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Research article

Scoliotic postural alignment in prepubertal children: somatoscopic analysis of anatomical landmarks and development of a working model to limit spinal changes

Mihai Constantinescu [1], Ilie Onu [2,3,5,*], Dan Trofin [2], Laurențiu Gabriel Talaghir [4,5,†], Daniel Mădălin Coja [4,5,†], Daniel Andrei Iordan [4,5,*], Florin Filip [6], Sînziana-Călina Silişteanu [6], Elena Vizitiu [7,†], Carmina Liana Musat [8,9,†], Oana-Diana Hrisca-Eva [2]

1 Faculty of Physical Education and Sport, Stefan cel Mare University of Suceava; University Street, 720229, Suceava, Romania;
2 Department of Biomedical Sciences, Faculty of Medical Bioengineering, University of Medicine and Pharmacy "Grigore T. Popa" Iasi, 700454 Iasi, Romania;
3 Department of Physiotherapy, Elipetro Med Clinic, 610119 Piatra Neamt, Romania;
4 Department of Individual Sports and Kinetotherapy, Faculty of Physical Education and Sport, "Dunarea de Jos" University of Galati, 800008 Galati, Romania;
5 Center of Physical Therapy and Rehabilitation, "Dunărea de Jos" University of Galati, 800008 Galati
6 Faculty of Medicine and Biological Sciences Stefan cel Mare University of Suceava, University Street, 720229, Suceava, Romania;
7 Interdisciplinary Research Centre for Motricity Sciences and Human Health, Stefan cel Mare University of Suceava, Romania;
8 Department of Morphological and Functional Sciences, Faculty of Medicine and Pharmacy, 'Dunarea de Jos' University, 800008 Galati, Romania;
9 'Sf. Apostol Andrei' Clinical Emergency County Hospital, 800578 Galati, Romania

* Correspondence: ilie.onu@umfiasi.ro (I.O.); daniel.iordan@ugal.ro (D.A.I.)
† This author contributed equally to this work with the first author.

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Abstract: Background. The study aims to perform a somatoscopic analysis on a sample of 100 prepubertal children aged 10-14 years, girls and boys, who are diagnosed with scoliosis. Somatoscopic assessment is one of the most commonly used, therefore we thought that making a way of interpreting the results could be useful to monitor postural attitude in children diagnosed with scoliosis. Identifying the early onset of physical impairment in the spine with somatoscopy can be a key factor in maintaining optimal postural status. This approach may help in achieving a way of working that limits the negative effects of scoliosis on the subjects. **Materials and methods**. The selection of subjects is based on exclusion and inclusion criteria related to age, comorbidities, therapeutic approach, and other criteria. Also, aspects that accompany the growth and development process of children in this prepubertal period and factors that may disturb this process are described in detail. Also in this context, we will present basic notions of body posture and etiopathogenesis of the onset of scoliotic deficiencies in children during this period of growth and development. Somatoscopic analysis is performed in the orthostatic position and is based on the identification of anatomical landmarks of the body concerning body posture. **Results**. From the total analyzed scoliosis, n = 100, 74% are type „C" scoliosis and only 26% are type „S" and in terms of gender, 59% are girls and 41% boys; type „C1" (Cobb angle <100) scoliosis n = 60, with an angulation < 100 are 43.24% stabilized, therefore type „C1" scoliosis are more likely to be stabilized. „S"-type scoliosis with an angulation < 150 is only 3 cases representing 11.53%, and those with an angulation from < 200 to < 400 are number 23 cases 88.64% which concludes that „S" type scoliosis is more aggressive and more difficult to manage. Conclusions. Our study show that only 13% of the subjects had a regression of the angulation following the kinetotherapy program, therefore the main objective remains to stabilize the scoliosis attitude and limit the effects of this pathology. A regular assessment and somatotopic analysis resulting in a physiotherapy exercises program containing corrective postural postures and postural education is the most beneficial approach to stabilize the postural deficit.

Keywords: prepuberty, posture abnormalities, scoliosis, somatoscopy, physiotherapeutic assessment

1. Introduction

The prepubertal period begins for both genders at around 10-11 years of age and lasts for an average of two years for girls up to 12-13 years and four years for boys up to 14-15 years. Moțet in 2011, specifies some aspects concerning the transformations that occur during this period of growth and development of children. The rhythm of children's growth and development in the pre-birth period, it is characterized by a rapid growth in height without a corresponding increase in weight and we will see what problems this creates in the overall economy of growth and development [1].

The structure of the skeletal system at this age is in formation, the bones are long and thin, muscle development is insufficient, and the joints are in a state of marked ligament laxity, which favors a lack of stability and, implicitly, the appearance of functional physical deficiencies, vicious postural attitudes which, once installed, have an evolutionary trend and are difficult to stabilize and correct.

In addition to these structural and functional inconsistencies, imbalances between the relationships of segments or even organs are sometimes observed - long and thin arms, bulging or flattened thorax - this is accompanied by functional or psychological disorders [2].

This prepubertal period is marked by the accelerated process of growth in height and weight, the intensity being greater in girls than in boys. For height, the acceleration starts at 11 years old and lasts until about 13 years old, and for weight, it lasts until about age 14. This period is unique in the human growth and development process when the most representative somatic values are higher in girls than in boys [1,3].

The dynamics of growth and development in this period, particularly prepubertal growth, come with a complex of specific changes. The organs and vital functions are continually improving, the bone system is improving its structure, and it should be noted that the bones of the ribcage and the spine are not strengthening at the same rate, which favors the appearance of growth disorders (sloping shoulders, sunken chest, rounded back, lordosis, scoliosis, etc.). It should be noted that these disorders in the development of the bone system not only lead to postural deficiencies but can also affect cardio-respiratory function or the nervous system [4].

In the pre-pubertal and particularly post-pubertal period, when growth processes are more rapid in the skeletal apparatus, with growth in length and less in thickness, so that height is the one that stands out, and the supporting muscles are deficient, malalignment of the structures of the musculoskeletal apparatus is favored. The muscular system also develops at a marked rate, along with the nervous system, which explains the dynamism, mobility, and desire for activity of children. The pubertal stage is characterized by multiple and intense transformations for most of the body organs and systems, including body composition indicators [4].

Deviations from normality, whether of an attitudinal or deficiency nature, are caused by a large number of pathogens of internal or external origin, which act on the body as predisposing, promoting, or triggering factors. These causes lead to the production of global or segmental physical deficiencies of the neuro-myo-arthro-kinetic apparatus: bones can become the cause of deficiencies when, through unequal positions, asymmetries are produced, joint mobility when it is in excess or reduced can create imbalances, limiting the physiological range of movement. Vicious or deficient posture implies a normal deviation from the body shape, without morphological support [5].

Functional deficiencies deviations, postures, or deficient attitudes as representing disorders of the support and movement function of the body, always attracting muscular imbalances that will disrupt the movement. If these deficiencies are not detected in time, they will turn into structural deficiencies that will produce degenerative degradations, which become functionally or even organically fixed, turning into deformities [5].

The most serious segmental deficiencies, the most important in terms of the consequences and complications that can result are, kyphosis, lordosis, scoliosis, and combinations of these. The etiology of functional deficiencies is very varied and widely debated in the literature, some authors mention that aetiological factors may act directly on the spine, producing deformities and deviations of various types and may also affect other segments or anatomical structures of the body, causing an imbalance of statics and dynamics, transmitted from step to step to the spine [6].

Among the etiological factors in the appearance and development of spinal deviations, the following are highlighted: congenital malformations of the vertebrae and ribs, rickets acting in early childhood, infectious diseases such as poliomyelitis, tuberculosis of the vertebral bodies, rheumatic and traumatic causes, sequelae of thoracic surgery. In addition to the causal factors listed above, in the prepubertal period, we also have the favoring factors that maintain or aggravate static disorders (nutritional, and metabolic disorders) [6].

Zaharia et al. 1980, in the paper "Scoliosis", a chapter dedicated to the etiopathogenesis of scoliosis, states that the oldest hypotheses can be grouped into two theories: the musculo-ligamentous theory and the osteopathic theory [7].

Unlike sagittal plane deviations, which are more difficult to detect, frontal plane spinal deviations, even the more discrete ones, are easily observed, as the normal spine has no physiological curvatures in this plane. In the frontal plane, forms of spinal deviations with one, two, or more curvatures, structural and non-structural deviations, with or without vertebral rotations, with or without thoracic deformities in the vicinity are described. This category of spinal deviations includes scoliosis and kyphoscoliosis [1,7,8].

Scolioses, whose etiology cannot be specified, are defined as idiopathic scoliosis, while progressive scoliosis is called scoliosis disease.

Non-structural scoliosis: is largely reducible (correctable), especially when discovered early, when the static component can be remedied, and when there is conscious, active participation of the person concerned [9].

Structural scoliosis: involves vertebral deformities of varying degrees, leading to more or less pronounced vertebral rotations and various deformations of the chest. They may sometimes be accompanied by disorders of the intervertebral joints and discs (osteoarthritis, disc disease), disorders of muscle tone and trophicity (contractures, retractions), and nerve damage due to tension or compression [9].

Scoliosis, like other spinal deviations, can be classified as hereditary, congenital, or acquired scoliosis.

Congenital scoliosis: the result of malformations due to distortions of the physiological curves or morphological abnormalities (Klippel-Feil's morbus, hemivertebrae, congenital synostosis, etc.) [9].

Acquired scoliosis can be differentiated into:

- scoliosis of osteogenic nature, a product of degenerative bone processes (rickets, osteomalacia) or a consequence of Pott's disease, osteomyelitis, vertebral fractures, or Paget's disease;
- arthrogenic scoliosis - caused by deforming or ankylosing spondylitis or other forms of arthropathy;
- myogenic scoliosis - caused by disturbances of muscle balance following poliomyelitis, spastic paralysis, and various myopathies;
- static scoliosis due to differences in length of the lower limbs, pelvic asymmetries, or large functional and weight differences of the upper limbs, as in paralysis and especially in amputations;
- post-operative, post-traumatic scar scoliosis or following severe burns of the chest;
- antalgic scoliosis - caused by the pain that can accompany various spinal injuries or visceral disorders. The most common of these are sciatica;

- habitual postural scoliosis - generally caused by frequent repetition or prolonged maintenance of asymmetrical positions;
- idiopathic scoliosis (with unknown cause), which has raised and still raises major problems because of its evolutionary nature and the generally pessimistic prognosis that characterizes it [7].

The classifications developed according to the imaging investigation are presented by Jianu in 2010: according to the X-ray of the face, in several topographic forms, the basic landmark being the "tip" vertebra; forms with one curvature of 70%, and with two curvatures 30%. We can find cervicothoracic, thoracic, thoracolumbar, and lumbar scoliosis. Single main curvature scoliosis („C"-shaped scoliosis), very rare cervicothoracic, thoracic scoliosis 25% of idiopathic scoliosis, thoracolumbar about 20%, lumbar scoliosis. Scolioses with two main curves (double or „S" scoliosis), account for 30% of idiopathic scoliosis, thoracic and lumbar scoliosis are the most common [10].

If we look at the treatment approach, we have to take into account the degree of angulation of scoliosis, which radically determines how the treatment scheme is designed. Stagnara proposes a protocol that is accepted by the vast majority of therapists and specialists in the field:

- from 0^0 - 30^0 - physiotherapy (exercises);
- from 30^0 - 50^0 - physiotherapy and orthopaedic treatment (brace);
- over 50^0 surgery.

The treatment of scoliosis can often be a major problem, because often, even if detected early, lack of knowledge about the condition and the wrong approach to the treatment regimen leads to complications. Early detection of physical deficiencies in children ensures effective intervention, given the plasticity and dynamics of the body at this age [11].

All the steps used in a therapeutic pathway must start with a positive diagnosis, accompanied by a clinical picture and objective investigations. Determination of the remaining functional, as well as the predicted prognosis of the evolution of the postural deficit, is an integral part of the recovery program initiated. The recovery treatment is specific to each form of deficit, to each patient, and is determined following specific assessments (somatoscopy, anthropometry, joint assessment, muscle assessment, morpho-functional assessment, etc.).

Our research aims to carry out a somatoscopic analysis on a sample of 100 prepubertal children, i.e. 10-14-year-old girls and boys, who are diagnosed with scoliosis, to find a way of working that limits the negative effects of this postural deficiency. Somatoscopic assessment is one of the most commonly used, therefore we thought that making a way of interpreting the results could be useful to monitor postural attitude in children diagnosed with scoliosis. This approach may help in achieving a way of working that limits the negative effects of scoliosis on the subjects.

From the analysis of the information presented in the literature on the etiology and therapeutic approach, it is clear that most postural deficits are idiopathic in nature and are often detected late. Also, the evaluation and implementation of the therapeutic pathway are well defined but there are no methods to identify deficits at an early stage. We believe that our proposed program can be useful in identifying and judiciously addressing scoliotic deficits.

Working hypothesis: it is assumed that we will record positive results in the final evaluation of the subjects and the way of working approach may be useful in preserving postural function in children with scoliosis.

2. Materials and Methods

The study was performed in the Department of Physiotherapy Elipetro Med Clinic from Piatra Neamt and the doctor's office in the Faculty of Physical Education and Sport, Stefan cel Mare University of Suceava, during March 2022 and December 2023. The research involved analyzing the outcomes of 100 prepubertal aged 10-14-year-old girls and boys who were diagnosed with scoliosis and underwent a physiotherapy program. The study protocol was approved by the Ethics Commission of the Faculty of Physical Education and Sport, Stefan cel Mare University of Suceava, with no. 53 from 10 March 2022. All patients were properly informed, and agreed with their participation in the study, and the legal tutors signed a consent form.

Inclusion criteria within the 100 cases were based on the following criteria: 10-14 years, positive diagnosis of scoliosis, X-ray or assessment by a pediatric orthopedic specialist, acceptance of legal tutors to carry out the proposed physiotherapy program, no comorbidities preventing the program from being carried out.

Exclusion Criteria were: age, lack of diagnosis, lack of results of physician's assessment, inability to be consistent in carrying out the physiotherapy program, neurogenic pathologies, psychological, post-traumatic sequelae, and endocrine-metabolic imbalances.

This study was motivated by the need to develop a working model for children diagnosed with scoliosis to maintain a postural status as close as possible to the physiological one. The working model started from a somatotopic analysis of the negative landmarks that are observed in the postural alignment in an orthostatic posture of the scoliosis patient viewed from behind. In this approach, we used this evaluation method the results of X-ray imaging investigations, and the Cobb angle measurement method.

2.1 Clinical evaluation

Somatoscopic analysis of the body in orthostasis viewed from behind is the simplest method of evaluation we can use to identify negative landmarks of body posture, namely, inequalities, asymmetries, and deviations from physiological status. The examiner must know the body posture concerning the anatomical landmarks being examined. Somatoscopic assessment is subjective and should therefore be confronted with imaging investigation to confirm malalignment if there is. The person being examined should be seated at a distance of about 1.50 m in an orthostatic position, legs shoulder-width apart, hands at their sides, facing forward. The patient should also be appropriately dressed (no clothes on the upper body). The data collected can only be noted or recorded with the patient's consent. The body will be analyzed from the front, back, and profile in the orthostatic position.

The body will be referred to as the median axis that descends from the vertex to the ground, i.e. the center of the supporting polygon (oo-axis). To this median axis, we will refer to four lines parallel to the ground: 1. the line between the acromions; 2. the line between the inferior angles of the scapulae; 3. the line between the posterior superior iliac spine (PSIS); 4. bitronchanteric line (the greater trochanters). Also in the same context, we will follow the thoraco-brachial triangles which must be symmetrical, and the scapular triangles which must also be symmetrically oriented. (figure 1). The radiographic assessment will be an objective examination confirming the malalignment of the spine.

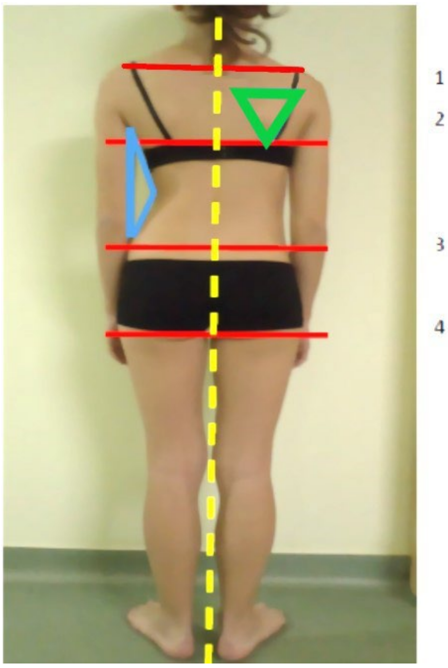


Figure 1. Somatoscopic assessment model in back orthostasis. The red lines represent the lines line between acromion, lower scapular tips, PSIS, and greater trochanter. The blue triangle on the left is the thoraco-brachial triangle and the green triangle is the scapulae.

Table 1. Somatoscopically analyzed subjects and identification of negative landmarks accompanying scoliotic postural alignment, in the orthostatic position, viewed from behind. (n=100)

No.	gender	line between the acromions	line between inferior angles of the scapulae	line between PSIS	bitronchanteric line	thoraco-brachial triangle	scapulae triangle	Postural deficiency	degrees of column angulation 1	corset / physiotherapy (PT)	degrees of column angulation 2
1	g	p	p	p	p	a	s	S2	< 15	PT	< 15
2	b	p	np	p	p	s	s	C1	< 10	PT	< 10
3	g	p	np	p	p	a	a	S2	< 15	PT	< 15
4	b	p	p	p	p	a	s	C1	< 10	PT	< 10
5	g	p	np	np	p	a	a	S4	>30	Corset/PT	>30
6	g	p	np	np	p	a	a	S4	>30	Corset/PT	>30
7	g	p	p	p	p	a	s	C1	< 10	PT	< 10
8	b	p	p	p	p	a	s	C1	< 15	PT	< 10
9	g	p	np	np	p	a	a	S4	>30	Corset/PT	>30
10	g	p	np	np	p	a	s	S3	< 20	PT	< 20
11	g	p	np	p	p	s	s	C1	< 15	PT	< 10
12	g	np	p	p	p	a	s	C1	< 10	PT	< 10
13	g	p	np	p	p	a	s	C1	< 15	PT	< 15
14	g	p	np	np	p	a	a	S4	>30	PT	>30
15	b	p	np	p	p	s	s	C1	< 10	PT	< 10
16	g	p	np	p	p	a	s	C1	< 15	PT	< 15
17	g	np	p	p	p	a	s	C1	< 10	PT	< 10

18	b	p	p	p	p	a	a	C1	< 15	PT	< 15
19	b	p	p	p	p	a	s	C1	< 10	PT	< 10
20	g	p	p	p	p	a	s	C1	< 10	PT	< 10
21	g	p	np	np	p	a	a	S4	>30	PT	>30
22	b	p	p	p	p	a	s	C1	< 10	PT	< 10
23	g	p	p	p	p	a	a	C1	< 15	PT	< 15
24	b	p	np	np	p	a	s	C2	< 30	Corset/PT	< 25
25	b	p	p	p	p	a	s	C1	< 10	PT	< 10
26	b	np	np	p	p	a	s	C2	< 20	PT	< 20
27	b	p	np	p	p	a	a	C1	< 10	PT	< 10
28	b	p	p	p	p	a	s	C1	< 10	PT	< 10
29	b	np	np	p	p	a	a	S4	>30	PT	>25
30	g	np	np	np	p	a	a	S4	>35	Corset/PT	>35
31	g	p	p	p	p	a	s	C1	< 10	PT	< 10
32	g	p	p	p	p	a	s	C1	< 10	PT	< 10
33	b	np	np	p	p	a	a	C2	< 25	PT	< 25
34	b	p	p	p	p	a	s	C1	< 15	PT	< 15
35	g	p	p	p	p	a	s	C1	< 15	PT	< 15
36	g	p	p	np	p	a	a	C3	< 30	PT	< 30
37	b	np	np	p	p	a	s	S3	< 25	PT	< 25
38	b	p	p	p	p	a	s	C1	< 10	PT	< 10
39	g	p	np	p	p	s	s	C1	< 10	PT	< 10
40	b	p	p	np	np	a	s	S4	>35	Corset/PT	>30
41	b	p	p	np	p	s	s	C1	< 15	PT	< 15
42	g	p	p	p	p	a	s	C1	< 10	PT	< 10
43	g	p	np	np	p	a	s	C4	< 40	Corset/PT	< 40
44	g	p	np	p	p	a	a	C2	< 20	PT	< 20
45	g	p	np	p	p	a	a	S3	< 25	Corset/PT	< 25
46	g	p	p	p	p	a	s	C1	< 10	PT	< 10
47	b	p	np	p	p	a	a	C1	< 15	PT	< 15
48	g	p	np	p	p	a	a	S4	> 35	PT	>35
49	b	p	np	np	np	a	s	S2	< 25	PT	< 20
50	g	np	p	p	p	a	s	C1	< 15	PT	< 15
51	b	p	p	p	p	a	a	C1	< 10	PT	< 10
52	b	p	p	p	p	a	a	C1	< 10	PT	< 10
53	g	p	p	p	p	a	s	C1	< 10	PT	< 10
54	g	p	p	p	p	a	s	C1	< 15	PT	< 10
55	b	p	p	p	p	a	s	C1	< 10	PT	< 10
56	g	p	p	p	p	a	s	C1	< 15	PT	< 15
57	b	np	np	np	p	a	a	C4	< 35	PT	< 35
58	g	p	np	np	p	a	a	S4	>30	PT	>30
59	g	np	np	p	p	a	a	C2	< 20	PT	< 20

60	b	np	np	np	p	a	a	S4	>35	Corset/PT	> 35
61	b	p	np	p	p	a	a	C2	< 20	PT	< 20
62	b	p	p	p	p	a	s	C1	< 10	PT	< 10
63	g	np	np	np	p	a	a	S4	>30	Corset/PT	>25
64	g	p	p	np	p	a	s	S4	>30	Corset/PT	>30
65	g	p	p	np	p	a	s	C1	< 10	PT	< 10
66	b	p	np	p	p	a	a	C1	< 15	PT	< 15
67	g	p	p	p	p	a	a	C1	< 15	PT	< 10
68	g	p	np	p	p	a	a	C1	< 15	PT	< 10
69	g	p	p	p	p	a	a	C2	< 25	PT	< 20
70	g	np	np	p	p	a	s	S3	< 25	PT	< 25
71	b	np	np	p	p	a	s	C1	< 15	PT	< 15
72	b	p	np	np	p	a	s	C2	< 20	PT	< 20
73	b	np	p	p	p	a	s	C1	< 15	PT	< 15
74	b	p	np	p	p	a	s	C1	< 15	PT	< 10
75	g	p	p	p	p	a	a	C1	< 15	PT	< 15
76	g	np	np	p	p	a	s	S3	< 25	PT	< 25
77	g	p	np	p	p	a	a	C1	< 15	PT	< 15
78	g	p	np	np	p	a	a	S2	< 25	PT	< 25
79	g	p	p	p	p	a	s	C1	< 10	PT	< 10
80	b	p	p	p	p	a	s	C1	< 10	PT	< 10
81	g	np	np	p	p	a	a	C1	< 15	PT	< 15
82	g	p	p	np	p	a	s	C1	< 15	PT	< 15
83	b	p	np	p	p	a	a	C1	< 15	PT	< 15
84	g	p	p	np	p	a	s	C1	< 15	PT	< 15
85	b	p	np	np	p	a	a	S3	< 25	PT	< 25
86	g	p	p	p	p	a	s	C1	< 10	PT	< 10
87	g	p	p	p	p	a	s	C1	< 10	PT	< 10
88	b	p	np	p	p	a	s	C1	< 10	PT	< 10
89	b	np	np	p	p	a	s	C2	< 20	PT	< 20
90	g	np	np	p	p	s	s	C1	< 15	PT	< 15
91	g	p	p	p	p	a	s	C1	< 10	PT	< 10
92	b	np	p	p	p	a	s	C1	< 10	PT	< 10
93	b	p	p	p	p	a	s	C1	< 10	PT	< 10
94	g	np	p	p	p	a	s	S2	< 15	PT	< 15
95	g	np	np	p	p	a	a	S3	< 25	PT	< 25
96	g	p	np	p	p	a	a	C2	< 20	PT	< 15
97	g	p	np	p	p	a	a	C2	< 20	PT	< 20
98	g	p	np	p	p	a	a	S3	< 25	PT	< 25
99	b	np	p	p	p	a	a	C1	< 15	PT	< 15
100	g	np	np	p	p	a	a	C1	< 10	PT	< 10

g=59	np=24	np=61	np=24	np=2	a=97	a=41	C1=60	11 corset	13 descend
b=41	p=76	p=39	p=76	p=98	s=3	s=59	C2=11		
							C3=1		
							C4=2		
							S2=5		
							S3=8		
							S4=13		

np = non-parallel lines; p = parallel lines; a = asymmetric triangles; s = symmetric triangles; C=scoliosis type C (grade 1,2,3,4); S=scoliosis type S (grade 2,3,4)

2.2 Physiotherapy rehabilitation programme

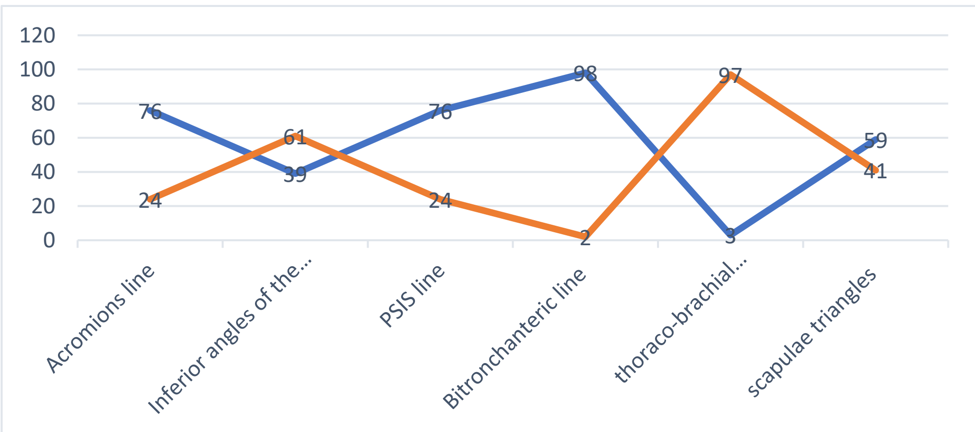
The rehabilitation programme is carried out in three stages: the first stage is the creation of the scheme that will help to carry out the corrective postures. The second stage is to carry out a program of analytical exercises of the shoulder girdle by mobilizing the upper limbs in an orthostatic position (free exercises on apparatus, or with objects). This stage, which lasts about 20 minutes, is designed to warm up and prepare the body for the next stage. This is followed by the main stage in which corrective postures are performed in the prone/back position.

A corrective posture starts with 3-5 minutes followed by a 1-2 minute break, repeated three times, a set of three prone postures then a set of three supine postures. Corrective postures are performed in supine because this is the only position in which the musculature is relaxed and the proprioceptive system can memorize corrective postures. At the end of the program, some muscle toning exercises will be performed in corrective mode on the paravertebral muscle groups of the abdominal and pelvic muscles.

Exercises will initially be performed with weights of 500 grams, in dorsal and ventral decubitus, mobilizing the scapular and pelvic girdle. The program will end with relaxation postures or stretching (a work program lasts no more than 45-50 minutes).

3. Results

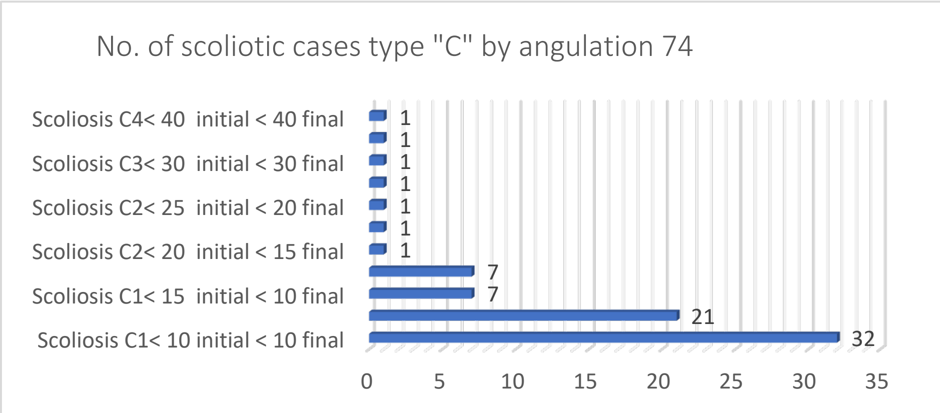
Somatoscopic analysis of the body in orthostasis viewed from the rear of the study subjects resulted in the following data. In the case of "S" scoliosis the primary curvature, i.e. the greatest angulation, was taken into account.



Graph. 1 Distribution of landmarks accompanying the scoliotic postural alignment (n=100)

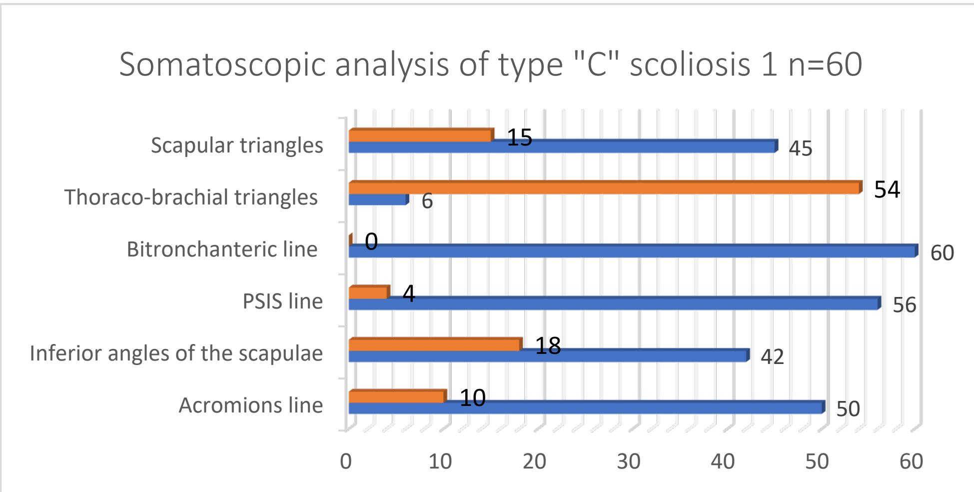
Analyzing graph no. 1, we can see that the negative landmarks found with a percentage above 50% are the thoraco-brachial triangles at 97% and the line between acromions at 61%, at the opposite pole with 98% the trochanteric line which is a positive landmark. Therefore it can be concluded that the bitrochanteric line cannot help in the analysis of posture in the given conditions. From the point of view of negative landmarks, the scapular triangles with 41%, followed by the acromions and inferior angle of the scapulae line with 24%, both landmarks, show that this somatoscopic evaluation method can be used to evaluate malalignments in the frontal plane of the spine.

The data show that out of the total number of scoliosis analyzed 74% are type "C" scoliosis and only 26% are type "S" scoliosis and in terms of gender 59% are girls and 41% are boys.



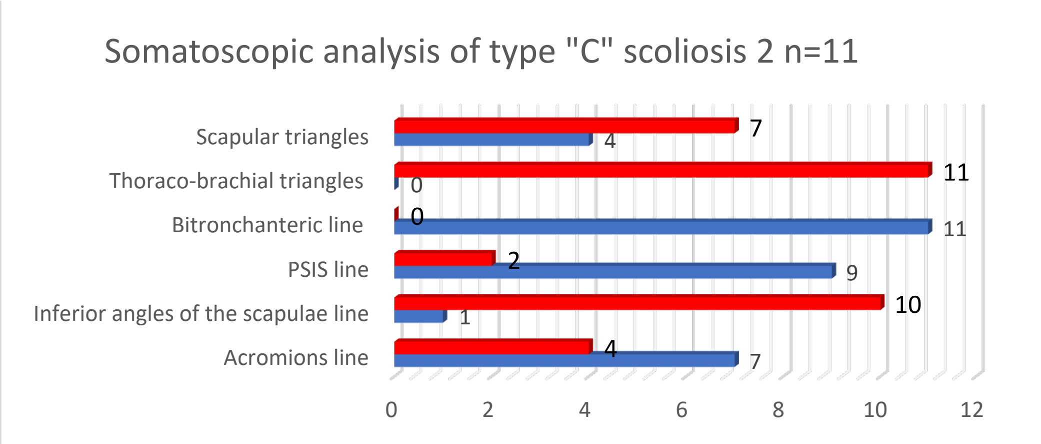
Graph. 2 Dynamics of type "C" scoliosis initial and final evaluation

Analyzing graph no. 2 it can be observed the evolution of type "C" scoliosis according to the angulation of each category, i.e. type "C"1 scoliosis with an angulation < 10^0 are 43.24% stabilized, those with an angulation < 15^0 28.37% stabilized and 9.45% even reduced. "C"2 scoliosis with angulation < 20^0 percentage of 9.45% and "C"3, "C"4 scoliosis with angulation < 25^0; < 40^0 percentage of 9.45% stabilized. We conclude that type "C"1 scoliosis is more likely to stabilize.



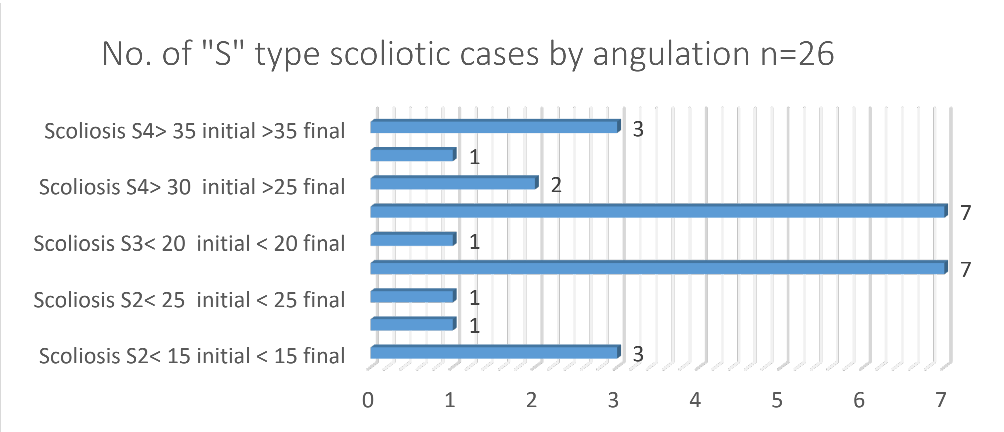
Graph. 3 Somatoscopic analysis of type "C" scoliosis 1

Analyzing graph no. 3, one can see the negative percentage landmarks identified in the somatoscopic analysis of type "C" scoliosis 1, n = 60. It can be seen that the only negative landmark found is that of the thoraco-brachial triangles, a percentage of 90%, and the rest of the negative landmarks are not significant, which concludes that type "C" 1 scoliosis is difficult to identify in a somatoscopic evaluation.



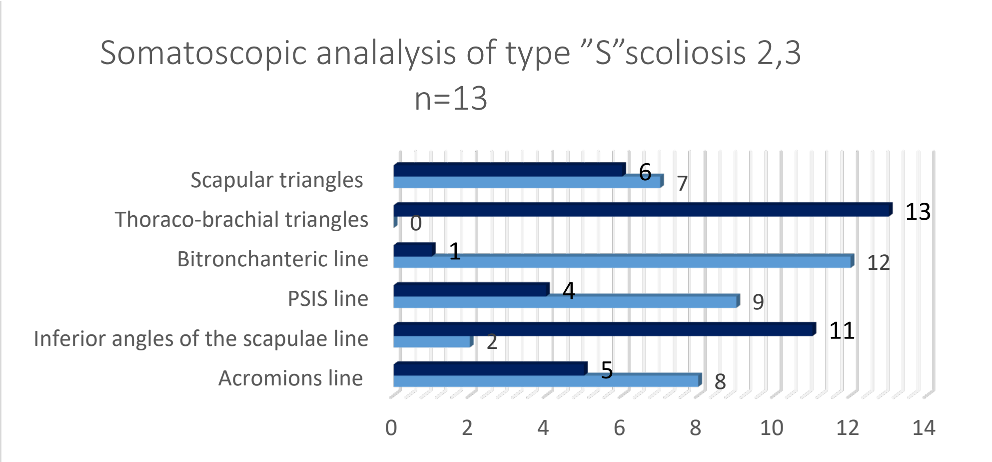
Graph. 4 Somatoscopic analysis of type "C" scoliosis 2

Regarding the analysis of the negative landmarks of the "C"2 type scoliosis with angulation < 20^0 n=11, in graph no. 4 it can be seen that the thoracobrachial triangles, bispinal line are in percentage of more than 99.9%. Scoliosis type "C"3, "C"4 with angulation < of 25^0 ; < of 40^0 , 3 cases, are found 100% negative landmarks in thoraco-brachial triangles and PSIS line.



Graph. 5 Dynamics of "S" scoliosis initial and final evaluation

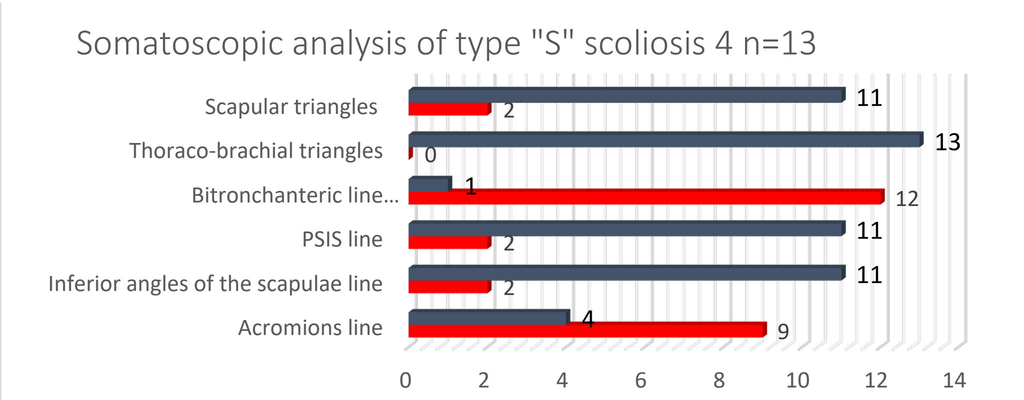
Graph no. 5 shows that "S" type scoliosis with an angulation < 15^0 are only 3 cases representing 11.53%, and those with an angulation from < 20^0 to < 40^0 are a number of 23 cases 88.64% which concludes that "S" type scoliosis are more aggressive and more difficult to manage.



Graph. 6 Somatoscopic analysis of "S" type scoliosis 2,3

Graph no. 6 shows the negative anatomical landmarks of "S" type scoliosis 2,3 which, unlike "C" type scoliosis, shows the following at n=13; negative landmarks 13 subjects 100% at the thoraco-brachial triangles, followed by 11 subjects 84.61% at the bispinal line followed by the other landmarks. The only landmark not identified as negative is the bitrohenterial line.

In the case of "S" scoliosis 4 the situation shown in graph 7 is much worse and the negative landmarks are 90% to 100% negative, which concludes that the approach is quite complex and the results are often unpredictable.



Graph. 7 Somatoscopic analysis of "S" type scoliosis 4

If we analyse the results of all the graphs that have been presented, we can see that among the negative landmarks that have been found in all types of scoliosis, but especially in "S" scoliosis, the thoraco-brachial triangles stand out in a percentage of 90% in "C" type scoliosis and 100% in "S" type scoliosis, which means that this landmark is the most obvious and easiest to analyse. In the same context, we also note the bispinous line (scapular tips) in type "C" scoliosis 2, 99.9% and in type "S" scoliosis 84.61%.

4. Discussion

Scoliosis is diagnosed as idiopathic in 70% of structural deformities, affecting the spine in children and adolescents. By definition, structural scoliosis should be the result of some primary disorder leading to a three-dimensional deformity of the spine [12,13,14].

Idiopathic scoliosis, with > 10° angulation of the spine in the frontal plane, is one of the most common spinal deformities. Age, initial magnitude of curvature, and other parameters define whether a scoliotic deformity will progress or not [15,16].

According to the results obtained on the etiopathogenesis and evolution of scoliosis, our analysis can confirm and strengthen the research done so far by the fact that a significant percentage of type "C" scoliosis1 n = 60, with an angulation < 10°, 43.24% have stabilized and those with an angulation > 10° may be progressive.

The etiology of adolescent idiopathic scoliosis (AIS) is still unknown despite many years of research efforts. Theories regarding the etiology of AIS have included mechanical, hormonal, metabolic, neuromuscular, growth, and genetic abnormalities [17-21].

Progressive AIS produces specific signs and symptoms, including deformity and imbalance of the trunk and spine, impaired respiratory function, pain syndromes, degenerative conditions progression into adulthood, psychological problems, and implicit disorders of motor functions, which can be disruptive factors, resulting in altered health-related quality of life. A scoliosis-specific rehabilitation program seeks to prevent, alleviate, or minimize these impairments [22,23,24].

Finally, we will present the working model that led to these results and that was developed following research carried out over 15 years, during which time we studied how to deal with postural deficits in the spine, particularly scoliosis. To carry out this approach, a positive diagnosis is required, accompanied by a set of investigations confirming and presenting the patient's complete clinical picture. Once this has been done by the orthopedic specialist, a postural analysis is carried out by the physiotherapist, resulting in a work plan. Based on the somatoscopic examination and X-rays of the subject, a diagram of the spine and the accompanying deviations is drawn up, and the corrections that need to be made to achieve a shape that is as close as possible to the physiological one are made. This drawing is the basis of the corrective posturing program that was carried out as part of the rehabilitation program.

We believe that in this approach we have presented a simple model of somatoscopic analysis to identify malalignments in the spine, however, the people involved in this process must have a minimum level of knowledge about body posture and the assessment itself. Producing material such as a guide can be useful for those working in education, sports, and even health. For those working in the field of recovery, this material can help pave the way for new models and methods of investigation. By analyzing the results obtained, a program can be created that can forecast the evolution of postural status. The somatoscopic postural analysis must be performed in such a way that all factors that may disturb and influence the outcome of the evaluation are removed. One of the most important factors in this is the position of the patient during the analysis (legs close together or too far apart, position of the pelvis, etc.). In the same context, imaging investigation can lead to errors of interpretation. Therefore, to make an objective assessment we have to take into account all the factors that can become variables in the interpretation.

5. Conclusions

In the prepubertal and especially postpubertal period when growth processes are faster in the bone apparatus, with growth in length and less in thickness, so height is the one that stands out, and the supporting musculature is deficient, it favors the appearance of malalignments of the structures of the musculoskeletal apparatus.

Of the total number of scoliosis analyzed n = 100, 74% are type "C" scoliosis and only 26% are type "S" scoliosis, and in terms of gender, 59% are girls and 41% are boys.

Type "C"1 scoliosis n = 60, with an angulation < 10° 43.24% stabilized therefore type "C"1 scoliosis is more likely to stabilize.

"S" type scoliosis with an angulation < 15° is only 3 cases representing 11.53%, and those with an angulation from < 20° to < 40° are number 23 cases 88.64% which concludes that "S" type scoliosis are more aggressive and more difficult to manage. Landmarks that were found in all types of scoliosis but especially in "S" scoliosis, thoraco-brachial triangles stand out in a percentage of 90% in "C" type scoliosis and 100% in "S" type scoliosis, which means that this landmark is the most obvious and easy to analyze. In the same context, we also observe the inferior angles of the scapulae line in type "C" scoliosis 2, 99.9%, and in type "S" scoliosis 84.61%.

Of the total number of scoliosis analyzed n=10, 11 subjects wore an orthopedic brace, and only 13% of the subjects had a regression of the angulation following the physiotherapy program, therefore the main objective remains to stabilize the scoliosis attitude and limit the effects of this pathology.

According to the results of somatoscopic analysis, we can see that at the level of the spine the thoraco-brachial triangles and the lower angles of the scapula line are observed as malalignment, and in current practice the vast majority consider the biacromial line to be the most visible.

Institutional Review Board Statement: The study was approved by the Ethics Commission of the Faculty of Physical Education and Sport, Stefan cel Mare University of Suceava, with no. 53 from 10 March 2022.

Funding: This research received no external funding.

Informed Consent Statement: The study was conducted following the principles set out in the Declaration of Helsinki. All patients were properly informed, and agreed with their participation in the study, and the legal tutors signed a consent form. The pediatric physiotherapy provider guarantees that research conducted on children is based on the moral obligation of respect to children in the provision of evidence-based healthcare. The research team recognized the right of children in the study to autonomous decision-making capacity by being mindful of full consent and carefully considered dissent.

Data Availability Statement: Data are contained within the main text of the article. Raw data were generated at the Faculty of Physical Education and Sport, Stefan cel Mare University of Suceava. Derived data supporting the findings of this study are available from the corresponding author I.O. on request.

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Conflicts of Interest: The authors declare no conflict of interest.

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