Full length original article

Efficacy of Physiotherapy on Spinal Mobility Parameters and Pain in Persons with Adolescent and Adult Idiopathic Structural Scoliosis

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Abstract

Background: Scoliosis cause changes in spinal alignment, mobility, flexibility rrecruitment of Para spinal muscles and postural reflex mechanism. Ssubjects might have hump on one side of spine, functional difficulties, and pain in multiple regions of body, change in lung function, nerve compression, dysmenorrhea and constipation in severe curves. Some studies shows mood changes, depression, handicap and social involvement. Gradually it is becoming clear that if good non operative treatment is given, only 1 in 25, or 0.1% cases may require surgery. Hence this study is aimed at effectiveness of physiotherapy on spinal mobility parameters.

Methods: Study was conducted at Nizam's institute of Medical sciences, department of Physiotherapy. 13 adolescent idiopathic scoliotic subjects aged between 12 to 40 years were taken into the study. Subjects had curve specific exercise for 25 weeks. Outcomes measures include 1.spinal mobility (flexion, extension, left bending right bending), 2. Flexibility of pectorals, Iliopsoas and hamstrings on both sides, 3. VAS (Visual analog scale) for pain, 4. Cobb angle for curve measurement.Change in VAS scores were significant (P <0.0001) and mean changes from 5.23 ±1.64 to 1.384 ±0.65 with IQR was from 6-4 to 2-1. Spinal flexion (p value: 0.003) and extension (P-Value: 0.007) showed significant results on Wilcoxon signed rank test. The improvements in Cobb angle was were more at lumbar region than the other areas in this study.

Conclusion: Though there is less curve correction may be up to 2 degrees, rate of progression was reduced. Pain levels reduced along with improvements in flexibility and mobility with exercise program. In conclusion results of this study shows scope for consideration exercise program to improve pain, spinal mobility, Flexibility along with a Cobb angle improvement.

Key words: *Idiopathic Scoliosis, Scoliosis specific exercises, Spinal mobility and flexibility, Spinal curves.*

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Introduction

Hippocrates was the first person to use the term "Spina Luxate" to denote all spinal changes. Galen defined scoliosis ("skolios" means crooked or curved) [1].Scoliosis research society (SRS) defined as"Scoliosis is lateral deviation of the normal vertical line of the spine which, when measured by x-ray, is greater

than 10°. Scoliosis consists of a lateral curvature of the spine with rotation of the vertebrae within the curve. Rotation of the vertebrae also occurs which produces the rib cage and flank muscle asymmetry" HYPERLINK \l "Sco18" [2,3]. The term Idiopathic scoliosis is used to signify a spinal deformity not caused by a specific disease[4]. This condition may not result from lifting and carrying heavy objects, sports, postural deviations or small leg length discrepancies. It is considered as multifactorial, because of changes in balance, functional symmetry along with vertebral changes[5].80% of scoliosis cases are Idiopathic and 20% are secondary to pathological causes. Prevalence of scoliosis is more in girls than boys, it may be because of growth spurt before skeletal maturity and anterior spinal overgrowth[6]. Prevalence of adolescent idiopathic scoliosis with Cobb angle above 10° in general population is 0.93 to 12% depending on reference Cobb angle.

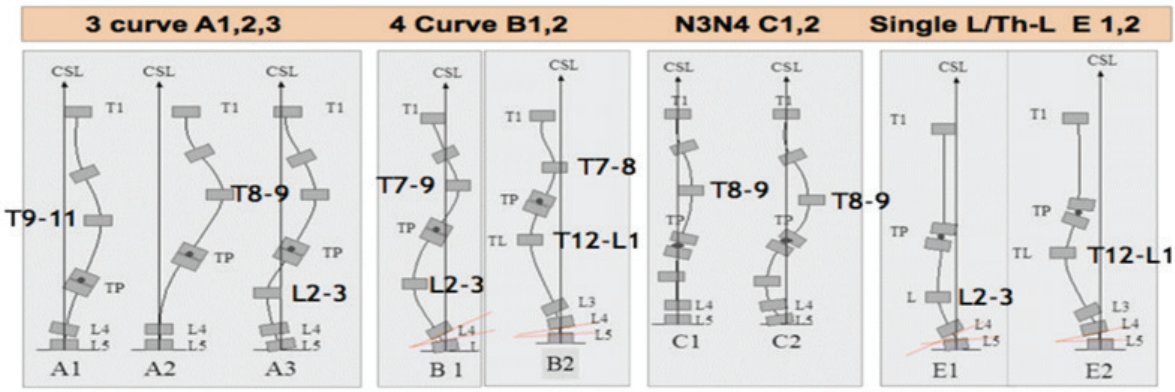
Scoliosis changes spinal alignment, mobility, flexibility, recruitment of Para spinal muscles and postural reflex mechanism. It is considered that if the cobb angle exceeds the critical threshold (30° to 50°) before the completion of growth , subjects might have high risk of developing health issues related to breathing, cosmetic changes, pain, disability and changes in quality of life[7]. If untreated subjects may experience one or more of following symptoms like hump on one side of spine, functional difficulties, pain in multiple regions of body (example: back, shoulders, neck), nerve compression, dysmenorrhea and constipationsevere curves. Persons with severe curve, hump and pain might experience altered states of mood, depression, handicap and social involvement.

Gradually it is becoming clear that if good non operative treatment is given, only 1 in 25, or 0.1% cases may require surgery[8] . As the underlying mechanisms are becoming clearer this study might add further evidence in support of conservative treatment for AIS[9,10,11]. Though many countriespracticing physiotherapy and bracing as conservative mode of management, there is a need for objective evidence of effectiveness of physiotherapy on spinal mobility and pain in persons with structural spinal curves[12]. As spinal mobility and flexibility plays important role in functional activities it is necessary look at the mobility parameters like spinal flexion, extension, left bending, right bending and flexibility parameters like pectorals, Iliopsoas, Hamstrings on both sides. Studies measured spinal posture and mobility using inclinometers and compass showed that thoracic forward flexion was smaller whereas sagittal mobility was greater[13], mobility above and below the apex of the curve is greater because of compensation and thoracic rotation most clearly decreased with increased curves[14],

Objective evidence for physiotherapy as conservative management and its effectiveness on spinal mobility and flexibility for persons with scoliosis is still a question. Hence this study was aimed at objective evaluation of efficacy of Physiotherapy treatment onspinal mobility parameters and pain in persons with Adolescent and adult idiopathic Structural scoliosis

Methodology

Study was conducted at Nizam's institute of Medical sciences, department of Physiotherapy. After Institutional ethical committee approval, 13 adolescent idiopathic scoliotic subjects aged between 12 to 40 years who met inclusion criteria were taken into the study with written informed consent. Each subject was explained about the purpose of study and explained about methodology prior to enrolment. Subjects were categorised based on Dr. Manuel Rigo classification of scoliosis (Figure 1). Each subject was stratified into Rigo classification categories and subjected to curve specific exercise program for the period of 25 weeks.Subjects enrolled into study were subjected to curve specific exercise program for the period of 25 weeks. Baseline evaluation was done after the enrolment, prior to exercise program and at the end of 25 weeks. Evaluation parameters includes age, gender, BMI (body mass index), spinal mobility and flexibility parameters, Cobb angle, VAS (visual analog scale) for pain,



Rigo and Weiss. Conservative Scoiosis Treatment. IOS press. 2008 page 303-319. Rigo et al. Scoliosis 2010, 5:1 http://www.scoliosisjournal.com/content/5/1/1.

Inclusion criteria:

1. Person with spinal curve with at least 10degrees or more.

2. Male and female, Adolescents & adults (12- 40 years),

3. Subjects diagnosed with Idiopathic scoliosis (adult and adolescent)-(G2, N3N4 & G 1-2)

4. Physician or surgeon referral for conservative management.

5. Subjects willing to provide written informed consent.

Exclusion criteria: Subjects with G1 category spine, Post-surgical, Congenital scoliosis, Inflammatory, Neoplastic, metabolic, Infectious, Developmental, Traumatic conditions, Psychological, psychiatric problems,Ehlers – Danlos syndrome, Mesenchymal disorders, Neurofibromatosis and Neuro muscular diseases are excluded. Subjects with any other disorders which lead to changes in spinal curves are excluded.

Efficacy parameters: Following outcomes were used for the documentation,

1. Spinal mobility (flexion, extension, left bending right bending),

2. Flexibility of pectorals, Iliopsoas and hamstrings on both sides,

3. VAS (Visual analog scale) for pain,

4. Cobb angle for curve measurement.

Spinal mobility measurement:

Spinal flexion measurement: individual was asked to keep feet at shoulder width and advised to bend forward while keeping their two palmar surfaces together. The distance from middle finger to the ground is taken in centimeters (Figure 2a)

Spinal extension measurement (Figure 2b):subject was advised to be in prone lying position and advised to lift the upper body off the couch while supporting at the feet by assistant. Measurement was taken from the couch to Xiphi sternum.

Spinal lateral bending measurement (Figure 2c): subject was asked to stand against wall without any contact and advised to bend laterally to left and measurement was taken from left side middle finger to the ground on left side, for measurement on right side bending subject was asked to bend on right side, measurement was taken for the right middle finger to the ground on right side.

Flexibility measurement:

Pectoral flexibility: In supine position subject is asked to perform upper limb elevation with thumb directed downwards at the end of movement. The distance between elbow lateral epicondyle and the couch is measured in centimeters (Figure 3a).

Iliopsoas tightness is tested and measured in supine lying position, subject is asked to take the knee to chest and the distance between couch and opposite knee joint is measured with measuring tape. For left side measurement Right knee is taken to the chest and for right side iliopsoas left knee is taken to the chest (Figure 3b). Hamstrings measurement is done while the person is in supine position. Examination side knee is kept in 90 –90 position, opposite lower limb is relaxed and kept as straight as possible and stabilized by an assistant. Subject was advised to perform knee extension from 90-90 position and the angle between longitudinal axis of Tibia and longitudinal axis of femur (universal perpendicular axis) was measured by goniometer. Similar recording is done for both sides (Figure 3c).

Visual analog scale (VAS): Visual analog scale tool was used for subjective assessment of pain, where subject documents their level of pain on a straight line of 10 to 15 cm length[15]. Extreme end points of this line corresponds to "no pain at all" and "pain as bad as it could be". Subject was explained about the line and meaning of end points and asked to mark on the line with pencil or pen. Subject gave rating of their own perception of pain without any input from others. (Figure 4).

Cobb angle measurement:

This is a standard way of measuring spinal column deviation[16]. Perpendicular lines are drawn from upper border of upper end vertebra and lower border of lower end vertebra till they intersect. The angle between these perpendicular lines was taken as Cobb angle or angle of curvature in the study (Figure 5).

Exercise program: Depending on curve categories subjects were categorized and subjected to scoliosis curve specific individualized program. Exercise program includes passive correction positioning, spinal mobility, flexibility, core stability, Taping, para spinal stimulation.

Passive correction positioning: Based on category of spine, subjects were kept in three basic positions 1. Supine, 2. Side lying, 3. Prone. In order to achieve best possible spinal alignment in each position wedges and pads were kept on concave and convex side of spine as per the body passive positioning schema diagrams. Each color indicate wedges and pads placement in one basic position (blue=supine,red=prone, green=side lying): (Figure: 7). these passive positions were superimposed with active muscular work (concentric and eccentric) to open the concave sides and activate the convex sides of the curve.

Spinal mobility and flexibility:10 minutes of warming up session followed by passive and active spinal mobility exercise in specific direction was given with aim of axial elongation, deflexion and de rotation of spinal segments. Mirror feedback was used during training of shift correction. Wall ladder was used for active elongation of spine and activation of specific muscle groups on either side of spine. Total duration of exercise was 25 to 30 minutes. Mobilization and manual release of tightened soft tissues was also part of flexibility exercises.

Core stability: Exercises for stabilization of core muscles was given following spinal mobility and flexibility. This include slight modification of general core stabilization exercises. Exercises include keeping pelvis in best possible alignment, activation of oblique, quadratus Lumborum, and latissimus dorsi muscles on elongated side with integration of breathing to facilitate optimal diaphragm function.

Kinesiological taping: Taping was used for neurological facilitation of corrected positions. Facilitation on convex side of curve and mechanical correction on rib cage to help the individual for derotation and deflexion[17,18,19.]

Taping for C shape curve

Posterior convex side: Facilitation of Iliocostalis was done with Y strip, 15 -35 % tension, ends with no tension. Taping applied with lateral flexion and

rotation to opposite side. Mechanical correction was given with Y strap, tension 50 -75%, just below the level of convexity during forward flexion, lateral flexion, horizontal abduction of arm and inhalation (figure: 6a)

Anterior side of convexity. Facilitation of external oblique was done with Y strip, 15 -35 % tension, ends with no tension. Taping applied with thoracic spine extension. Mechanical correction was given with Y strap, tension applied was 50 -75%. Downward and inward at the costal ridge on the level of convexity while subject was asked to do shoulder external rotation and trunk lateral flexion to the opposite side and inhalation. (Figure: 8a)

Taping for S shape curve:

Posterior side Taping lumbar region: Facilitation of Longissimus on lumbar region was done with Y strip, 15 -35 % tension, ends with no tension. Tape was applied with forward flexion of spine. Mechanical correction was given with Y strap, tension 50 -75%, at the level of convexity during forward flexion with inhalation (figure: 8b).

Posterior side Taping thoracic region: Facilitation of Longissimus thoraces was done with Y strip, 15 -35 % tension, ends with no tension, anchor at 2 to 3 vertebrae below the level of convexity opposite side, arm abduction and trunk lateral flexion to opposite side. Mechanical correction was given with Y strap, tension 50 -75%, anchor at the spinous process at level of convexity during lateral flexion to opposite side with inhalation (figure: 8b).

Anterior side Taping lumbar region: Facilitation of rectus abdominus was done with Y strip, 15 -35 % tension, no tension at ends and below the umbilicus along linea Alba. Mechanical correction was given with Y strap, tension applied was 50 -75%. Downward and inward pressure, subject was asked to do trunk lateral flexion and rotation to opposite side and inhalation (figure: 8c).

Anterior side Taping thoracic region: Facilitation of intercostals Fascia correction was done with application of Y strip, with no tension at anchor 2-3 vertebra below convexity, subject asked to neck extension, tape applied with 10 to 25% tension, no tension at ends of tails. Mechanical correction was given with Y strap anchor at the manubrium sternum (no tension), subject asked to do thoracic extension with inhalation. Tape applied with Downward and inward pressure and tension 50 -75% (figure: 6c).

Results and Discussion: Total of 13 adolescent and adult idiopathic scoliosis subjects (10 female, 3 male) were taken into study after screening of 20 persons (7 subjects excluded). Female subjects (77%) are more in total population than male (23%) in this study. Mean age of is 21.92±6.78 years, ranging from 12 to 34years (BMI 20.27±2.6 kg/M^2, Risser ranging from 1 to 5). Prevalence in girls is more than boys. As the Cobb angle increases the prevalence ratio between boys and girls increases[20]. Subjects were categorized basedon Dr. Manuel Rigo classification of scoliosis. Number of subjects in 3C (three curve), 4C (four curve),N3N4 (Non three non-four) and G1-2 (Group one- two) curve patterns are 2, 2, 5 & 4 respectively (Table1: demographic data description).

Table 1 Demographic data description:

Parameter	N	Minimum	Maximum	Mean	SD
Age (in years)	13	12	34	21.92	6.78
Height (in cm)		143	175	159.30	10.77
Weight (in kg)		39.0	72.0	51.54	8.88
BMI (in kg/m2)		17.20	25.30	20.28	2.67
Risser		1	5	3 to 5 (IQR)	
Gender		10 Female (77%)		3 Male (23%)	
No. of cases category wise		3C (2cases), 4C(2 cases), N3N4(5 cases) & G1-2(4cases)			

Subjects showed good results on pain scores (VAS) with physiotherapy exercises (Table 2: pain scores on visual analog scale). Initial average VAS scores was 5.23 ±1.64 with minimum score 3 to maximum score of 8 and IQR was 6 to 4, at the end of exercise program score change to 1.384 ±0.65 with no pain to maximum of 2 and IQR was 2 to 1. The difference was significant on paired test with P value of <0.0001.

Table 2 pain scores on visual analog scale

VAS	N	Minimum	Median	Maximum	Mean ±SD	IQR	P-value	test
pre	13	3	5	8	5.23 ±1.64	6 to 4	<0.0001	"Paired t test"
post		0	1	2	1.384 ±0.65	2 to 1		

Results of Spinal mobility parameters are shown below (Table 3: spinal mobility parameters).Spinal flexion (p value: 0.003) and extension (P-Value: 0.007) results were significant on Wilcoxon signed rank test. Level of significance of spinal bending to left (p value: <0.0001) and right (p value: <0.0001) was tested with paired t test and the result was significant. Spinal Flexion improved more than extension and bending was almost similar in improvement

Flexibility results at the end of exercise program was significant. Measurement of right and left sides of Pectoral region on arm elevation was done in centimeters, Iliopsoas on Thomas position in centimeters and Hamstring 90-90 position to extension was measured in degrees. Significance of Results of pectoral and Iliopsoas on left and right side was analyzed using Wilcoxon signed rank test and Hamstrings was tested using Paired t test. The results were significant (Table 4: Flexibility parameters).

Table 3 spinal mobility parameters

Spinal mobility (in cm)		N	Mini-mum	Median	Maxi-mum	Mean ±SD	IQR	P-value	test
flexion	pre	13	0	21	43	18.69 ±11.97	26 to 7	0.003	Wilcoxon signed rank test
	post		0	14	32	11.23 ±9.4	16 to 0		
extension	pre	13	0	2	4.5	1.769 ±1.37	2 to 0.5	0.007	
	post		2	3	4	3 ±0.577	3.5 to 2.5		
left bend	pre	13	18	45	58	44.12 ±10.27	49 to 40	<0.0001	Paired t test
	post		8	41	43	36 ±9.806	43 to 34		
right bend	pre	13	16	45	62	45.81 ±11.38	45 to 41	<0.0001	
	post		6	37	46	36.15 ±10.25	42 to 34		

Table 4 Flexibility parameters

flexibility			N	Minimum	Med ian	Maximum	Mean	IQR	P-value	test
pectoral	Left	pre	13	0	2	5	1.53 ± 1.45	2 to 0	0.008	Wilcoxon signed rank test
		post		0	0	1	0.076 ±0.277	0 to 0		
	Right	pre		0	2	4	1.923 ±1.32	3 to 0	NE	
		post		0	0	0	NE	0 to 0		
Iliopsoas	Left	pre	13	2	5	9	5.276 ±2.46	7.5 to 3	0.002	
		post		0	1	5	1.076 ±1.382	1.5 to 0		
	Right	pre		2	6	14	6.269 ±3.166	8 to 4.25	0.002	
		post		0	1	8	1.461 ±2.25	2.5 to 0		
ham strings	Left	pre	13	45	70	81	65.38 ±11.56	75 to 55	<0.0001	"Paired t test"
		post		65	80	90	79.08 ±7.342	83 to 73		
	Right	pre		40	65	80	65.92 ±11.21	75 to 64	<0.0001	
		post		63	78	90	79.38 ±7.366	83 to 76		

There were 2cases of 3C (3CA1-1, 3CA2-0, 3CA3-1), 2 cases of 4C (4CB1-1, 4CB2-1), 5 cases of N3N4 (N3N4 C1-3, N3N4C2-2) and 4cases of G1-2 (G1-2E1-3, G1-2-E2-1). Out of all those categories 9 caseshadRt. thoracic curves(including single thoracic and double curves), 2 cases has Lt Thoraco lumbar, 7 cases has Lt Lumbar(including single lumbar and double curves) and 1 case had Rt. lumbar region.. The improvements with exercise programme showed varied level of significance as shown below (Table 5: Cobb angle details).All types of curves are showing slowing of progression of curve or some improvement in the curve up to 1.6 to 2 degrees overall. The improvements in Cobb angle was were more at lumbar region than the other areas in this study.

Table 5 Cobb angle details

cobb angle		N	Minimum	Maximum	Mean±SD	P-Value	test
Rt thoracic	pre	9	28.4	40	35.16±3.91	0.000	Paired t test
	post	9	27	39	33.56±3.94		
Lt thoraco lumbar	pre	2	21	26	23.50±3.54	NE	
	post	2	20	25	22.50±3.54		
Lt lumbar	pre	7	18	39	27.30±7.71	0.008	Paired t test
	post	7	17	37	25.86±7.86		
Rt Lumbar	pre	1	20	20	20± NE	NE	
	post	1	21	21	21±NE		

Conclusion

Spinal mobility is the pre requisite for all functional activities. Though there is less curve correction may between 1.6 to 2 degrees, rate of progression was reduced. Pain levels reduced along with improvements in flexibility and mobility with exercise program. In conclusion results of this study shows scope for consideration of exercise program to improve pain, spinal mobility, Flexibility along with a Cobb angle improvement in adolescent and adult idiopathic structural scoliosis.

Ethical Clearance: Nizam's Institute of Medical Sciences Institutional Ethics committee ESGS No: 793/2019.

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References

1. Elias S Vasiliadis TBGAK. Historical overview of spinal deformities in ancient Greece. *Scoliosis*. February 2009;4(6).
2. Chair Larry Lenke MGo3DCTC. *Scoliosis research society*. 2000. Accessed February 22, 2018.
3. Negrini S DSAAea. 2016 SOSORT guidelines: orthopaedic and rehabilitation treatment of idiopathic scoliosis during growth. *Scoliosis Spinal Disorders.* January 2018;13(3).

4. SAMUEL KLEINBERG MD. THE OPERATIVE TREATMENT OF SCOLIOSIS. *The Archives of Surgery*. 1922;5(3):631-645.
5. NACHEMSON ALM, SAHLSTRAND TM. Etiologic Factors in Adolescent Idiopathic Scoliosis. *Spine*. 1977;2(3):176-184.
6. Burwell RG. Aetiology of idiopathic scoliosis: current concepts. *Pediatric Rehabilitation*. July-December 2003;6(3-4):137 - 70.
7. Stefano Negrini TBGTKTMMRHRW. Why do we treat adolescent idiopathic scoliosis? What we want to obtain and to avoid for our patients. SOSORT 2005 Consensus paper. *Scoliosis*. april 2006;1(4).
8. Marc A Asher DCB. Adolescent idiopathic scoliosis: natural history and long term treatment effects. *Scoliosis and Spinal Disorders*. March 2006.
9. Weiss HR GD. The treatment of adolescent idiopathic scoliosis (AIS) according to present evidence. A systematic review. *European Journal of Physical and Rehabilitation Medicine*. June 2008;44(2):177-93.
10. Hagit Berdishevsky VALJBSMRAL AHMRM-BAMTBJCdMaJD. Physiotherapy scoliosis-specific exercises – a comprehensive review of seven major schools. *Scoliosis Spinal Disorders*. Aug 4 2016;11.
11. Sungyoung Yoon MHR. Effect of physical therapy scoliosis specific exercises using breathing pattern on adolescent idiopathic scoliosis. *The Journal of Physical Therapy Science*. 2016;28(11).
12. Dr Stuart L Weinstein MLADPJCCMADMJAMM. Adolescent idiopathic scoliosis. *The Lancet*. may 2008;371(9623):1527-1537.
13. M Poussa HHGM. Spinal mobility in adolescent girls with idiopathic scoliosis and in structurally normal controls. *Spine*. February 1989;14(2).
14. M Poussa GM. Spinal mobility and posture in adolescent idiopathic scoliosis at three stages of curve magnitude. *Spine*. July 1992;17(7):757-60.
15. Haefeli M&EA. Pain assessment. *European Spine Journal*. december 2005;15(suppliment 1):517-524.
16. Chair Larry Lenke MaTC. *scoliosis research society*. 2000. Available at: https://www.srs.org/professionals/online-education-and-resources/glossary/revised-glossary-of-terms. Accessed june 12, 2018.
17. Gözde Yağcı ETYY. Effect of elastic scapular taping on shoulder and spine kinematics in adolescents with idiopathic scoliosis. *Acta Orthopaedica et Traumatologica Turcica*. may 2020;54(3):276-286.
18. Yunus Atici CGAAAOBYAMBB. The effect of Kinesio taping on back pain in patients with Lenke Type 1 adolescent idiopathic scoliosis: A randomized controlled trial. *Acta Orthopaedica et Traumatologica Turcica*. March 2017;51(3):191-196.
19. Ru Ed. The possibilities of using elastic therapeutic (Kinesio) tape in patients with scoliosis. *scoliosis*. december 2014;9((suppl 1)).
20. P N Soucacos PKSKCZAEBTAX. School-screening for scoliosis. A prospective epidemiological study in northwestern and central Greece. *The journal of Bone and Joint surgery, American Volume*. October 1997;79(10):1498-503.