

# Adolescent Idiopathic Scoliosis: Review of Conservative Treatment with Physiotherapy Scoliosis Specific Exercises

Maria-Aikaterini Giordamni<sup>1</sup>, Konstantinos Chandolias<sup>2</sup>, Dimitris Pollatos<sup>3</sup>, Anna Chalkia<sup>4</sup>, Eugenia Trelaki<sup>5</sup>

<sup>1</sup>PT, Postgraduate Program, International Hellenic University, Greece

<sup>2</sup>PT, PhD, NDT, Academic Fellow, Department of Physical Therapy International Hellenic University, Greece

<sup>3</sup>PT, Postgraduate Program, International Hellenic University, Greece

<sup>4</sup>PT, PhD, Academic Fellow, Department of Physical Therapy, International Hellenic University, Greece

<sup>5</sup>PT, MSc, Academic Fellow, Department of Physical Therapy, International Hellenic University, Greece

Corresponding Author: Maria-Aikaterini Giordamni

## ABSTRACT

**Background:** Idiopathic Scoliosis is a complex issue in the lives of patients who develop this deformity, especially in adolescents during the period of development to skeletal maturation. The purpose of this review is to present the current data in the conservative treatment of Adolescent Idiopathic Scoliosis and to be a guide in the conservative treatment and the treatment strategy of these patients.

**Method:** A literature review was conducted in the PubMed, PEDro, Google Scholar databases with articles during the period 2000-2019. The terms "adolescent idiopathic scoliosis", "special physiotherapy exercises for scoliosis", "conservative treatment", "physiotherapy" was searched.

**Results:** Physiotherapy Scoliosis Specific Exercises (PSSE) "share" common principles in treating patients. In general, in terms of the effectiveness of Physiotherapy Scoliosis Specific Exercises, it seems that all methods present positive results in terms of prevention of surgery, posture and deformity correction, respiratory capacity, strength, balance and neuromuscular coordination. In particular, it seems that the Schroth Method and its most advanced version, the BSPTS, present excellent data in the treatment and prevention of the development of scoliosis. SEAS exercises show an improvement in Cobb angle compared to simple physical therapy and good results in preventing aggravation by weaning braces.

**Conclusions:** The results of the review showed that the combination of methods and means of treatment seems to have better results in the treatment of scoliosis, mainly in moderate to severe scoliosis, especially through the application of exercises Schroth & BSPTS and SEAS.

**Keywords:** adolescent idiopathic scoliosis, physiotherapy scoliosis specific exercises, conservative treatment, physiotherapy.

## INTRODUCTION

According to the Scoliosis Research Society (SRS), scoliosis is any curvature of the spine that exceeds 10° and is accompanied by simultaneous transverse rotation of the vertebrae (Negrini et al., 2015). It is a general term that includes heterogeneous conditions that show changes in the shape and position of the spine, chest,

and trunk (Negrini et al., 2018). In more than 80% of cases, they are not due to a specific cause and are therefore referred to as 'idiopathic' (unclear aetiology). Therefore, Adolescent Idiopathic Scoliosis (AIS), which is discussed in this article, is a type of scoliosis with unclear aetiology that occurs in patients during the period of physical development.

Idiopathic Scoliosis (IS), according to the Scoliosis Research Society (SRS), is characterized as a rotational deformity of the spine. Adolescent Idiopathic Scoliosis (AIS) tends to occur in a healthy population and can be exacerbated by many factors during the developmental period. It is more common in girls and if not treated early, can lead to severe torso deformities, which may limit chest development function, ability to exercise, general fitness, ability to work and quality of life.

The Society of Scoliosis Orthopaedic Rehabilitation and Treatment (SOSORT) promotes and encourages evidence-based medicine with adequate clinical findings by providing training and guidance on the treatment of scoliosis (Berdishevsky et al., 2016). An important element in the progress of scoliosis is the monitoring of the development of curvatures over time and the clinical evaluation of the condition even after the end of the treatment program. The three main interventions of the conservative treatment of Adolescent Idiopathic Scoliosis, Physiotherapy Scoliosis Specific Exercises, Bracing and Observation are certified by the guidelines of the international organization Society on Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT) good physiotherapy practice (Negrini et al., 2012).

Every method and school internationally is called upon to endorse the principles of SOSORT and share a common mission. SOSORT uses the term Physiotherapy Scoliosis Specific Exercises (PSSE) for all schools and methods represented in the organization. Then there is an extensive reference to the seven basic methods in the treatment of Adolescent Idiopathic Scoliosis as well as to the braces who appear mainly due to the modern therapeutic focus.

### **Physiotherapy Scoliosis Specific Exercises**

**Schroth method:** developed by Katharina Schroth in 1920. It is used to treat idiopathic scoliosis and various deformities of the

sagittal plane such as Scheuermann kyphosis and lordosis (inverted back). It aims to prevent the development of deformation before the end of development (Berdishevsky et al., 2016). In the Schroth Method there are five basin correction principles. These five principles ensure that the pelvis is better aligned with the trunk before major spine corrections [Autoelongation (detorsion), Deflection, Derotation, Rotational breathing, Stabilization] and which comply with SOSORT guidelines (Negrini et al., 2012). It also includes mobilization and flexibility techniques of the spine and ribs to improve the mobility of all the joints involved before performing the exercises. Muscle activation is achieved through the activation of specific muscles that enhance the correction of the spine, such as the iliopsoas (Berdishevsky et al., 2016).

**Lyon method:** combines Physiotherapy Scoliosis Specific Exercises (PSSE) with the application of Lyon braces and the use of a special casting. In recent years, the method combines PSSE with the application of the modern Lyon braces, ARTbrace (Asymmetrical Rigid Torsion brace) (Berdishevsky et al., 2016). For this method, the development of scoliosis is neither certain nor predictable, as the nervous system is constantly fed, adjusts the joints, and corrects the asymmetric growth during the early development of scoliosis (Burwell et al., 2013). Physiotherapy includes 3D spinal mobilization, mobilization of the sacroiliac joints (in lumbar scoliosis), training of patients in the treatment program and activities of daily living, including the correction of the sitting position. He also uses Rotational angular breathing (RAB), which combines diaphragmatic breathing and simultaneous breathing machine training to increase lung capacity. Finally, it improves the endurance of the deep paraspinal muscles and the rest of the torso muscles and aims to mobilize the involved joints to correct the posture (Berdishevsky et al., 2016).

**SEAS (Scientific Exercise Approach to Scoliosis) method:** is a method for the treatment of scoliosis, which focuses on regaining static control and improving the stability of the spine, through active exercises that focus on the patient's self-correction. Active self-correction (involving all three basic levels of movement) is performed without any external assistance and is integrated into various functional exercises. It aims to stimulate neuromotor receptors to activate the self-correcting reflex during daily activities and neurosensory receptors to 'maintain' the correct posture. Active 3D self-correction exercises can be reproduced in thousands of ways in daily activities that require increased neuromuscular control to increase dynamic stability and correct posture. The primary goal of the muscular activation of the SEAS exercises is the stabilization of the torso, while the mobilization of the joints of the spine and the elasticity exercises also play an important role in the development of the treatment (Berdishevsky et al., 2016).

**Barcelona Scoliosis Physical Therapy School (BSPTS) method:** based on the principles developed by Katharina Schroth, and is mainly used to treat patients with adolescent idiopathic scoliosis, some forms of congenital scoliosis and other anteroposterior deformities such as Scheuermann disease. The predecessor of BSPTS was founded in 1968 in Barcelona, Spain by physiotherapist Elena Salvá (1926-2007). It is a physiotherapy method that includes cognitive, sensory and kinesthetic retraining to improve scoliosis at a three-dimensional level. All principles follow a complete posture correction pattern including the trunk, upper and lower limbs. High-intensity forces are applied to the exercises through isometric contractions, stretching and breathing exercises. In summary, the principles of the BSPTS Method as they appear in the international literature are: 1) 3D postural correction

(translation, rotation, sagittal expansions), 2) Expansion / Contraction, 3) Stabilization, 4) Integration, (Berdishevsky et al., 2016) ).

**Dodomed Method:** developed in 1979, by the Polish Dr. Krystyna Dobosiewicz (1931-2007) and is a conservative approach to Idiopathic Scoliosis, which aims at both deformity of the trunk and restoration of respiratory function. It has incorporated in its techniques both the position of the Klapp Method for the retraining of the normal 'kyphosis' of the thoracic spine and the technique of active asymmetrical breathing by Lehnert-Schroth (Lunes et al., 2010 , Berdishevsky et al., 2016). The mobilization of the primary bulges is carried out through a closed kinetic chain, in a symmetrical position of the pelvis and shoulders, emphasizing both the pelvis and the shoulders so that they are kept stable during the exercise and during the phase of inhalation and exhalation, respectively. active asymmetric respiration (Berdishevsky et al., 2016).

**Side Shift method:** based on the theory according to which a flexible hump can be stabilized through targeted corrective movements in the frontal plane (lateral movements). Targeted and intense lateral movements of the torso can correct the excessive and 'abnormal' deviation of the body from the midline to the frontal plane. The main goal of the method is the active correction of the spine, through targeted movements towards the concave side of the deformity towards the top vertebra of scoliosis. Regarding the therapy exercises, it focuses on the stabilization of the torso (core stabilization) and the spine. This is achieved through isometric exercises in the abdomen, gluteus and shoulder muscles. The breathing exercises of the method aim at the development of the ribs and the chest to improve the vital capacity. Finally, balance and receptivity exercises are added to the treatment program and are an indication of a high level of sensory

integration of the treatment elements (Berdishevsky et al., 2016).

**FITS (Functional Individual Therapy of Scoliosis) method:** created in 2004 by Marianna Białek and Andrzej M'hango. It is based on the patchwork of different techniques from other therapeutic approaches which have been adapted and modified into another form of scoliosis treatment. The guidelines and principles of the method were published by Białek & M'hango in 2008 and 2011 (Bialek & M'hango, 2008). In addition, the method can be applied auxiliary in parallel with the use of a special braces, during the preparation before surgery or even after surgery to align the shoulders with the pelvis. Promotes the improvement of the respiratory function and the better development of the ribs and the chest through special exercises. The required muscle activation is achieved through the corrective tendencies created by the muscles in an attempt to stabilize the pelvis and spine in maintaining the correct posture. Finally, this method places special emphasis on myoperitoneal release, promoting the mobilization and elasticity of the spine before therapeutic intervention (Berdishevsky et al., 2016).

## METHOD

A search was conducted for randomized studies that compare the effectiveness of the methods mentioned before, related to the treatment of Adolescent Idiopathic Scoliosis and obey the term "Physiotherapy Scoliosis Specific Exercises ". The exclusion criteria included observational studies and case series.

Searched Medline databases (via Pubmed), PEDro (Physiotherapy Evidence Datadase) and Google Scholar. The terms used were "adolescent idiopathic scoliosis", "physiotherapy scoliosis specific exercises", "conservative treatment", "physiotherapy", with articles during the period 2000-2019. There are 13 articles that refer to different, mostly methods related to the term

"Physiotherapy Scoliosis Specific Exercises".

## RESULTS

The search results were studied at the title and abstract level. Those studies that were not rejected were secured and their full text was studied in order to collect those studies that met the admission criteria for the review. Finally, 13 articles were published which refer to the effectiveness of the methods applied in the treatment of Idiopathic Scoliosis and are mentioned in detail in Table 1.

The effectiveness of PSSE, endorsed by SOSORT, for the treatment of patients with Idiopathic Scoliosis in deformities with mild to moderate curvature has now been demonstrated through various studies. The following is an extensive reference to the 13 studies that present some of the most important factors that affect the effectiveness of the methods mentioned before.

Specifically, Rigo and colleagues in 2003 studied the prevalence of surgery in patients with Adolescent Idiopathic Scoliosis receiving conservative treatment compared with those who did not receive treatment. Patients who met the criteria for the study (diagnosed with EIS at age 10 or older, minimum age 15 at last check-up, Cobb angle guard without braces at least 10°) were group patients (who were treated in a rehabilitation center), while the control group consisted of patients who took part in the research of Goldberg et al., 1993 (n = 153) and who met the same criteria for admission to the research. The intervention group consisted of 157 people, of whom 106 patients wore braces (67.5%) in parallel with the Schroth exercise program and had a mean age of 12.5±1.1 years. The intervention group followed an exercise program in sessions lasting 2 hours, 2-3 times a week for 3-4 months. After this cycle of sessions patients received a home exercise program for one year with partial supervision 1-4 times a month and then every 3-6 months. The results showed in the

intervention group that only 6/157 (3.8%) resorted to surgery, while from the subcategory of 106 patients who applied braces only 6/106 (5.6%). Patients in the control group had a prevalence of 28.1% surgery, significantly higher than the intervention group.

Kuru and colleagues in 2015, in Istanbul, studied the effectiveness of Schroth exercises in patients with Adolescent Idiopathic Scoliosis. The randomized trial included 45 patients who met the criteria for admission to the study (age: 10-18 years, Cobb angle 10-60 °, Risser point 0-3, no other intervention for scoliosis), and who were divided into 3 groups. The first group (n = 15) concerned inpatients who followed Schroth exercises under supervision, the second (n = 15) followed a Schroth exercise program at home and the third (n = 15) was the control group. The protocol that was applied concerned the implementation of the exercises for 6 weeks (3 times a week - lasting 1.5 hours - 18 sessions in total). The Cobb angles of the patients, the ATR angle, the height of the bulge and the asymmetry of the pelvis were also measured for the effectiveness of the intervention. The results of the study showed that the first group had better progress in treatment than the second, while the third group in the control group showed worsening of scoliosis.

As the BSPTS Method is based on the principles developed by Katharina Schroth, the scientific evidence demonstrating the effectiveness and benefits of this method is the same as that of the Schroth Method mentioned above (Berdishevsky et al., 2016). However, in 2005, Otman and colleagues conducted a study to determine the effectiveness of 3D therapy in the treatment of Adolescent Idiopathic Scoliosis. The study involved 50 patients with a mean age of  $14.15 \pm 1.69$  years. Patients followed a Schroth exercise program (such as the Muscle cylinder exercise applied to BSPTS), as outpatients 5 times a week, lasting 4 hours per session for 6 weeks. Patients then had to follow the

same program at home. Before the start of the program, the Cobb angle, vital capacity and strength of the patients were measured, while the measurements were repeated at 6 months and 1 year, for comparison of the results. Both the Cobb angle [avg. : 26.10° (before), 19.25° (6 months), 17.85° (1 year)], as much as the vital capacity [avg. : 2795 ml (before), 3125 ml (6 months), 3215 ml (1 year)] and strength increased in all patients ( $p < 0.01$ ).

Regarding the SEAS Method, Negrini and colleagues in 2008 compared the effectiveness of SEAS exercises with conventional rehabilitation programs. Specifically, 23 patients, who were the intervention group, with a mean age of  $12.7 \pm 2.2$  years (and a Cobb angle of  $15.3 \pm 5.4$  °) followed a SEAS exercise program in 1.5 hour sessions every 2-3 months. This group was allowed to perform SEAS exercises close to home twice a week for 40 minutes or daily SEAS exercises for 5 minutes. The control group consisted of 25 patients with a mean age of  $12.1 \pm 1.1$  years (and with a Cobb angle of  $14.9 \pm 6.0$  °), who followed a conventional protocol by a physiotherapist, 2-3 times a week for 45-90 minutes. The results showed that the intervention group improved at the Cobb angle by 28.9%, 68% remained stable and deteriorated to 3%, while the control group improved by only 5%, 82% remained stable and 13% deteriorated. The measurements were made at the beginning and at the end of the intervention. Finally, it was noted that there was no statistically significant difference between the two groups ( $p < 0.05$ ).

In addition to the SEAS Method, Zaina and colleagues conducted a study in 2009 to examine whether SEAS exercises could reduce the reduction in correction that occurs after weaning patients. The study involved 68 patients aged  $15 \pm 1$  years with a Cobb angle of  $22 \pm 8$  ° at the onset of weaning. For all patients, the period at which the braces application was less than 18/24 hours was defined as the 'beginning' of the measurements and the start of the

program, while the 'end' of the measurements was complete weaning (lasted 2.7 years). Patients were divided into two groups. The first group was the intervention group and consisted of 39 patients in total who were divided into two subgroups, in the EX group: 14 patients following a SEAS exercise protocol and in the OTH group: 25 patients following a simple exercise program). The second group was the control group, which consists of a total of 29 patients, who were divided into two subgroups, in the DIS subgroup: 19 patients with intermittent exercise program and in the NO subgroup: 10 patients who did not follow any exercise program. The patients in the EX group did a 1.5 hour session every 2-3 months under supervision, while they had to do SEAS exercises on their own twice a week for 40 minutes or 5 minutes daily. Patients in the OTH group followed a specific exercise protocol for 45-90 minutes 2-3 times a week. Patients in the DIS group had to complete less than 45 minutes per week or be more than 6 months away from exercise. Cobb angle and ATR were measured. The results showed that the Cobb angle of DIS and NO increased by  $3.9^\circ$  and  $3.1^\circ$  respectively ( $p < 0.05$ ), while that of EX and CTI remained constant. The results for ATR did not change.

Furthermore, Romano and his colleagues, in 2011, studied the effectiveness of PSSE and in particular SEAS exercises in relation to the conventional conservative treatment of scoliosis with physical therapy and the application of braces in patients with Adolescent Idiopathic Scoliosis. Specifically, 288 patients older than 10 years ( $12.8 \pm 1.5$ ), with scoliotic curvatures of  $10-20^\circ$  and Risser point 0-3 were divided into 5 groups. The first group (BG) was that of the braces, which consisted of 40 patients who practiced braces for 18 hours / day. The second group (SEAS) was that of patients who practiced specific SEAS exercises, consisted of 101 patients and who had re-examination by a specialist at least 3 times / year. The third group (UP) was the group

that followed conventional physiotherapy and consisted of 70 patients, the fourth group (NC) was a group of patients consisting of 46 patients who followed SEAS exercises with 2 or fewer expert examinations per year. Finally, the fifth group (CG) was the control group that did not follow any treatment program. The treatment programs of the groups were followed for  $12 \pm 4$  months and the Relative Risk of failure of the treatment was judged the development of scoliosis by  $5^\circ$  or the prescription of a braces. The results showed that BG differed significantly in all parameters from the rest while showing 10% failure and 10% improvement in scoliosis (45% improvement). Respectively, SEAS presented 16% and 30%. Specifically, comparing the SEAS team with the others, the Relative Risk of failure was statistically significant while for the BG and SEAS teams it was not. Thus, for the CG group it was 1.9 (IC95 1.28-2.53), for the NC 2.02 group (IC95 1.34-2.70) and for the UP -1.52 group (IC95 0.91-2.13). Therefore, treatment with braces and the SEAS Method can reduce the risk of developing Adolescent Idiopathic Scoliosis.

Regarding the Dodomed Method, Durmala and his colleagues in 2009 studied the development of scoliosis in patients using Cheneau braces and Dodomed Method exercises. 28 premenstrual girls with a mean age ( $12.6 \pm 1.1$  years) started a treatment program for thoracic scoliosis with radiological evidence for the rapid progression of scoliosis. 18 of them additionally had lumbar scoliosis. The Cobb angle for thoracic scoliosis was  $30.8^\circ \pm 5.5^\circ$  and for the lumbar region  $29.1^\circ \pm 8.2^\circ$  before the start of treatment. Cheneau braces were given full-time exercise in parallel with their daily Dodomed exercise program. The average duration of treatment was  $43 \pm 9$  months, while out of the total number of patients, 11 were completed.  $\pm 10.4^\circ$ . Therefore, the goal of stabilizing the development of scoliosis during the rapid growth period of girls by 89% was achieved

using a combination of Cheneau Guardian therapy & Dodomed exercises.

Dobosiewicz and colleagues in 2006 conducted a study to study the radiological findings of 3D asymmetric scoliosis treatment in strictly symmetrical initial positions (see Dodomed Method Principles). The study involved 152 patients (137 girls - 15 boys) with progressive idiopathic scoliosis according to radiological findings that took place from 1999-2004. The mean age of patients was 14.22 years and the mean follow-up time of patients was 31.8 months. All patients followed a Dodomed exercise program. The patients' mean Cobb angle was 25.92 ° and the mean initial vertebral rotation was 9.55 ° before the start of the treatment program. At the end of the program these angles were 31.04 ° and 12.97 ° respectively. In conclusion, the radiological findings showed that the Dodomed Method can be applied to developing scoliosis in order to stabilize their development.

In 2011, Bialek studied the effectiveness of the FITS Method for single-curved or double-scoliosis at Cobb angles of 10-20 ° (group A) and in patients with Cobb angles of 20-45 ° (group B), respectively. A total of 115 children participated in the study, who attended a 60-minute FITS exercise session once a month and followed a 45-minute FITS exercise program at home. The average attendance period of the program was 2.08 years. The improvement was defined as the reduction of the Cobb angle by 5°, as the progressive-stable scoliosis were considered those that had a difference of up to 5° ( $\pm 5^\circ$ ) and as aggravating were defined those that had an evolution over 5°. In group A, 78 patients participated: A1) single bulges, 50% improved, 46.2% remained stable and 3.8% worsened, A2) double bulges, 50% improved, 30.8% remained stable and 19.2% worsened. In group B, 37 patients participated: B1) single bulges, 20% improved, 80% remained stable and none worsened, B2) double bulges, 28.1% improved, 46.9% remained stable and 25%

worsened. Finally, none of the patients showed such deterioration that they resorted to surgery. From the results of the study it is easily understood that the FITS Method shows better results in scoliosis with an angle of Cobb 10-25 °.

In 2007, the same researcher Marianna Bialek and her colleagues studied the change of angle of trunk rotation (ATR) in primary scoliosis and in secondary curvatures of adolescent girls during the application of FITS exercises. The method involved 64 girls with age-related scoliosis ( $13.9 \pm 1.9$  years, mean Cobb angle  $30.6 \pm 14.7$  and mean Risser point 2.0), who followed a 14-day intensive physiotherapy program as inpatients according to the FITS Method. The evaluation of the turning angle of the trunk was done with a Bunnell scoliometer, and the measurements were made from relaxed or active positions where the primary curve rotation angle (PCR) was also measured. Still, 14 girls continued treatment for one year according to the FITS Method as outpatients, along with partial bracing (12 hours / day). The results showed that the patients who received intensive treatment had an improvement of the PCR angle from  $9.5^\circ \pm 4.7$  to  $8.5^\circ \pm 4.5$  in primary relaxation in a relaxed position but overall the rotation decreased from  $13.1^\circ \pm 6.7$  to  $11.6^\circ \pm 6.4$ , while in active position and PCR angle improved from  $8.2 \pm 4.3$  to  $7.2.4.6$ . The torso rotation and therefore the ATR did not change in the upper compensatory curves, while in the lower ones it had a small increase from 0.9 to 1.7.

In 2003, Maruyama and colleagues studied whether conservative treatment in Adolescent Idiopathic Scoliosis could prevent surgery. The conservative treatment in this case consists of a combination of guardian application (Boston & Milwaukee, 8 hours / day) and Side Shift exercises (and mainly Hitch exercise). The study included 328 girls with Adolescent Idiopathic Scoliosis, with a mean age of 13.8 years and a mean Cobb angle of 32.4 °, who were monitored from approximately 10 years of age until 15 years of age until skeletal

maturation occurred. Only 6.1% of patients (20/328) resorted to surgery as their scoliosis worsened from  $48.5 \pm 9.3^\circ$  to  $62.2 \pm 8.5^\circ$  at the age of  $16.0 \pm 2.6$  years. Of the remaining 308 girls with a Cobb angle of  $32.4 \pm 11.1^\circ$ , none showed a significant increase in scoliosis ( $33.6 \pm 11.5^\circ$ ) until adulthood.

In addition, Mamyama and colleagues in 2002 studied the effectiveness of Side Shift exercises in patients with idiopathic scoliosis after skeletal maturation. Specifically, 69 patients participated in the study who followed a treatment program entirely with Side Shift exercises. Their mean age at the beginning of the treatment program was 16.3 years and the mean follow-up period was 4.2 years. The results showed that the mean Cobb angle at the start was  $31.5^\circ + 11.2^\circ$  and at the end of the follow-up was  $30.3^\circ - 12.3^\circ$ .

Therefore, Side Shift exercises can be effective in treating scoliosis even after skeletal maturation.

Finally, Duconge and colleagues in 2002 studied the effectiveness of Lyon Method exercises on posture control, strength and balance. The intervention group consisted of 422 patients, who followed an exercise program twice a week with a physiotherapist and sometimes followed an exercise program at home, while the control group consisted of 169. The age range was 7-16 years and the overall treatment program lasted a total of ~ 55 months. The results showed that the intervention group improved by 58% while deteriorating by 42% (mean Cobb angle value, from  $17^\circ$  to  $21^\circ$ ), while the control group improved by only 23% and deteriorated by 77% (mean Cobb angle value  $12^\circ$  at  $25^\circ$ ).

**Table 1: Results of studies in interventions of patients with Adolescent Idiopathic Scoliosis with PSSE.**

Researchers	Subjects	Intervention	Comparison	Results
Rigo et al.,2003	N=310 patients in total Age $12.5 \pm 1.1$ years old. Control at the end of the intervention.	N1:157 Schroth, 106 of which Schroth & braces. Sessions:2hrs, 2-3 times a month, for 3-4 months. Home exercise program for one year & partial supervision.	N2:153 no interference	N1: 3.8% & 5.6% herded to surgery. N2:28.1% herded to surgery.
Kuru et al.2015	N=45 patients in total, divided into 3 groups Cobb $10-60^\circ$ Age:10-18 years old Control at the end of the intervention.	N1=15 Schroth in clinic N2=15 Schroth at home. Schedule 6 weeks, 1.5 hours, 18 sessions.	N3=15 no interference	Improvement: N1>N2. N3: aggravation Measured: Cobb, ATR, curvature height, pelvis asymmetry
Otman et al, 2005	N=50 patients Cobb $26.10^\circ$ Age: $14.15 \pm 1.69$ years Follow-up: 6months, 1 year	All 50 patients Schroth-BSPTS. 6 weeks, 4 hours, 5 times/week schedule	Follow-up : 6 months 1 year	Improvement: Cobb: $19.25^\circ(6m)$ , $17.85^\circ(1\text{ year})$
Negrini et al,2008	N=48 patients in total. Aged $12.7 \pm 2.2$ years.	N1=23 SEAS. Cobb $15.3^\circ \pm 5.4$ 1.5 hour sessions, every 2-3 months 2*40 minutes or 7*5 min/weeks. exercise at home.	N2=25 conventional exercise program. Cobb $14.9^\circ \pm 6.0^\circ$ 2-3/week, for 45-90minutes.	N1:28.9% improved,68% steady,3% aggravation N2:5%improved, 82%steady,13% aggravation
Zaina et al., 2009	N=68 patients in total. Cobb $22 \pm 8^\circ$ Aged $15 \pm 1$ . Control at the end of the intervention	EX: 14, SEAS Session 1.5 hours, every 2-3 months. 2*40 minutes or 7*5min/weeks. exercise at home.	OTI:25, exercise program,2-3 times/week, for 45-90 minutes. DIS:19, exercise.45 minutes/week or 6 months abstinence. NO:10 no intervention.	Cobb: Aggravation DIS, NO (by $3.9^\circ$ , $3.1^\circ$ ) EX,OTH stable.
Romano et al., 2011	N=288 total Cobb $10-20^\circ$ Age $12.8 \pm 1.5$ Control at the end	SEAS:101, SEAS, supervision 3 times/year. NC:46, SEAS unsupervised. Sessions for $12 \pm 4$ months	BG:40, braces UP:70, p/o  CG:46, no interference.	BG:10% aggravation ,45% improvement.  SEAS:16% aggravation,30% improvement

	of the intervention			NC,UP,CG: 2.02,1.52,1.9(Relative Risk of failure)
Durmala et al.,2009	N=28 girls with thoracic scoliosis, Cobb 30.8°±5.5° (thoracic) 29.1°±8.2° (lumbar) Age 12.6 ± 1.1 years old Control at the end of the intervention	28, Dodomed and Chêneau braces (full-time) Duration of treatment:43±9 months.	-	11/28 is over. Cobb: 34°±9.2° (thoracic) 29.2°±10.4°(lumbar)
Dobosiewicz et al.,2006	N=152 in total. Cobb 25.92° Control at the end of the intervention	All patients applied Dodomed, for 31.8 months, to rapidly evolving Idiopathic Scoliosis	-	Cobb : 31.04°. Achieve curvature
Bialek et al.,2011	N=115 patients Group A: 78 patients, Cobb: 10-20°. A1:single curvatures A2:double curvatures Group B: 37 patients, Cobb 20-45° B1:single curvatures B2:double curvatures Control at the end of the intervention	All patients have implemented a FITS exercise program, one session of 60 minutes,1 /month, The house was followed by a 45-minute FITS exercise program. The intervention lasted 2.08 years.	-	A1: 50% improvement, 46.2% constant, 3.8% worsened A2: 50% improvement, 30.8% constant, 19.2% worsened B1: 20% improvement, 80% constant, No aggravation B2: 8.1% improvement, 46.9% constant, 25% worsened
Bialek et al., 2007	N=64 Girls. Cobb 30.6°±14.7 Aged 13.9±1.9 years old Control at the end of the intervention The PCR & ATR angle was measured.	64 girls applied FITS exercises for 14 days as internal patients. 14/64girls applied FITS as outpatients & braces (12 hours/day), for another year	-	Angle: PCR: From 13.1°± 6.7 to 11.6° ± 6.4, in a relaxed position and from 8.2± 4.3 to 7.2 ± 4.6, in an active position. ATR Angle: did not change to the upper compensatory convex, in the lower had a slight increase from 0.9 to 1.7.
Mamyama et al.,2003	N=328 girls. Cobb 32.4°. Average age 13.8 years Control at the end of the intervention	328 girls applied Side-shift exercises and braces (Boston & Milwaukee, 8 hours/day)	-	20/328 or 6.1% deteriorated from 48.5°±9.3° to 62.2°±8.5°. 308/328 showed no serious increase in scoliosis until adulthood. Cobb from 32.4°±11.1° to 33.6° ±11.5° .
Mamyama et al., 2002	N=69 patients. Cobb 31.5°+11.2° Aged 16.3 Follow-up 4.2 years.	All patients followed a Side Shift exercise program.	-	Cobb Angle Improvement : From 31.5°+11.2° to 30.3°-12.3°.
Duconge et al., 2002	N=591 Patients. Aged 7-16 years. Duration of treatment ±55 months.	N1:422 patients, Lyon , 2 f./week. and exercises at home. Cobb: 17°	N2:169 patients. No interference	N1: 58% improvement, 42% aggravation (from 17° to 21°). N2: 23% improvement, 77% aggravation (from 12° to 25°)

## DISCUSSION

The effectiveness of PSSE, endorsed by SOSORT, for the treatment of patients with Idiopathic Scoliosis in deformities with

mild to moderate curvature has now been demonstrated through various studies. Then we refer to various studies that present some

of the most important factors that affect the effectiveness of the above methods.

Regarding the Schroth Method, Rigo et al., In 2003, demonstrated that the Schroth Method in combination with the application of braces prevented surgery in the majority of patients. Only 3.8% and 5.6% of them went to surgery. Furthermore, Kuru et al., In 2015, concluded that the application of Schroth exercises to supervised or homeless patients had better results than control patients who did not follow any intervention, and Otman et al. In 2005, in their study of the effectiveness of the Schroth Method - BSPTS, they found that both the Cobb angle and the vital capacity and strength improved in all patients following a Schroth exercise program.

For the SEAS Method, Zaina et al., In 2009, in their research on the effectiveness of SEAS, found that the SEAS Method is able to reduce the deterioration after weaning and stabilize the result and Negrini et al. , in 2008, they found that a personalized SEAS exercise program is more effective than simple physiotherapy. The intervention group improved at the Cobb angle by 28.9%, the control group improved by only 5%.

Regarding the Dodomed Method, Dobosiewicz et al., In 2006, in their research found that although the results after the sessions showed a relative increase in the Cobb angle (from 25.92 ° to 31.04 °), the method may stop the rapid development and stabilize the result. In addition, Durmala et al., In 2009 studied the progression of scoliosis in patients with Cheneau braces and Dodomed Method exercises over a period of  $43 \pm 9$  months. Radiological results showed that the development of scoliosis was stabilized during the rapid growth period of girls by 89% using a combination.

Mamyama et al., In 2002, confirmed the effectiveness of Side Shift exercises in patients with Idiopathic Scoliosis after skeletal maturation. The results showed that the mean Cobb angle at start was  $31.5^\circ +$

$11.2^\circ$  decreased to  $30.3^\circ - 12.3^\circ$ . Maruyama et al., In 2003, studied the Side Shift Method with braces Boston and Milwaukee. Only 6.1% of patients (20/328) resorted to surgery. The remaining girls did not show severe worsening of scoliosis until adulthood.

Regarding the Lyon Method, Duconge et al., In 2002, confirmed the effectiveness of the Lyon exercises in controlling posture, strength and balance. The intervention group improved by 58%, while the control group improved by only 23%.

For the FITS Method, Bialek, in 2011 studied the effectiveness of the FITS Method, in scoliosis with single or double curvature, with Cobb angles of 10-20 ° and 20-45 °. The results showed better results in scoliosis with a Cobb angle of 10-25 ° in both single and double curvatures.

## CONCLUSION

Idiopathic Scoliosis is an extremely complex issue in the field of treatment. It is noted that the "key point" in the conservative treatment of Adolescent Idiopathic Scoliosis should be the thorough evaluation of the deformity and the clinical picture of each patient. Regarding the effectiveness of Physiotherapy Scoliosis Specific Exercises, it seems that the Schroth Method and its most advanced version, BSPTS, present excellent data in the treatment and prevention of the development of scoliosis. In addition, the SEAS Method exercises show an improvement in Cobb angle compared to simple physical therapy and good results in preventing aggravation by weaning braces. Although the other methods seem to show some positive results in the treatment of scoliosis, these three methods (Schroth, SEAS, BSPTS) seem to deal with the main bulges, help reduce the progression of scoliosis by stabilizing the result and offer a better quality of treatment. But also life in the patients involved. In conclusion, the scientifically substantiated knowledge and its corresponding application in the part of

Adolescent Idiopathic Scoliosis should be the compass in the therapeutic practice, so that the complexity of this deformity is just an additional motivation in the treatment strategy and clinical reasoning of therapists and not a blocking agent in treatment.

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