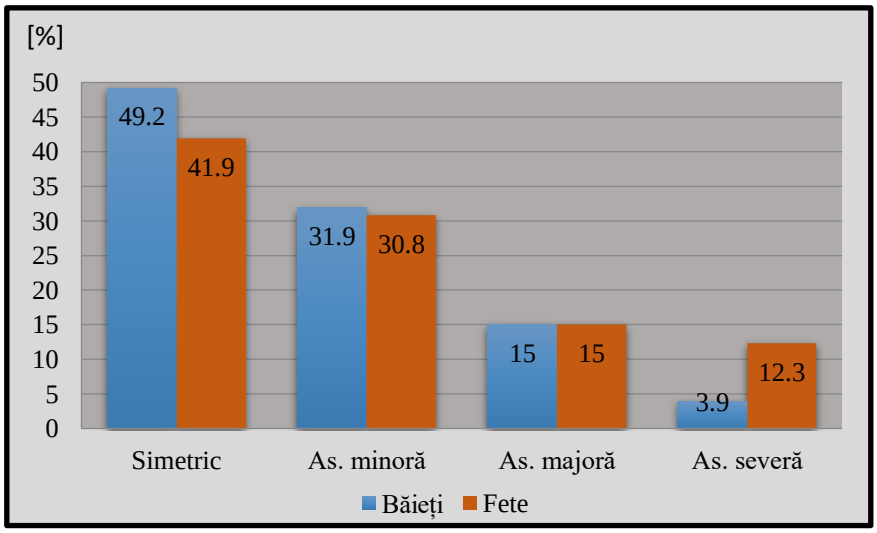
Tabel 2. - Frequency of symmetrical and asymmetrical trunk in study subjects (N=487)

Gravitatea asimetriei	Frecvency	Percentage [%]	Mean values
Symmetry	223	45,8	0

Light asymmetry	153	31,4	3,44º
Moderate asymmetry	73	15,0	5,34º
Sever asymmetry	38	7,8	8,08º
Total	**487**	**100,0**	**4,63º** (±1.80)

Of the schools included in the research, 487 students were evaluated. After analyzing the data we found that 54.2% of the students had TA (≥ 1º). The remaining students (45.8%) have symmetrical trunk in all regions (= 0º). Accentuated (major + severe) asymmetries are present in 22.8% of subjects (Table 15).

The percentage of asymmetries and symmetry was not identical in boys and girls, severe asymmetries being more common in girls, while major and minor asymmetries have the same frequency in both genres. In the symmetrical trunk group, only subjects who scored 0 degrees per



measured region (ncy was higher in boys than in girls. (Figure 16). As a result of the Mann-Whitney non-parametric test, the AT at boys (4,32º ± 1,40) was statistically significantly less than the asymmetry in girls (4,95º ± 2,09), (U = 7375, p = .026).

The chi-square test was applied to examine the relationship between genre and severity categories of asymmetry. The relationship between these variables was significant, X2 (3, N = 487) = 12,679, p = .005, which shows an association between the subject's genre and the severity of the asymmetry. The prevalence of asymmetries was the highest among urban girls (59.7%), followed by rural girls (55.4%), urban boys (52.9%) and boys from urban areas rural area (46.7%). Table 16 shows severe trunk asymmetries, ie major and severe asymmetries. Both in boys and girls, the right

side of the trunk was more affected by asymmetries than the left one. Regarding the regions of the column, the most affected area was the toracolombary area for both boys and girls.

Tabel 3. - Percentage of accentuated asymmetries by gender and spine region

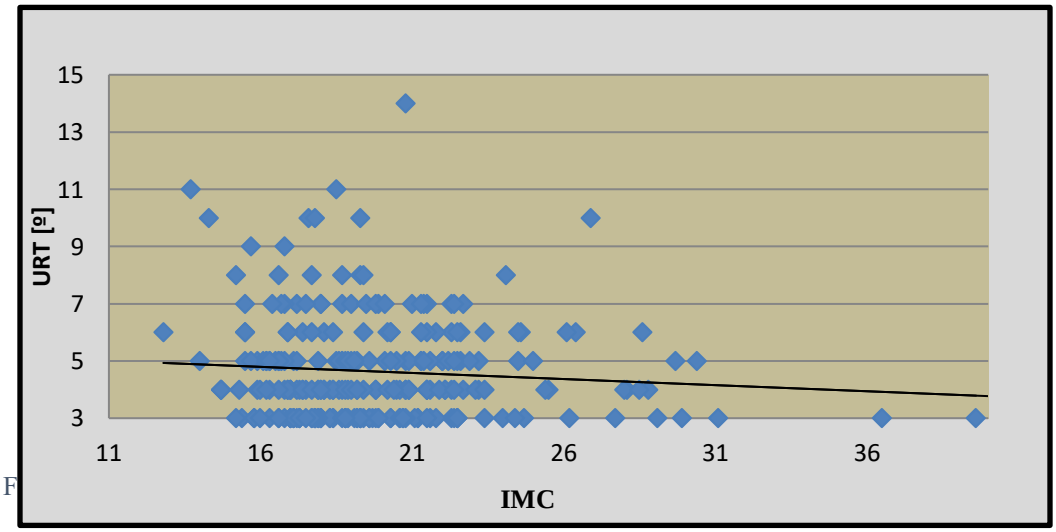
Regions of the trunk ↓	**Side of the trunk→**	**Boys**		**Girls**	
		Left	Right	Left	Right
Regiunea Toracică		2,7%	3,5%	3,1%	8,4%
Regiunea Toracolombară		5,4%	8,8%	4,0%	15%
Regiunea Lombară		2,3%	2,3%	4,0%	5,7%

The symmetrical trunk, in the case of boys, was present at the highest proportion at the age of 10 and 13 years, while the lowest proportion was reached in the 12-year-old boys. The proportion of minor asymmetries remains almost the same from 10 to 15 years, the lowest value being reached at 14 years. Major asymmetries are present in a relatively large number, the highest values being reached at 12 and 15 years. Severe asymmetries are more common in boys aged 14 to 15, while in 10 to 11 years their presence was minimal (see Table 17).

Tabel 4. - Percentage of symmetry and TA depending on gender and age

Age(years)	Symmetry (%)		Light asymmetry (%)		Major asymmetry (%)		Sever asymmetry (%)	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
10	56,5	42,9	34,8	34,2	8,7	11,5	0,0	11,4
11	48,8	47,8	34,2	19,5	17,0	21,7	0,0	11,0
12	42,3	24,4	33,7	40,0	20,2	15,5	3,8	20,1
13	52,6	50,0	33,3	31,6	12,3	7,9	1,8	10,5
14	50,7	44,9	28,3	30,6	12,0	16,3	9,0	8,2
15	45,0	42,9	30,0	28,5	20,0	14,3	5,0	14,3

The chi-square test of the association was applied to examine the relationship between the type of transport used and the severity categories of asymmetry. The relationship between these variables was significant: X2 (12, N = 487) = 21.994, p = .038, which shows an association between the means of transport used and the severity of the asymmetry.



F

The association between ATR and BMI was measured with the Spearman non-parametric test of correlation of rank, but no correlation was found between these variables (r = - 0.032, n = 264, p = .601). No correlations were found even when the test was applied only on boys (r = 0.135, n = 132, p = .122) or on girls (r = - 0.145, n = 132, p = .096). Another variable examined was the SAF. The average score was 2.72. There is no significant correlation between SAF and ATR (r = - 0.005, n = 264, p = .937). Accentuated asymmetries are as common in subjects with a small physical activity score as well as those with a medium or high score. Between the SAF and the age of the sample a very weak and negative correlation was found but statistically significant (r = - 0.205, n = 264, p = .001). In the case of girls, there is a slightly stronger correlation and inversely proportional between SAF and age (r = - 0.377, n = 132, p = <0.0005). SAF gradually decreases as the age increases from 10 to 15 years.

Conclusions – Our study highlighted the increased prevalence of TA in romania adolescence population. We would like to highlight those results and discoveries that seem to us more important.

Most of the examined subjects (54.2%) possessed a certain degree of TA. Accentuated asymmetry (major and severe) was present in 22.8% of students. Severe asymmetries are characteristic of girls, while the frequency of major and minor asymmetries was approximately equal to girls and boys. At the same time, the number of boys with symmetrical trunk was significantly higher than girls.

The number of subjects with symmetrical trunk was higher in rural areas, as was the average ART lower for those in rural areas. The severe asymmetries are characteristic of urban students. Most of the asymmetries are present in the sub-sample of urban girls (59.7%), followed by the sub-sample of girls in rural areas (55.4%). Most severe asymmetries are present in urban girls (16.7%).

Severe asymmetries are common in girls of all ages (10-15 years), the smallest percentage being 8.2% at 14 years and the highest, at 20.1% at 12 years. Among boys, severe asymmetries are uncommon, with the highest values being reached at 14 and 15 years. The right side of the trunk was more affected by asymmetry than the left one for both girls and boys. The most affected spinal region was thoracolombar.

Nearly a quarter of the examined subjects (23%) are overweight (15%) or obese (8%). It was found that at the same age there are more overweight and obese boys than girls. At the same time, the frequency of overweight and obesity is the highest in the sub-sample of boys in rural areas, the difference being statistically significant. While in rural areas 22% of boys are obese, only 7% in urban areas. This trend was also present in girls, but their values are lower (6% in rural areas, 3% in urban

areas). This finding was in line with the results of other studies conducted in Romania and Europe.

The physical activity level of the sample was moderate (SAF = 2.72), the mean score being inferior to the values of the groups included in the analysis. The highest values are boys and girls in the urban area, followed by boys and girls in rural areas.

Regarding the correlations, no correlation was found between the BMI and the ATR at the level of the entire sample, but there is a very poor and negative one for the boys who have an increased asymmetry (≥5 °).

The magnitude of the angle was higher in subjects traveling through bus and car schools than those who walked to school. No correlation was found between SAF and ATR for either girls or boys. An inversely proportional relationship was found between the SAF and the age of the subjects, which means that elderly growth results in lowering the physical activity score (level). ATR has no significant relationship with the age of subjects, asymmetries are present at all ages.

ATR has no significant relationship with the age of subjects, asymmetries are present at all ages:

- severe TA are more common in girls than in boys;
- TA (light, major and severe) are relatively common in both genres;
- Severe asymmetries are characteristic of urban subjects;
- Most asymmetries are found on the right side of the chest and in the toracolombar region of the spine;
- The level of physical activity was average in the studied sample, SAF being higher in urban subjects;
- Boys are more overweight and obese than girls, rural subjects being more obese;
- There is a statistically significant relationship between ATR and the gender of subjects, as well as between ATR and the home environment;
- There is no statistically significant relationship between ATR and subject age, ATR and SAF, ATR and BMI.

Synthesis of Chapter VIII. - Study II - Correction of trunk asymmetry in 10-15 year olds through basic gymnastics exercises

The chosen theme is in the field of physical education and physical therapy, and the main objective was to experiment with a physical exercise program based on basic gymnastics (such as free exercises, exercises with and on apparatus, and exercises with objects) to reduce TA present in subjects of this research.

After identifying the subjects with these asymmetries, we developed an intervention program based on the basic gymnastics, in the form of physical education lessons, the physical activities being carried out only with those material bases that have the school unit in which the intervention took place.

Over 260 subjects with trunk asymmetries were identified, 73 of whom had asymmetries between 5º-7º and 38 subjects had severe asymmetries (≥7º), were found after school screening. Subjects with ≥5º asymmetries were included in an experimental program whose purpose was to reduce TA.

education, the objectives of physical education can be fulfilled, among which we mention "... maintaining an optimal state of health ..." (Cârstea, 2000, p. 32) and "influencing the normal growth of the organism, the harmonious physical development ... "(Mitra & Mogos, 1980, p. 28), we decided that in these activities we would apply only exercises from basic gymnastics.

If the treatment of asymmetry is done by exercising regularly and scientifically, we will exert influence not only on TA but also on the level of development of some motoric qualities. In fact, TA or the value of asymmetry has been dependent on the physical development of a person. Several studies have shown that those subjects who practice physical exercise regularly are better physically and motorically.

These, despite having a predisposition to the appearance of scoliosis, the disease does not evolve as in other predisposed individuals. Starting from this premise, we intend to measure in addition to modifying the asymmetry value and changing the values of the motor quality level. Consequently, we will perform three motor tests to measure the strength of different muscles and two motor tests to measure joint mobility.

Purpose and Objectives - The aim of this study was to correct the thoracic asymmetry and to verify the level of development of physical abilities following the application of an intervention program for the treatment of adolescence idiopathic scoliosis in the physical education lesson**.** This experimental study has proposed the following main objectives:

- diminishing AT by using exercises in basic gymnastics;
- development of the spinal mobility in the frontal and sagittal plane;
- developing the strength of the abdominal and dorsal muscles of the trunk.

In addition to the main objectives, we have also decided to determine the level of physical activity through two questionnaires. The purpose of questionnaires was to measure the level of physical activity of the subjects before and during the intervention..

Hypothesis

In this study, it was hypothesized that by applying a basic gymnastics exercise program to students with moderate asymmetry of the trunk, in activities organized in the form of physical education lessons, it contributes to reduce the frequency and decreasing the ATR.

Subjects and methods

Subjects

A sample of 41 subjects (14 boys and 27 girls) participated in the study, students from the Báthory István Theoretical High School in Cluj-Napoca with asymmetries ≥5º, divided into two subgroups: the experimental group of 20 subjects (13 girls and 7 boys aged between 10.3 and 13.8 years) and a control group of 21 subjects (14 girls and 7 boys aged between 10.4 and 14.3 years). In the case of the experimental group, the right prominence was present in 12 subjects and the left prominence (60% -40%) in 8 subjects. In the right prominence control group was found in 16 children, respectively left in 5 children (76% -24%).

Participation in the experiment was voluntary on the part of the subjects after the written consent was completed by the parents or guardians of the subjects. In the experimental group were accepted all students who wanted to participate in the organized activity. The control group included students who did not want to participate in the activity.

Methods and measuring tools

In order to evaluate the effect of the TA reduction program, in addition to measuring TA, a series of motor tests were used. The most important variable investigated was TA, which was measured using the scoliometer. The intervention program aimed at developing the strength of muscle groups that act directly or indirectly on the spine and at the same time increasing the articular mobility of the column in order to reduce TA, so the effectiveness of the program can be assessed by some motor and mobility tests. First of all, it is about driving tests that measure the level of development of the force of muscle groups and those that measure the mobility of the spine directly or indirectly. These tests are as follows::

A) Adam's test - forward bending test and scoliometric measurement to determine ATR.

B) Somatic measurements: measurement of weight and height.

C) Motor test (1), to measure the abdominal muscle endurance force.

D) Motor test (2), to measure the level of isometric strength of the back muscles in the resistance mode.

E) Motor test (3), long dorsal support, holding position. With this test, the level of development of the strength of the back muscles and the buttocks in resistance mode was measured, the muscular contraction being isometric.

F) Mobility Test (1) from the initial position standing, bending the trunk to the side. With this test the amplitude of the bending of the spine in the frontal plane was measured.

G) Mobility Test (2), torsion of the trunk forward from the lying position. With this test the mobility of the spine and coxo-femoral joint was measured.

Experimental method

In order to test the hyphothesis, a quasi-experimental design was used, because the requirement of random selection of the subjects was not satisfied. In the experimental group were included all subjects who had the intention to participate in the practical part of the experiment, and the control group included those who did not want it but accepted to be tested at the beginning and at the end of the experiment. So we do not have a random division of the subjects, but the groups are equivalent and we have two measuring waves. The phases of intervention for each sample are as follows::

Expermemtal group	O_1	X	O_2	Rt
Control group	O_1	-	O_2	Rt

The research was conducted in four phases:

1. Measurement (O1), ie initial group testing;
2. Phase of intervention (X) between the two measurements;
3. Measurement (O2), ie final group testing;
4. Retesting subjects (Rt) after a period of time to see the persistence of the effect of the intervention.

Variables of the study

The element manipulated in the study refers to the intervention program which tried to reduce the trunk asymmetry.

Independent variable: TA correction program.

Dependent variable: - ATR;

- abdominal muscular force in speed mode;
- endurance strength of the back muscles;
- endurance strength of back muscles, isometric contraction;
- mobility of the spine in the frontal plane;
- mobility of the spine and co - femoral joint.

Another important element in design was the isolation of other independent variables, such as independent physical activities and sports training. During the 8 months of intervention, subjects were asked to continue the regular activities as they did before the experiment.

The goal of corrective physical exercises after Antonescu, Obraşcu and Ovezea (1993) consists in the spinal collapse by:

- strenghtening the spinal muscles (especially the convex side of the curvature);
- strenghtening of the muscles on the opposite side of the convexity;
- reduction of hump (TA);
- development of scapular belt mobility;
- development of trunk force;
- forming the reflex of correct attitude.

Physical exercise is the main group of didactic tools applied in the activity of physical and sports education, but also in active kinesiotherapy. The proposed objectives of the activities are achieved with their help, but optimal efficiency can only be achieved if they are done in a scientific way.

"Physical exercise is the basis of active kinesiotherapy and represents systematic motric action, which is the main means of accomplishing the tasks of kinetotherapeutic program" (Câmpeanu, 2008, p. 43).

The adapted yearly plan of the intervention program presents the thematic components, the reference objectives, the means of action of the intervention. The plan is in the appendix of the thesis (Anexa 8).

The static and dynamic exercises applied in the intervention program in the form of symmetrical and asymmetric exercises are the following:

1. Exercises for breathing;
2. Trunk exercises;

3. Combined exercises (trunk, legs and arms);

4. Exercises with portable objects:

    a. With a medicinal ball

    b. With a stick;

5. Applied exercises;

6. Exercises with a gymball.

7. Stretching exercises;

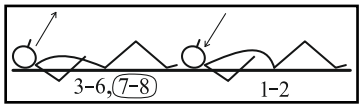
8. Stall bar exercises;

Ex. 1. *P. I. culcat dorsal cu picioarele îndoite, mâinile sub coastele flotante:*

T 1-2: inspirație cu bombarea abdomenului;

T 3-6: expirație lentă cu încordarea musculaturii abdomenului;

T 7-8: pauză de respirație.

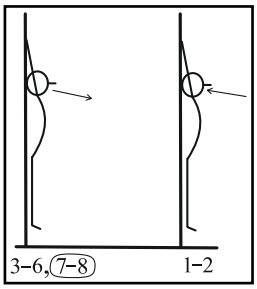


Ex. 2. *P. I. Atârnat dorsal la scara fixă:*

T 1-2: inspirație;

T 3-6: expirație lentă;

T 7-8: pauză de respirație.



Results

Since the sample is less than 50 subjects, testing of the normality of the data distribution was performed with Shapiro-Wilk test. Test results are shown in Table 20. Data is normally distributed across most variables. Consequently, we will use both non-parametric and parametric significance tests depending on the type of the tested variable.

In order to test the hypothesis, motor tests were applied and the central values specific to each group were calculated. Comparing the mean values obtained in the control and experimental groups, there are significant differences between the results of the motor and TA tests. The results of the experiment are synthesized and illustrated in the following tables and figures.

Analysis of the data referring to trunk asymmetry

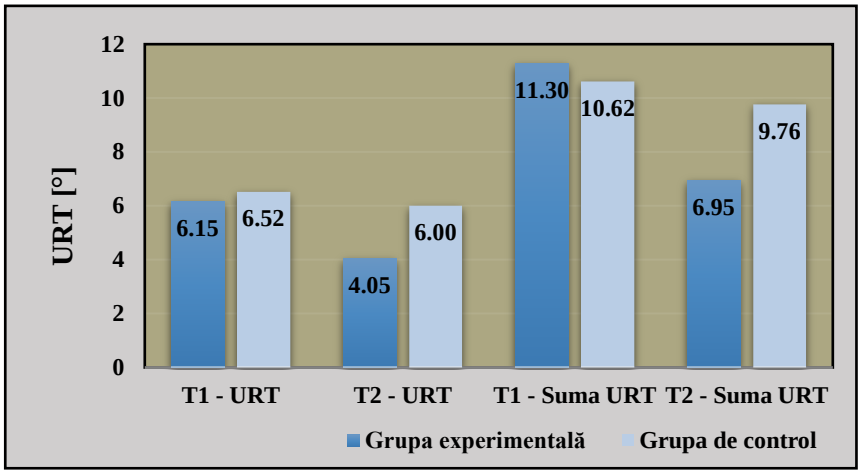
We believe that the success of the intervention is primarily reflected in the manipulation of the dependent variable (ATR).

The mean asymmetry in the experimental group at the beginning was 6.15º (± 1.56º) and 6.52º (± 1.66º) in the control group. The difference between the mean values of the groups was statistically insignificant, U = 177.5, p = .380. We mention that the highest value of the three measured values was included in all statistical analyzes, for example: in the thoracic region, an asymmetry of 3º was measured in the torso-cylindrical region 7º and in the lumbar region of 5º. In this case the statistical analysis included the value of the toracolombar region (7º).

To make sure that there is no difference between the averages of the two groups, we have gathered the values of the asymmetry of each region, so we received the sum of the asymmetries. The mean value of the asymmetries gathered in the experimental group at the initial testing was 11,30º (± 5,93º), and 10,62º (± 3,82º) in the control group, the difference between the mean of the groups being again statistically insignificant, U = 206, p = .917.

At the end of the experiment the measurements were performed under the same conditions and with the same instruments as at the beginning of the experiment. In the final analysis, the results obtained in the Adam's test were superior to the initial results in the entire sample of the experiment (i.e., the asymmetry value decreased). The mean asymmetry in the experimental group at the final test was 4.05° (± 1.66 °) and 6.00° (± 1.94 °) respectively for the control group. The difference between group averages was statistically significant: U = 92.5, p = .002. The decrease in TA in the experimental group was 2,10º, while in the control group of 0,52º (see Figure 37). Consequently, the statistical analysis of the results shows that AT decreased significantly in the subjects who participated in the experiment. The magnitude of the effect was estimated by Cohen's coefficient, d = 0.95.

Analyzing the sum of asymmetries (thoracic asymmetry + thoracolombar region asymmetry + lumbar asymmetry), we note that the results of the first test are confirmed and between these mean values the difference was statistically significant U = 117, p = .015 Both in the experimental group and the control group can see the decrease of asymmetries, but in the experimental group the amount of reducing was higher.



Notă: T1 = testarea inițială; T2 = testarea finală.

Figură 3. – The values of trunk asymmetry in the control and experimental group at initial and final testing

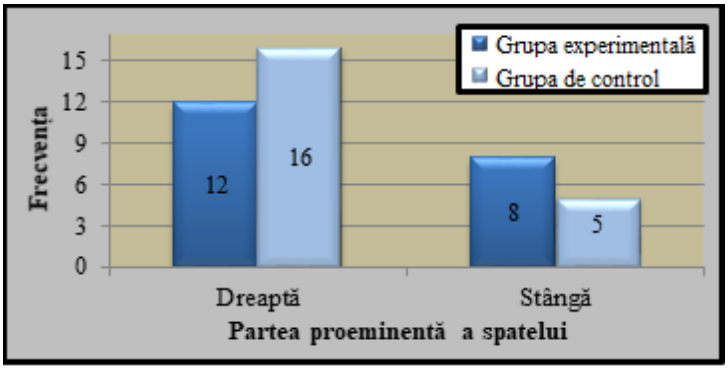
The Wilcoxon test shows that the intervention program resulted in a significant decrease in TA (Z = - 3.710, p = 0.000). The median TA was 6º before the intervention and 4º after. In the case of the control group the difference remained insignificant (Z = - 1.555, p = 0.120). The median TA was 6º before the intervention and 5º after.

Tabel 5. - Frequency of ATR value by group and test

Valoarea URT [°]	**Grupa de experiment**				**Grupa de control**			
	Testarea inițială		Testarea finală		Testarea inițială		Testarea finală	
	N	Procentaj %	N	Procentaj %	N	Procentaj %	N	Procentaj %
1	0	0	4	20.0	0	0	0	0
2	0	0	4	20.0	0	0	2	9.5
3	0	0	5	25.0	1	4.8	2	9.5
4	9	45	4	20.0	6	28.6	7	33.3
5	6	30	1	5.0	4	19.0	1	4.8
6	1	5	1	5.0	6	28.6	5	23.8
7	3	15	1	5.0	1	4.8	1	4.8
8	0	0	0	0	1	4.8	2	9.5
9	0	0	0	0	2	9.5	1	4.8
10	1	5	0	0	0	0	0	0

The frequency of asymmetries has changed visibly from the beginning to the end of the experiment. The most frequent pre-test asymmetries were 4º-5º-6º, and at the end of the experiment their number decreased, especially in the experimental group (Table 22)..

The first study found that the proeminences are at least twice as frequent on the right side of the back. Analyzing the asymmetries of the subjects included in the experiment, it can be observed that the tendency is also present in this sample (Figure 38)..



Figură 4. - Frequency of proeminences depending on the sides of the back

Some study variables have been subjected to correlation analysis to verify the presence or absence of significant statistical associations. The relationship between ATR and SAF (according to the FELS questionnaire) was evaluated on the experimental sample (N = 41) with the Pearson correlation test, but no correlation was found (r = - 0.032, p = 0.842) (Figure 46). Also, there is no correlation between SAF (according to the FELS questionnaire) and BMI of the experimental group (r = - 0.139, df = 40, p = 0.387). Second, the relationship between ATR and SAF (PAQ-C) was evaluated. The mean SAF was 2.84 (± 0.61) and the TA at 6.34 ° (± 1.60). No correlation was found between the variables analyzed (r = 0.065, df = 40, p = 0.686) (Figure 47). As shown above, neither the analysis of the FELS questionnaire results resulted in a significant correlation between ATR and SAF, irrespective of the length of the period (one week or a year) to which the questions refer..

Retesting the groups

In order to see how the physical exercises applied in our intervention were effective, in September of the 2016-2017 school year we reapplied Adam's test and scoliometric measurement. The retest step took place within 4 months of the end of the formative experiment, and aimed at verifying the stability of the results obtained during the experimental period. The retesting of subjects in the experimental and control group was aimed at validating the experimental intervention. Through this retest, we sought to identify the long-term URT stability and reconfirmation of the research hypothesis. The two groups were again assured of equal testing conditions.

It has been seen from the beginning of the experiment that the subgroups formed are equivalent from all points of view considered, despite the fact that the requirement of random division was not satisfied.

The mean TA of the control group at the end of the experiment was 6.0°, while in the experimental group of 4.05°. Within the next four months, until retesting, small changes occurred in both groups, with respect to the mean value of TA. In those in the control group the TA value decreased to 5.76 °, and to the experimental group at 3.95 ° (see Figure 49).

We used the Wilcoxon test to see if the TA remained stable or there were significant changes in its size. Statistical analysis shows that no significant change in the mean value of TA was observed, neither in the control group ($Z = - 1.147$, $p = 0.251$) nor in the case of the experimental group ($Z = - .632$, $p = 0.527$).

Based on the statistical analysis, we can say that the effect of the experimental intervention was stable, at least between the end of the intervention program and the retesting of the groups.

Conclusions

The objective of this experiment was to propose a program based on basic gymnastics and to test efficiency in the case of pupils with moderate or severe trunk asymmetry.

During the experiment, static and dynamic, symmetrical and asymmetric exercises were used. Of particular importance were exercises with portable objects, whose beneficial effects have long been known, as well as stall-bar exercises and stretching exercises.

The results of the experiment have shown that the exercises used to improve TA and develop motor abilities are effective and we recommend using them in physical education lessons or other physical activities, specifying that they are adapted and completed according to the age of the subjects, the type of physical deficiency, the existing material basis and the level of motor abilities of students. Both the main objective of the experiment (improvement of TA by applying basic gymnastics exercises) and the secondary ones (development of trunk force and increase of articular mobility of the spine) have been achieved.

Experimental research, through applied strategy and test results confirms the hypothesis that TA can be diminished or eliminated by applying basic gymnastics exercises, of which we refer to exercises with portable, free-standing exercises with a bench bench and a fixed scale. TA significantly diminished in the experimental group with respect to both its own results and the results of the control group.

Educating a proper body posture and properly treating students with deficient physical attitudes is possible by a physical education teacher if he/she has received the necessary qualifications during university studies. Consequently, it is recommended to include physical therapy disciplines in the field of university studies at the faculties of physical education.

Equally important is the identification of deficiencies at an early stage, when there is the possibility of correcting completely or preventing the aggravation of that deficiency, but also in this case the teacher's multilateral qualification is indispensable, and last but not least must have the obligation to find the children who have deficiencies.

During physical education classes there is a good opportunity to observe children with physical deficiencies, intellectual disabilities, low levels of motor skills development or insufficient mastery of basic or sporting driving skills.

Most parents do not have the necessary knowledge about the severity of the physical deficiencies that may be present in their children. Children's parents have been informed through several ways of communicating, but have remained equally disinterested in the health of children, many believing that the deficiency is not important until it is accompanied by considerable pain.

Study boundaries

The experiment itself took place over a school year, and this overlapped with the maturation period of some students enrolled in the study. It is not excluded that the anatomic and physiological changes in the body of the subjects influenced the final results of the experiment.

Progress in developing motor skills is all the more positive as students' attitudes towards activity and the greater the personal significance for them. Learned and energetic students were much more alert to guidance, and their execution was more accurate.

The participation in the experiment was voluntary on the part of the students, but some of them did not come willingly, they were forced by their parents. In such children it became necessary to accept the activity and to detail the importance of carrying out those exercises.

Proposals

1. Including in the curriculum of faculties of physical education and sports theoretical and practical disciplines related to the recognition and treatment of the most frequent physical deficiencies in school-age children. As shown in the presentation of school curriculum provisions (Chapter 4.1.), Some physical deficiencies can be dealt with in physical education and sports lessons, but we must recognize that physical education is not the most appropriate activity for many reasons, such as classroom size, class heterogeneity, incompatibility of topics, supervising executions if the teacher's attention is divided, etc. We believe that involvement of teachers in detecting physical deficiencies (by simply recognizing deficiencies in activities) would be of great help.

2. Performing regular school screenings by doctors and school assistants. These screenings can be performed at any time of the school year, more important is the age at which students are examined. The ideal age for girls is 10-11 years and 13-14 for boys. In girls, screening should be repeated at least once a year, but it would be ideal to make it up to the age of 14..

3. We consider it necessary to inform and involve parents in the early detection of physical deficiencies. Physical signs of scoliosis are visible in the back. Parents of children, if well informed, can recognize these signs easily, after which, in consultation with an orthopedic physician, they can have complete diagnosis. Parents are the ones who have permanent contact with their children, so they can monitor body morphological changes much more frequently than any other person.

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