National Sports Academy

"VASIL LEVSKI"

DEPARTMENT OF THEORY AND METHODS OF THE PHYSIOTHERAPY

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EFFECTS OF SCHROTH EXERCISES AND SCHROTH CORRECTIVE BREATHING THERAPY ON IDIOPATHIC SCOLIOSIS

ABSTRACT

OF DISSERTATION FOR AWARDING THE EDUCATIONAL AND SCIENTIFIC DOCTOR's DEGREE

for the Degree of Doctor of Philosophy in the Field of higher education 7.Healthcare and Sport, Professional field: 7.4. Public Health/Health care Scientific specialty: Kinesitherapy/Physiotherapy

SUPERVISOR:

Scientific Supervisor: prof. Evgeniya Dimitrova, PT, PhD, DSc

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The dissertation contains 115 pages of standard type-written pages. It is presented through 8 figures, 19 tables and 6 graphics. There are 7 appendixes. In those we show the study's surveys (7), indicators for completing the questionnaires. The ethical approval of the study and the informed consent form, the information will be held in strict confidence and only used for the purpose of the study. The bibliography includes 173 literary sources.

The dissertation was selected, discussed and directed for official defense at a meeting of the Department of Theory and Methods of the Physiotherapy, NSA "Vasil Levski".

The public defense of the dissertation will take place on…. , 2022, of NSA "Vasil Levski"

THESIS INTRODUCTION

In recent decades in our country, there has been a call for change among all actors involved in the management of scoliosis. Patients with scoliosis have complained about the so-called "wait and see" approach that many physicians use when estimating scoliosis curves between 10 ° and 25 °.

Numerous physiotherapists have reported that patients with scoliosis react to their lack of empowerment as they wonder how to help themselves beyond simply waiting and shaking. Physical therapists in our country are mostly still uneducated and adequately equipped to provide quality treatment for scoliosis. Orthopedists have realised that traditional braces cannot make 3D corrections, producing a flat ridge or other weak cosmetic changes, and now they are looking for more effective options. Finally, doctors have sought alternatives to help patients who are not good candidates for surgery.

Most practitioners consider the industry standard for a successful tightening result to be the stabilisation of the curve. Unfortunately, not all patients can reach this benchmark when wearing one Thoracolumbosacral orthosis (TLSO) since a subset of patients continue to progress despite bracing.

Bracing can also be a stressful experience for patients who place it almost all the time. Its uses can worsen self-image and body image, interactions with others and total QOL, which has already been affected by the state of AIS. Patients have started to refuse extended vigilant waiting access and prefer to ask for knowledge of effective curve management through exercise rehabilitation. Through exercise rehabilitation, the patient must gain an understanding of their unique backbone and the postural modifications needed to improve symmetry and stabilisation of the spine. Since idiopathic scoliosis usually develops during early adolescence, patients learn curve management techniques that can be used throughout their lives if needed. Concepts should be easy to involve the patient and should not lack pain stimulation - when the goal is to induce the correction.

The Schroth method consists of sensorimotor, postural and breathing exercises to recalibrate normal postural alignment, static/dynamic postural control and spinal stability. Schroth exercise showed positive results in back muscle strength, respiratory function, slowing curve progression, Cobb angles improvement, and operation prevalence reduction.

Our team wanted to determine the minimal change in Cobb angle associated with the perceived improvement in spine status. The

sample consisted of participants receiving the standard of care (observation and tightening) or standard of care plus

exercises.

The participants' postural awareness and overall body and trunk balance may have improved after the intervention with conservative interventions.

SUMMARY OF LITERATURE REWIEW

Literature review examines all aspects of the problem: history and definitions of scoliosis, epidemiology and etiology of AIS; its natural history; classification; diagnostic and physical assessment; effects of different interventions for scoliosis and conclusion.

The Schroth approach primarily aims to improve postural awareness to correct the misalignments imposed by scoliosis. The latter uses specific corrective breathing and auto-correction (Fusco et al., 2011) consisting of self-elongation and postural corrections specific for each curve pattern that is eventually integrated into daily activities. The majority of Schroth corrections target aspects additional to the coronal plane deformity.

Bracing does not solely focus on improving the Cobb angle; it also aims to stop the progression.

Moreover, observation reassures patients that they do not need more aggressive treatment.

Therefore, the participants' perceived positive change could occur in response to the additional effects of these conservative interventions despite the Cobb angle improvement. Research suggests that as

measured by surface topography, Schroth exercises improve posture in all three planes (Parent et al., 2016).

After the conservative intervention, the participant's postural awareness and overall body and trunk balance might have improved, and some might have perceived improvement unrelated to the changes in the Cobb angle.

Some participants with AIS experience back pain and discomfort (Sato et al., 2008; Upasani et al., 2002), as well as decreased function (Danielsson et al., 2003), self-esteem, and mental health concerns (Payne et al., 1997; Sanders et al., 2018). The severity of these changes is merely related to the Cobb angle, especially in curves severities treated conservatively (Parent et al., 2010). It may be that these outcomes, which are not routinely monitored in scoliosis research, are being positively affected under the influence of the Schroth therapy (Parent et al., 2016). It is necessary to decide on guidelines for evaluating the effectiveness of the exercise, as proposed for braces (Richards BS et al. 2005).

The conservative intervention could affect other impairments, signs, and symptoms of scoliosis, which may be determinants of the perceived clinically significant changes.

A systematic review of the literature evaluating the effectiveness of physiotherapy exercise in AIS was undertaken to determine the extent of previous research, to check the value of the future research in the topic area, and to inform the development of a future trial intervention and the choice of appropriate outcomes for such a trial.

II. THESIS METHODOLOGY

1. Working hypothesis

Treatment of adolescent idiopathic scoliosis (AIS) is an up-to-date and socially significant problem. Based on the literary sources studied and our experience in this field, we formulated the following ***working hypothesis*****:** The creation of a *complex, scientifically justified, specialized physiotherapeutic methodology* based on the principles of K. Schroth and its implementation as part of the overall treatment plan for adolescent idiopathic scoliosis would lead to stopping progression and maximum possible correction of deformation.

2. Thesis outline and objective

Purpose of the dissertation work

The purpose of the dissertation work is to develop, implement and study the effect of the application of physiotherapeutic methodology

based on the principles of K. Schroth in adolescent idiopathic scoliosis.

Goals of the dissertation work

1. To make a critical analysis of the literature on applying the Schroth method in idiopathic scoliosis.
2. To specify the criteria for inclusion and exclusion from the study and select an appropriate contingent for research.
3. To develop a methodology for functional examination in this contingent of patients.
4. To develop an author's methodology of kinesitherapy based on the principles of K. Schroth.
5. To apply the methodology to a statistically reliable contingent of patients with adolescent idiopathic scoliosis.
6. To analyze the results obtained on changes in the shape and functionalities of scoliotic deformation, the perception of trunk deformity by scoliosis patients and the satisfaction with treatment under the influence of kinesitherapy applied.
7. To formulate conclusions and recommendations on practice.

The main objective was to determine the effects of Schroth exercises on the characteristics of the curve, the stability of the back muscles and the quality of life in adolescents with idiopathic

scoliosis. The goal was to provide much-needed evidence to inform global clinical practice about the effectiveness of the Schroth exercises used as a treatment to the standard of care for adolescent idiopathic scoliosis, which generally consists only of monitoring, reinforcement with a brace and exercise program.

3. Subjects and Methods

Study design and data collection

Between June 2018 and June 2021, 40 patients with AIS were enrolled at the Sports University of Tirana in collaboration with the Lady of Good Counsel University, Albania. The patients' evaluations within the trial occurred between June 2018 and May 2021. The protocol of the study was approved by the Ethics Committee of Sports University of Tirana (Appendix 1).

Prior to proceeding with data collection, an information sheet detailing the research was provided to the participants and informed written consent was obtained from all the participants, for participation and publication of anonymous data, before starting the data collection (Appendix 2).

The interdisciplinary care team consists of a doctor, a physiotherapist, nurse practitioners and an engineer. A doctor, a

physiotherapist, and a nurse practitioner diagnose and prescribe the scoliosis care plan, typically involving further investigation, observation, bracing, or surgery.

After the initial evaluation, all patients were taught to do exercises for correction according to the Schroth method. All patients had to practice their exercises regularly for at least four months.

Patients were evaluated at least six months after their first evaluation – X-ray of the spine after six months of therapy.

To evaluate the effect of treatment, we considered the last x-rays available for every patient.

Inclusion Criteria were:

- 18-21 years old patients, both genders
- Curves between 20º- 50º
- Risser grades 0 to 5
- With or without a brace

Exclusion Criteria were:

- Patients with a diagnosis other than AIS
- Having completed brace treatment
- Previous spine surgery

- Scheduled for surgery
- Curves less than 10º

4. Methodology of the survey

For the examination, evaluation, and analysis of the results, obtained on changes in the shape and functionalities of scoliotic deformation, the perception of trunk deformity by scoliosis patients and the satisfaction with treatment under the influence of kinesitherapy applied, we used the following:

Measuring Instruments

1. Cobb Angle
2. Angle of Trunk Rotation
3. The Adam's forward bending test
4. The Visual Analogue Scale (VAS)
5. SRS 22 questionnaire
6. SAQ questionnaire

Statistic and data management

Statistical processing of data collected on 03.07.2020 was performed through the application IBM SPSS Statistics 26. First,

descriptive frequency statistics were generated for each questionnaire question before the start of patient treatment, and then patients were re-asked after a period of 3, 6 and 12 months. Through ANOVA, we tested hypotheses related to the relationship between different variables. For the continuous outcomes, we used linear mixed-effects models' analysis to assess differences in changes from baseline to 3, 6 and 12 months while adjusting for important covariates. We used a generalised linear mixed-effects model analysis for the ordinal outcome, SAQ curve, based only on one item with five levels. Separate analyses were conducted for each outcome to ensure the best covariate set was selected in the model. Covariates considered included age, weight, height, self-efficacy, and pain, whether a person wore a brace or not, and Schroth scoliosis classification.

Therapeutic methodology

The therapy consists of teaching the patients to perform Physiotherapeutic scoliosis-specific exercises (PSSE) according to the Katharina Schroth method. The treatment concept consists of *specific postural correction, correction of breathing patterns,* and *correction of postural perception*.

The **Schroth exercise program** used in this thesis consisted of three phases and was implemented three times a week for 12 weeks.

The treatment plan includes the following steps:

- First, the patients are getting familiar with their scoliosis spine deformity and trunk changes.
- Then the patients are educated in auto-distraction of the torso and corrective rotational breathing aiming for transverse plane correction and muscular activation.
- In the end, patients are educated on keeping the correction in daily activities.

PT procedure

The first stage consisted of stretches for 10 minutes to relax tight muscles and improve joint flexibility.

The second phase consisted of Schroth exercises. Schroth Breathing (mostly rotational breathing), mainly the basic Schroth Exercise, was used to correct breathing patterns.

The third phase was a palliative phase consisting of ten minutes of muscle-strengthening exercises to activate corrected muscles using Schroth exercises and maintain the posture.

Methods

One of the most critical factors of the original Schroth method is the *automated pre-correction of the deformity* with the help of postural reflex activity in certain asymmetric upright starting positions.

The exercise begins pre-corrected with the help of postural reflex activity in upright asymmetric starting positions, and *the exercise itself increases this pre-correction* (Weiss, 1988).

The Schroth *rotational breathing technique* enables further improvement of the corrections and the approach to one's posture. The patient breathes in, selectively, into the thoracic concave side in a lateral/dorsal direction, and the ventrally oriented ribs are de-rotated dorsally; this correction is, if possible, increased with every inhalation.

Stabilization

After using the rotational breathing techniques in the inhalation phase, the trunk musculature is tensed as much as possible with an optimal overall correction in every subsequent exhalation. In this way, depending on the patient's condition, the inhalation correction from the rotational breathing and the tension during exhalation can be repeated many times. It is, however, required that the patient be able to keep up the fundamental correction.

Even after a brief period of learning, an engram for the correction value evolves, and one needs to remind the patient once the *appropriate resistances* have been set and an apparent increase in the correction will be observed.

Physical rehabilitation, which focuses on ADLs

All patients were taught to do physical rehabilitation, which focuses on ADLs to avoid loss of postural control during everyday activities. Add-ons derived from the original Schroth approach aim at unloading the curve and were essential elements for postural control. It is important to note that thirty minutes of scoliosis exercise daily is less effective without knowing curve-pattern specific ADLs since, without them, the curves are loaded during the rest of the day (Weiss, 1988). It should also be noted that it was essential to incorporate physical rehabilitation during brace wear whenever possible, with more intensive work as the patient is weaned from the brace. The Schroth Best Practice program has been improved with respect to the sagittal plane correction. It has become standard practice for therapists to perform the majority of the exercises in a lying position while crouching near the patient in an attempt to provide corrective assistance. However, this means that a significant “correction booster” is lacking in this starting position, namely the use of automatic corrective positioning

reflexes. These positioning reflexes are essential for constructing a corrected sense of posture because it is only via asymmetric trunk muscle tension that the corrected posture can be perceived.

With the patient lying down, the therapist must work laboriously on the asymmetric correction tension, alongside many other exercises (props, intricacies of the exercise) that demand attention (Lehnert-Schrooth, 2007). Stools, rolling devices, cushions, elastic bands, and many other objects are used, even though they neglect to consider the importance of everyday activities. The exercises have tended to become more acrobatic and about themselves, resulting in an exercise with no significant engram processed for application in everyday life. Of significant importance is the exercises' simplification to focus the patient's attention on the sense of posture and make the exercises more relevant to everyday activities. The goal is to influence the patient's everyday activities via beneficial movements and exercises since, with only twenty minutes per day of exercise, one cannot make a significant impression on the prognosis of scoliosis (Lehnert-Schrooth, 2007). It is necessary to concentrate on only five essential exercises in the program, along with simple tactile stimulation reminders, which a practitioner can use effectively to help the patient facilitate the execution of the exercise (Schroth, 2015).

When utilizing these simple techniques, the patient needs only recall the therapeutic reminders to be able to trigger the optimal attitude for the exercise automatically. Finally, the most recent insights regarding the extremity-induced synergism should be recognized: when both arms are brought into an elevated position, this leads to an anti-kyphotic synergy in the thoracic spine. If both arms are placed into retroversion (and, if necessary, abduction), then a kyphosis-inducing synergy in the thoracic spine region is achieved. However, suppose the arm on the parcel side is brought into an elevated position, and the arm on the weak side is brought into retroversion. In that case, one achieves an anti-kyphosis-inducing effect on the parcel side and a kyphosis-inducing effect on the weak side that specifically and selectively counteracts the thoracic concave side flatback – generally desired with idiopathic scoliosis (Lee, 2014). One of the main tasks of physiotherapy in scoliosis is the correction of body vision, symmetry, and aesthetics. Therapeutic exercises included proprioceptive re-education, learning and integration of trunk correction.

III. RESULTS AND CONCLUSION

1. Results and Analysis

Subjects and Dropouts

At the beginning of the study, there were 50 subjects, but ten subjects abandoned it very early in the study. These ten subjects had the brace treatment. Subjects did not revisit the orthopaedist and did not have a further x-ray; however, they had two to five physiotherapy visits and did not return. The results will be presented for the remaining 40 subjects.

These 40 subjects, which met the inclusion criteria, were taken out by private practice physiotherapy and exercised three or more times a week.

There were three different curve types in the group of 40 subjects. The curve types and numbers in the whole group are shown in Table 3 below, which is a simplified description of curve types according to the Rigo Classification (Rigo, 2005).

Table 3. Curve types in the study (n=40).

Curve Type	**Description of curve type**	**Number of subjects (%)**
Double Major Curves	Two Cobb angles: one in the thoracic area (T) and one in the lumbar (L) or thoracolumbar (TL) region. Similar Cobb angle size. (T + L) or (T + TL)	**21 (**52.5%) [12 (30%) were thoracic and lumbar 9 (22.5%) were

		thoracic and thoracolumbar]
Thoracic Curves	Main curve, the apical vertebra in the thoracic region. There could be a minor (smaller) lumbar curve.	**13** (32.5%)
Thoraco lumbar Curves	A single curve, apical vertebra at the thoracolumbar junction, T12 or L1.	**6** (15%)
	Total	**40 (100%)**

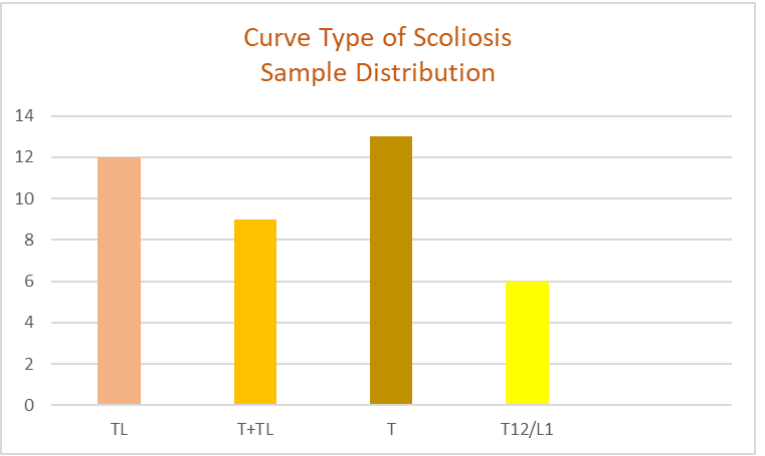

Chart 3.1.Curve types in the study. (n=40)

The distribution of the curve types is presented as follows: twenty-one (52.5%) with two Cobb angles [TL (Thoracolumbar region), twelve (30%) were thoracic and lumbar, nine (22.5%) were thoracic

and thoracolumbar], thirteen (32.5%) with the main curve, the apical vertebra in the thoracic region. There could be a minor (smaller) lumbar curve and six (15%) with a single curve, apical vertebra at the thoracolumbar junction, T12 or L1.

Baseline Data

Social and demographic characteristics of all participants were collected including age, gender, height, weight, BMI, sport/physical activity involvement, and employment (Appendix 6).

Table 3.2. Descriptive Statistics (n=40) Frequency Table

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Age	40	18	23	21.93	1.403
Height (m)	40	1.50	1.85	1.6760	0.09350
Weight (kg)	40	45	80	64.05	8.605
Gender	40	0	1	0.63	0.490
Sport Group	40	0	1	0.93	0.267
Employed	40	0	1	0.65	0.483
BMI Group	40	0	1	0.70	0.464

The total number of patients treated in the study is 40.

The *ages of patients* range from 18 to 23 years, with a mean age of 21.93 and a standard deviation of 1.403.

Patient height range from 1.50m to 1.85m, with an average height of 1.676 m and a standard deviation of 0.0935.

Patient weights range from 45kg to 80kg, with an average weight of 64.05kg and a standard deviation of 8.605.

Patients who engage in a *sporting activity* (any) are identified with 1, and those who do not engage in any sporting activity are identified with 0. The average value of "Sport Group" is 0.93 (almost 1), which means 93% of all treated patients engage in the sports activity. The standard deviation from the mean is 0.267.

Patients who are *employed* are identified with 1, and those who are not employed are identified with 0. The average value of "Employed" is 0.65, which means that 65% of patients treated are employed. The standard deviation from the average is 0.483.

Patients with the *BMI* parameter in normal value are identified with 1, and those who do not have BMI in normal value (may be above or below the normal value) are identified with 0. The average value of "BMI Group" is 0.7, which means 70% of all treated patients have normal BMI, standard deviation from the mean is 0.467.

When the *Cobb angle* is 10 to 20°, the ratio of affected girls to boys is similar (1.3:1), increasing to 5.4:1 for Cobb angles between 20° and 30° and 7:1 for angle values above 30° (Parent S et al. 2005; Lonstein JE. 2006).

Table 3.2.1:The gender distribution of girls and boys in this sample.

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Females	15	37.5	37.5	37.5
	Males	25	62.5	100.0	62.5
	Total	40	100.0		100.0

The total number of patients treated in the study is 40, of which 15 were females and 25 males; expressed in percentage, we have: 37.5% females 62.5% males.

Inclusion criteria for this study were *Cobb angles* 20º – 50º degrees. The Cobb angle size distribution in the subject is presented in Table 3.3 below.

Table 3.3 The Cobb angle distribution in a subject at baseline (nr=40)

Cobb Angle	**Total** (n, %)
20 - 29°	24 (60 %)
30 - 39°	16 (40 %)
40 - 50°	0 (0%)
	40 (100%)

An observational analysis of the above shows that most of the subjects tested had more *Cobb angles* in the lower ranges 20º-29º – 24 (60%). The lower number of subjects had Cobb angles in the highest ranges, 30º-39º – 16 (40%). Zero percentages of subjects had Cobb angles in the 40º-50º ranges.

The Risser sign was observed on the X-ray of the iliac apophysis in each subject.

The Risser sign, an accurate and reliable method of determining skeletal growth (Risser, 1958), is presented for each subject in Table 3.3.1 below.

Table 3.3.1 The Risser sign distribution at baseline (n=40).

Risser Sign	Total
0	4 (10%)
1	12 (30%)
2	21 (53%)
3	3 (7%)
4	0 (0%)
5	0 (0%)
Total	40 (100%)

However, most of our patients were considered at moderate risk of progression with the distribution of Risser signs presenting as follows:

Chart:3.3.2 Risser sign distribution for our sample of 40 patients

zero patients with Risser 5, zero with Risser 4, three (7%) with Risser 3 compared to twenty-one patients (53%) with Risser 2, twelve (30%) with Risser 1 and four (10%) with Risser 0.

Results for outcomes with significant differences between baseline to endpoint

SRS (Scoliosis Research Society)-22 questionnaire

SRS-22r pain

SRS-22r pain was transformed to its power of four. The change in the transformed pain score from baseline to 3-months did not differ between the other month (Table 3.4). However, from 3 to 6 months and from 6 to 12 months, patients who performed Schroth experienced significant improvement compared to baseline.

Table 3.4: SRS-22r Pain

				0-3 months	3-6 months	6-12 months
		Mean	Std. Error	p-value	p-value	p-value
SRS 22r Pain	1. Which one of the following best describes the amount of pain you have experienced during the past 6 months?	2.48	0.16	0.00	0.32	0.74

SRS-22r self-image

From baseline to 3 months, self-image decreased in patients who performed Schroth, but this difference was insignificant (p=0.00). However, from 3 to 6 months (p=0.62) and from 6 to 12 months (p=0.53, some of the samples did not answer to self-image question after 12 months), the self-image in patients who performed Schroth improved. Only brace-wear was retained as a covariate, but it did not have a significant main effect.

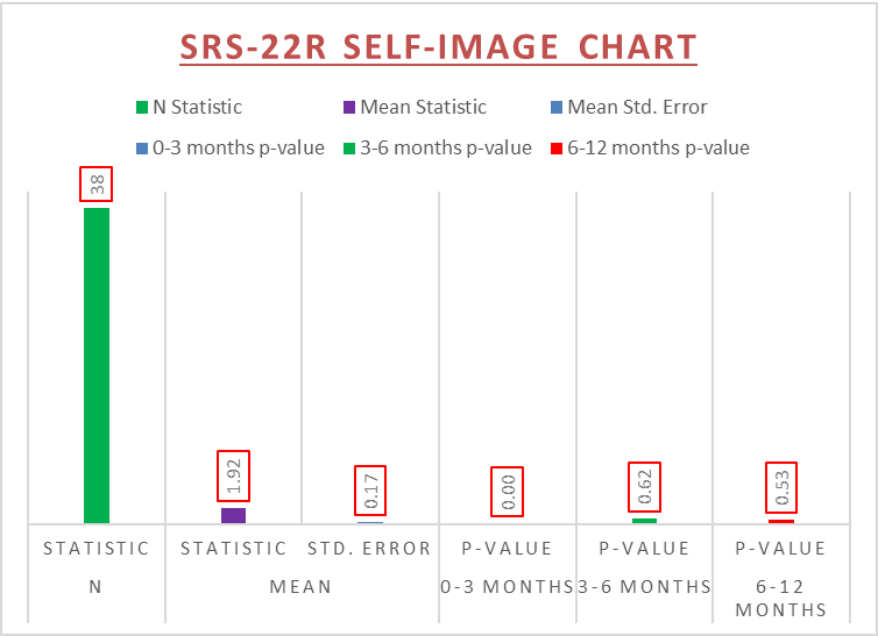

Chart.3.4.1: SRS-22r self-image.

SRS-22r function

SRS-22 function was transformed to its power of four -(SRS-22r function) to meet the normality assumption. Covariates included weight and curve classifications, with only curve classification having a significant main effect. The best function score was observed for the T curve type. The differences in the function domain between patients classified as TL, T vs TL, T and T12/L1 were all statistically significant (for 0-3 months p =0.00; 3-6 months p =0.01, and 6-12 months p = 0.74, respectively).

SRS-22r Total

The covariates retained included height and age, but only the latter had a significant main effect, such that for every 1-year increase in age, the SRS-22r total dropped by 0.04 (p = 0.03).

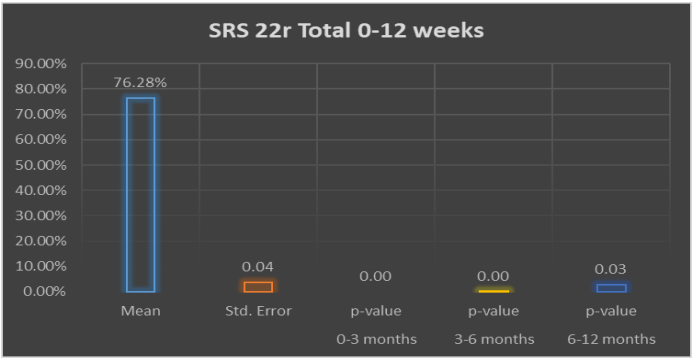

Chart: 3.4.3: SRS-22r Total

Correlation between SRS-22 and SAQ

Values r with ** show that they have a significant correlation, as the value of p is less than or equal to 0.01. The values r with * show that they correlate with each other since the value p is less than or equal to 0.05. Values without * indicate no statistically significant correlation between the data. In cases where r values are positive, the correlation is positive, which means that if the SRS Function increases, the SAQ also increases. Vice versa for the negative values of the r-value, the SAQ value decreases if SRS increases.

Table: 3.4.4: Correlation between SRS-22 and SAQ.

Correlations+A1:S43																		
			SRS 22 Function	12. After 3 months	12. After 6 months	12. After 12 months	SAQ Body curve	1. After 3 months	1. After 6 months	1. After 12 months	SAQ Head chest hips	4. After 3 months	4. After 6 months	4. After 12 months	SAQ Spine prominanc e (Bump)	10. After 3 months	10. After 6 months	10. After 12 months
SRS 22 Function	r value	Pearson Correlation	1	.633**	.493**	0.054	0.184	0.191	0.120	0.105	0.229	-0.212	-0.199	-0.285	-0.114	-0.082	0.008	-0.104
	p value	Sig. (2-tailed)		0.000	0.001	0.742	0.255	0.238	0.461	0.518	0.156	0.189	0.218	0.075	0.496	0.625	0.964	0.525
		N	40	40	40	40	40	40	40	40	40	40	40	40	38	38	38	40

SAQ (Spinal Appearance Questionnaire)

SAQ prominence

The SAQ prominence was transformed to its square root to meet the normality assumption. The only classification was retained as a covariate, with TL curve type having a significant main effect. Best

scores were observed in patients with major thoracic T12/L1 curves. For those with a TL curve type, when scoliosis affects the position of the pelvis, this type of curve had the worst scores.

Table.3.5.1: The ANOVA Table for the SAQ Spine Prominence, Bump (Spinal Appearance Questionnaire).

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
SAQ Spine prominance (Bump) After 3 months	Between Groups	179.277	7	25.611	91.106	0.000
	Within Groups	8.433	30	0.281		
	Total	187.711	37			
SAQ Spine prominance (Bump) After 6 months	Between Groups	12.433	7	1.776	7.540	0.000
	Within Groups	7.067	30	0.236		
	Total	19.500	37			
SAQ Spine prominance (Bump) After 12 months	Between Groups	8.386	7	1.198	5.828	0.000
	Within Groups	6.167	30	0.206		
	Total	14.553	37			

The table above is the ANOVA table where SAQ Spine prominence (Bump) was tested at baseline (as an independent variable) and after 3, 6 and 12 months. Sig in all cases came out ≤ 0.05, which means that there is a significant difference between the variances of the groups.

SAQ curve

Covariates included brace wear and classification. The model predicted that persons classified into TL indicating outcomes (0–3-month p =0.00; 3-6 months p=0.03; 6-12 month p= 0.24), as shown in the Chart 3.5.2 below.

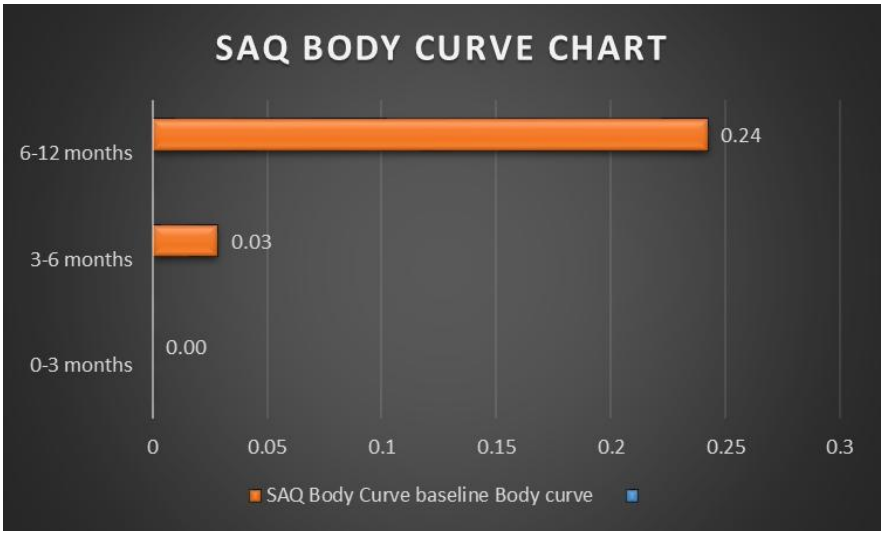

Chart 3.5.2: SAQ BODY CURVE

The SAQ (Spinal Appearance Questionnaire) Body curve was tested at baseline (as an independent variable) and after 3, 6 and 12 months. Sig in all cases came out ≤ 0.05, which indicates a significant difference between group variances.

Visual Analogue Scale (VAS)

The majority of scoliosis patients suffer from pain; the adolescent interviewed reported a significantly higher incidence of pain. Under supervision, the Schroth exercises were performed in a dance hall on the University of Sports of Tirana premises. The pain was measured via the VAS scale before and after the intervention.

Table. 3.6.Visual analogue pain scale before and after Schroth exercises.

	OPTION 1 At the beginning of the treatment	OPTION 1 After 3 months	OPTION 1 After 6 months	OPTION 1 After 12 months
Mean	3.43	2.6	1.62	0.75
Std. Deviation	1.973	1.598	1.17	0.87

For the variable OPTION1, patients had to choose the pain scale from 0 to 10 (0 means that the patient does not feel pain and 10 means that the pain is maximal). At the beginning of treatment, the average value of the pain rate for the 40 patients analyzed in the study is 3.43, with a standard deviation of 1.973. The values are significantly improved where as shown in table 3.6; after three months, the average pain was 2.6 with a standard deviation of

1.598; after six months, the average pain was 1.62 with a standard deviation of 1.17; after 12 months, the average pain was 0.7 (so much. Close 0) with a standard deviation of 0.87.

Table 3.6.2:ANOVA Table for VAS

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
VAS After 3 months	Between Groups	79.378	8	9.922	15.210	0.000
	Within Groups	20.222	31	0.652		
	Total	99.600	39			
VAS After 6 months	Between Groups	40.164	8	5.020	11.781	0.000
	Within Groups	13.211	31	0.426		
	Total	53.375	39			
VAS After 12 months	Between Groups	13.989	8	1.749	3.495	0.005
	Within Groups	15.511	31	0.500		
	Total	29.500	39			

Table.3.6.2 is the ANOVA table where VAS was tested at baseline (as an independent variable) and after 3, 6 and 12 months. Sig in all cases came out ≤ 0.05, which indicates a significant difference between group variances.

Results for outcomes without significant differences between baseline to endpoint

Cobb Angle

Cobb angle outcomes reported here were measured only at baseline and 12-month follow-up. In our sample, 60% of participants perceived improvement in their back, accompanied by a slight improvement of 1° at the Cobb angle over a 12-month treatment period. No statistically significant changes were observed in the terms of Cobb angle and vertebral rotation ($p>0,05$). Many clinicians and researchers consider a 5˚ change in the Cobb angle to be clinically significant (Richards BS et al., 2005). This threshold is based on standard measurement error (SEM) errors for manual Cobb angle measurements. SEM for our semi-automated method is <2.5˚ (Zhang J. et al., 2010). Our results suggest that adolescents with AIS in this study, who underwent conservative treatment, experienced a positive change in spinal condition even if the Cobb angle did not improve beyond the conventionally accepted 5° or 2.5° approach threshold.

Angle of Trunk Rotation

This parameter is fundamental for monitoring the effects of the treatment, even without radiographic evaluation. The angle of trunk rotation (ATR) – rib hump (difference in elevation between right and left chest) was averaged over each individual by 15°, as measured by Adam's flexion test using a scoliometer. ATR reductions are not related to the curvature size or age of the patients treated. In table 3.7 below: in the rip prominence, there were no changes from the beginning of therapy and up to 3 months later, then see that the means are the same, the improvement started after three months of treatment where the average went from 1.21 to 1.13, and there was an improvement even greater after 12 months of treatment where the average has shrunk to 1.08.

Table 3.7. Rib Hump (ATR)

	2. ATR (Hump)	2. After 3 months	2. After 6 months	2. After 12 months
Mean	1.21	1.21	1.13	1.08
N	39	39	39	40
Std. Deviation	.469	.469	.339	.267

Back Muscle Endurance

Stretching exercises implemented in the first stage may have relaxed muscles that have been shortened asymmetrically around the spine and have lengthened the trunk, thus normalizing spinal ROM. Reinforcement exercises implemented in the final phase activated the corrected muscles using Schroth exercises and helped the patient maintain spinal stability by strengthening the trunk muscles. The strengthening exercises for weakened muscles on the convex side corrected body gravity lines and improved muscle balance. Therefore, changing the spine's structure by performing successive stretches, Schroth and strengthening exercises, lower Cobb angle and back pain in our patients.

2. Discussion and general remarks of limitation

Our study aimed to investigate the effect of Schroth exercises on AIS patients undergoing the 12-month Schroth program to observe a positive change in their back. In our sample, 60% of participants perceived improvement in their back, accompanied by a slight improvement of 1° at the Cobb angle over a 12-month treatment period. The Schroth approach primarily aims to improve postural

awareness to correct the maladaptations imposed by scoliosis. Schroth uses specific corrective breathing, automatic correction consisting of self-extension and postural corrections specific to each curve model, which eventually integrates into daily activities (Fusco.C. 2011). Most of Schroth's corrections target mainly aspects of coronal plane deformation.

One of the most discussed and commented parameters in the world literature is the Cobb angle. It is very important for determining the treatment approach and success. We support the opinion of other autors (Chongov, B., 2021; Chongov, B., Dimitrova, E., 2016) that, it should not be taken only as evidence of success orfailure. Support and observation do not only focus on improving the Cobb angle. The large number of indicators that we monitor/follow up in a few months give us information on what to pay more attention to in the relevant period. There are patients who need more attention in the frontal plane, others in the transverse and/or sagittal plane.

Bracing aims to stop the progression, and observation assures patients that they do not need more aggressive treatment. Therefore, the positive perceived change of participants may arise in response to the other effects of these conservative interventions, despite the improvement in the Cobb angle. Research suggests that Schroth exercises improve posture in all three planes as measured by surface

topography (Parent.E. 2016; Chongov, B., et al., 2017; Chongov, B., 2021). With conservative interventions, participant postural consciousness and overall body and torso balance may have improved after the intervention, and some participants may have perceived improvement not related to changes in the Cobb angle. Conservative intervention can affect other lesions, signs and symptoms of scoliosis, which may be determinants of clinically perceived substantial changes. This topic may be the focus of future research. SOSORT suggests aesthetics, quality of life, disability, and back pain as the most important outcomes to be monitored in treating scoliosis patients.

The primary objective of conservative treatments, including bracing and PSSE, is to prevent progression to avoid further exacerbation of scoliosis's signs and symptoms and address these signs and symptoms directly, with the ultimate goal of preventing surgery (Negrini S. 2006).

Patients undergoing conservative treatments make up different populations with specific characteristics and needs (Negrini S. 2006). Patients under observation and candidates for surgery may be perceived as two extremes throughout treatment, whereas patients under observation may exhibit little or no concern for scoliosis depending on the individual. Patients undergoing surgery

are on the other side of the spectrum, presenting with severe consequences due to scoliosis. Patients are treated conservatively with apparent signs and symptoms of scoliosis but not severe enough to require surgery (Asher, M. 2003). Outcomes that are considered clinically relevant may vary throughout treatment.

Our results suggest that adolescents with AIS in this study, who underwent conservative treatment, experienced a positive change in spinal condition even if the Cobb angle did not improve beyond the conventionally accepted 5° or 2.5° approach threshold. Future studies are needed to determine if this observation is generalizable. The purpose of using a Cobb angle in this study was to show that while it is generally reliable and most commonly used to evaluate the effectiveness of a treatment, it does not appear to be the one that pushes patients' perception of back improvement. Patients often perceive changes in their bodies, self-image, and sense of control over their medical condition that is not reflected in the most widely used clinical indicators such as Cobb angles. This paper supports this by finding that patients report improvement despite little or no change in their radiographs.

Bracing has recently been reported to be effective in preventing progress in the surgical interval (defined as ≥50˚) but did not produce curve improvements on average (Weinstein et al., 2013).

As described by Stokes, lateral curvature of the spine can produce asymmetric spinal load resulting in changes in bone growth rates within an individual vertebra. (Stokes, 2007). The changes lead to a progressive self-perpetuating deformity during skeletal growth, known as the "vicious cycle" (Stokes, 2002). The goal of Schroth therapy is to teach patients the automatically corrected posture, stabilize it, and integrate it into daily life. Self-correction, defined as the ability to reduce spinal deformity through active postural spine rearrangement in three dimensions (Fusco. C et al., 2011), balances load on the convex and concave sides of the ascending spine and can reverse "vicious cycles" (Stokes, 2004). The goal of treatment is to stimulate a counteraction to the reaction. This reaction cannot be adequately invoked if the patient has not been able to train correctly. It is not helpful to set up a self-correction exercise that is theoretically "best" for a specific case of scoliosis if the patient cannot perform it properly and maintain it for the required duration. It is vital to evaluate a more precise movement that the patient performs correctly and then gradually focus on increasing the difficulty of the exercises. Once the patient has successfully learned the correct movements, active self-correction is performed independently and then applied to each exercise performed by the patient.

A combination of different measures is beneficial in a broad anamnesis for treating research patients. In doing so, patient questionnaires are of high value to improve a medical diagnosis, understand a patient's needs, and assess the potential need to provide psychotherapeutic support. A summary of the questionnaires is recommended for clinical use depending on the therapist intentions.

As a general recommendation, we suggest applying a combination of SAQ (Spinal Appearance Questionnaire), VAS (Visual Analogue Scale) and SRS-22 (Patient Questionnaire) as screening instruments for patients with scoliosis about twice a year.

Limitations of this study include the limited number of patients with scoliosis 40° or higher and the difficulty finding time for participants because most were students who had to attend school. The fundamental limitations of this thesis are the relatively small sample size and the intermediate duration of the follow-up.

Ten participants left due to time constraints. Radiographs were missing because the treating clinician had not ordered them or were taken too late. The reasons for the disappearance had nothing to do with the results. Therefore, we believe the sample was representative of the complete data.

In the future, a study comparing the effects with a group will be needed, among which Schroth's exercises combined with orthosis treatment.

We have included patients of all levels of maturity. Mature patients (Risser 3–5) have a lower risk of progression and potentially better treatment success. However, the sample's estimated risk of progression was higher than in most exercise trials. When performing subgroup analysis in high-risk patients (Risser 0 in 2) versus low-risk progression (Risser 3 in 5) is guaranteed, our sample size does not allow this comparison. However, most of our patients were considered at moderate risk of progression with the distribution of Risser signs appearing as follows: zero patients with Risser 5, zero patients with Risser 4, three with Risser 3 compared with twenty-one patients with Risser 2, twelve with Risser 1 and four with Risser 0.

Exercising treatment requires daily goals, dedication and dedication of patients and their parents, as well as their adaptation to a daily routine.

Shorter follow-up can provide tangible and meaningful feedback to patients and stimulate motivation to continue this demanding treatment.

In addition, this shorter test allowed for stricter intervention control, including lack of co-intervention and high compliance, which would have not been more likely to occur during a longer follow-up.

Although the evidence suggests that Scroth's long-term intervention until maturity leads to improved curves, the curves may worsen after a shorter follow-up, despite the initial improvement.

For assessing QOL in AIS patients after treatment, the SRS-22r is the most frequently used questionnaire. SAQ is increasingly utilized in the same population.

The results indicate that, due to the effects of a high ceiling and the point scale close to the best values, in both questionnaires, different QOL tools should probably be used in patients with conservatively treated AIS.

Further, the study's design does not allow the determination of whether the exercises can replace the braces. To define whether the braces can be replaced, our analysis must randomize patients with whom we meet prescription criteria groups for only one exercise or only one support group.

3. Conclusions and Recommendations

Conclusions

1. The results of the VAS suggest that the Schroth exercises improve pain.
2. The results of the SAQ questionnaire demonstrated more significant benefits for self-image and self-efficacy.
3. Schroth exercises showed a small but positive influence on back muscles endurance consistency in AIS patients during a long 12-month intervention.
4. The study showed a high prevalence of ceiling effects and the optimal results in both questionnaires.
5. The results of this study confirm the opinion of other authors that there seems to be a need for more responsible use of questionnaires to capture changes in are treated patients with AIS conservatively and ≤35° curves. QOL is a significant result but not well related to the size of the curve, especially when the curves are smaller.
6. Maintaining the improvement achieved through supervision exercises is essential, and the importance of compliance should be emphasized at length in treatment sessions.

7. The success of Schroth exercises is a responsibility shared by both the physiotherapist and the patient and is supported by engagement.

Recommendations

- Future research investigating the effect of Schroth intervention should include *a larger population of AIS patients.*
- It is necessary to decide on *guidelines for evaluating the effectiveness of the exercises.* This way, comparisons between trials of similar exercises would be easier and more valuable.
- Future work should highlight the *cost-benefit* of this promising conservative treatment for scoliosis before implementing a widespread change in practice.
- A clinical prognosis rule to identify patients who would benefit from Schroth treatment is also an important step *to avoiding overdose*.

We assess if our Schroth education, with curve and attitude analysis, may have sensitized patients to how they perceive their

scoliosis. This study requires further investigation into results that may be more important in determining the AIS patient perceive as most important to monitor during conservative treatment.

4.CONTRIBUTIONS OF THE DOCTORAL THESIS

With an original character

1. An own methodology has been introduced, following the Schroth's principles and the compliance to a specific exercise programin the conservative treatment of idiopathic adolescent scoliosis with very good practical results.

2. An innovative technique for widening deformed areas of the torso with the help of breathing mechanics and adjacent muscles is described in detail.

3. For the first time in my country the Schroth method was used as a rehabilitation method in idiopathic adolescent scoliosis.

With scientifically applied and confirmatory character

4. For the first time in my country, a large number of statistically reliable students at the University of Sports of Tirana diagnosed with idiopathic adolescent scoliosis were treated conservatively according to a standardized protocol and indications, was monitored.

5. Practical rehabilitation protocols for therapeutic exercises depending on the type of scoliotic deformity are presented according to Rigo classification.

6. For the first time in my country, modern methods for disease assessment are introduced and their high informativeness in monitoring and their treatment is practically proven.

LIST OF SCIENTIFIC PUBLICATIONS IN RELATION TO THE TOPIC OF THE DISSERTATION

1. Conference Reports

During three years I have produced written work in two papers which I presented at international sports scientific conferences. The topics presented are:

14-15 November 2019

1. Participant in International scientific congress "Applied Sport Sciences, Balkan Scientific congress" Physical Education, Sports, Health, Sofia, Bulgaria. "Functional assessment on the patients with adolescent idiopathic scoliosis".

6-7 December 2019

2. Participant in 16th International Conference in Social Science ICSS "Sport toward the future" Tirana, Albania. "Quality of Life in Patients with Adolescent Idiopathic Scoliosis".

2. Publications

1. **Oseku, A.,** Dimitrova, E. (2019). Functional assessment on the patients with adolescent idiopathic scoliosis. International Scientific Congress "Applied Sports Sciences" and the Balkan Scientific Congress "Physical Education, Sports, Health", *Proceeding book,* ISSN (Online): 978-954-718-601-9, ISSN (Print): 978-954-718-602-6, NSA Press, pp. 547-549. Ref in Web of science
2. **Oseku, A.,** Metolli, S. (2021). Effects of Schroth exercise on Cobb's angle, vital capacity and the improvement of daily activities on patients with adolescent idiopathic scoliosis. *European Journal of Health & Science in Sports* Volume 8 Issue 2, pp. 1-5.
3. **Oseku, A.,** Metolli, S. (2021). Quality of life in patients with adolescent idiopathic scoliosis. *European Journal of Physical Education and Sport Science,* Volume 7 (4). DOI: 10.46827/ejpe.v7i4.3885