A Cost-Effective and Innovative Screening Approach, for Idiopathic Scoliosis in Girls, Before their Skeletal Maturity

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Abstract

Background: Adolescent idiopathic scoliosis is a three dimensional deformity of the spine with no identifiable causes. Early detection of scoliosis prevents progress into severe scoliosis in a growing child before the skeletal maturity**.** There are two critical stages in the development of body posture during the school years. These are the age when a child goes to school and the attainment of puberty. The growing children may show accelerated or retarded periods of growth at certain stages giving rise to a rapid or slow progression curve. In girls the pre-pubertal growth spurt falls in the age range of 10-13 years.

Objective: To identify high risk idiopathic scoliotic curve in pre pubertal school girls using non-invasive technique**,** Adams forward bending test (FBT), Scoliometer and I phone app.

Method: The present descriptive cross sectional study was conducted in pre pubertal girls aged 10-13 years enrolled in both the aided and unaided schools of Dakshana Kannada (Karnataka-India). All the willing students (n=600) were screened using physical examination (Adams forward bend test), Scoliometer device and Scoliometer application.

Results: A total of 24/600 of the pre pubertal girls were found to have asymmetrical back when physically examined in standing position with FBT, resulting in right thoracic level curve 3^0 , 5^0,7^0 . All 4% of the high risk identifiable participants had a reading $>5^0$ when screened using the Scoliometer device and I phone App i.e. similar results were obtained. Body mass index (BMI) was increased in some of the positive cases.

Conclusion: The study found that the inclination degree of 5° or greater is more acceptable in early detection of scoliotic curve before the skeletal maturity of the spine. This predictive value was satisfactory to advocate the school screening programme in early detection of scoliosis**.**

Key words: *idiopathic scoliosis, skeletal maturity, scoliometer, scolioguage, BMI*

Introduction

Adolescent idiopathic scoliosis (AIS) is defined as a three dimensional (3D) deformity of spine [1-3], with no recognizable causes,[4] in an otherwise healthy growing child. The children with AIS on inspection have a trunk asymmetry, which accentuates when bending forward. The accentuation results due to the prominence of the costal or lumbar hump in a forward bending position.[5] The reported prevalence of Idiopathic scoliosis is about 0.4 to 7% among adolescents in Asian countries.[6] Scoliosis can affect a child's appearance, may lead to symptoms of pain, and can lower a child's self-esteem due to a feeling of social isolation.[7] There has never been a universal agreement about scoliosis screening due to its controversial nature, therefore, the screening efforts vary considerably around the world.[8] Many countries

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including USA, UK and Japan have legislated scoliosis screening programmes and have included screening in the health curriculum of their schools.[9] It is important that scoliosis be diagnosed between the ages of 10 and 15 years. The early identification of potentially progressive curves allows conservative management in the form of physiotherapy and bracing allowing the patient to avoid surgery for the correction of developing curve.[10] The human skeleton comprises of two periods of rapid growth, the first one between the birth to 5 years and the second one at the onset of puberty.[11] The body posture is influenced by two critical stages of development during the school years, when a child starts school, and at the attainment of puberty. The rapid or slow rate of progression in curve may result due to certain faster or slower periods of growth at certain stages during growth. The pre-pubertal growth spurt in girls falls in the age range of 10-13 years. The pre-pubertal girls have Risser 0 at standard, and are 0 before the onset of menarche with a progression factor at 2, which represents a risk for being progressive of 90%. The risk of progression can be calculated using Lonstein and Carlson (1984) formula.[12] They carry risks to the quality of the body posture, in the age range of 6-7 and 12-16 years old, i.e., during the puberty stage. The child is exposed to the vulnerability of various external features during this stage and the development of the muscular system does not follow the rapid growth of the bones.[13] The bone density and its metabolism have been correlated with the serum levels of tartrate-resistant acid phosphatase serum band, 5(TRAP5b). Lower bone density in AIS patients show higher rate of bone resorption.[14] High peak bone mass is directly related to high physical activity.[15-17] As a higher gain than the loss in the density of bone occurs during the pre-pubertal period, it is the perfect period for physical training compared to the rest of the lifetime.[18,19] The reported incidence of scoliosis was 0.2%, favouring girls more than the boys in the ratio of 2.2:1.[7] The scoliosis research society (SRS) considers scoliometer, used alone with Adams forward bending test (FBT) as a reliable and valid measure for trunk asymmetry.[20] The scoliometer identifies any rotational deformity, associated with scoliosis in a very dependable and a simple fashion. Although, scoliometer shows low correlation with the lateral curvature of the spine, yet it shows a good reproducibility.[21] Advanced technology like, iPhones have been used for the measurement of asymmetry in the trunk and results indicate that such advanced tools are equally efficient to measure trunk asymmetry similar to conventional tools like manual protector. Furthermore, the use of iPhones consumes 15% less time for measurements than the conventional tools. The Mobile phones (with inclinometer application) can store measurement data in updated versions of the software for measurement of angle, and thus make these modern tools useful for clinical measurement applications.[22] The evaluations of the Scoligauge, iPhone application, show outstanding intra and inter observer dependability and validity comparable to that of Scoliometer. This application renders itself as an effective means for assessing clinical measurements and does not require a special adapter.[23]

This study was carried out for a cost-effective approach of screening 10 to 13-year old girls and to identify pre-pubertal girls with a potential progressive scoliotic curve.

Materials and Method

A descriptive cross-sectional study involving a total of 600 school-going girls, aged 10-13 years, enrolled in both aided and unaided schools. The permission was taken from the regional block education officers. Ethical clearance was obtained from the University ethics committee before recruitment of the participants. Informed consent and accent was obtained from the students and their parents, prior to the screening. Based on the student population data provided by the block education officers in 2018, participants were recruited by cluster sampling technique from 6 randomly selected clusters out of the 15 clusters from Dakshina Kannada, Mangalore, India. The screening was conducted in the school premises with permissions from the concerned management. Each student was accompanied by her mother and class teacher during screening. Physical examination was carried and students with altered gait pattern and other deformities were excluded from the screening. The girls had light clothing and without footwear during the examination. The physical attributes (height, weight, and age) were recorded using stadiometer to calculate the Body Mass Index (BMI). The Adam's forward bending test (FBT) was applied for the scoliosis screening. The test considered positive when back asymmetry in the form of a hump was detected. Further measurement of inclination degree using scoliometer and scolioguage was conducted when FBT was positive. The girls with positive FBT and scoliometer/ scolioguage angle of 3 degree or more were considered to pose some risks to the quality of the body posture, occurring during the puberty stage. The parents

of these girls were notified of the potential for progressive curves and referred to the orthopedic and physical therapy departments of the University hospital for further evaluation and treatment recommendations.

Results

Six hundred school girls in the age range of 10-13 years were screened for potential curves for scoliosis. (Table I). Twenty four pre-pubertal girls were found to have an asymmetrical back (hump detected, resulting in a positive Adam's forward bending test and scoliometer test. Body mass index (BMI) was increased in some of the positive cases (Figure 2).

Table 1: Frequency of Axial Trunk Rotation (ATR)

Sl.No		Characteristics of based on age of the study participants					ATR1 (in degree)	Type of curve		BMI2	Referral for radiography	
	Age	0	3	5	7	suspected	mean±SD	no	Right thoracic curve	mean±SD	no	yes
1.	10	158	1	6	2	2	.28±1.20 .25±1.14 .14±.93 .21±1.19	160	9	15.4786±2.5449 15.2339±2.7502 15.7691±3.0827 15.7942±2.3745	164	5
2.	11	149	2	4	2	2		151	8		156	3
3.	12	162	0	2	2	4		166	4		165	5
4.	13	97	0	0	3	2		99	3		97	5

Abbreviations used: ATR-Axial trunk rotation[1] .BMI-Body mass index[2]

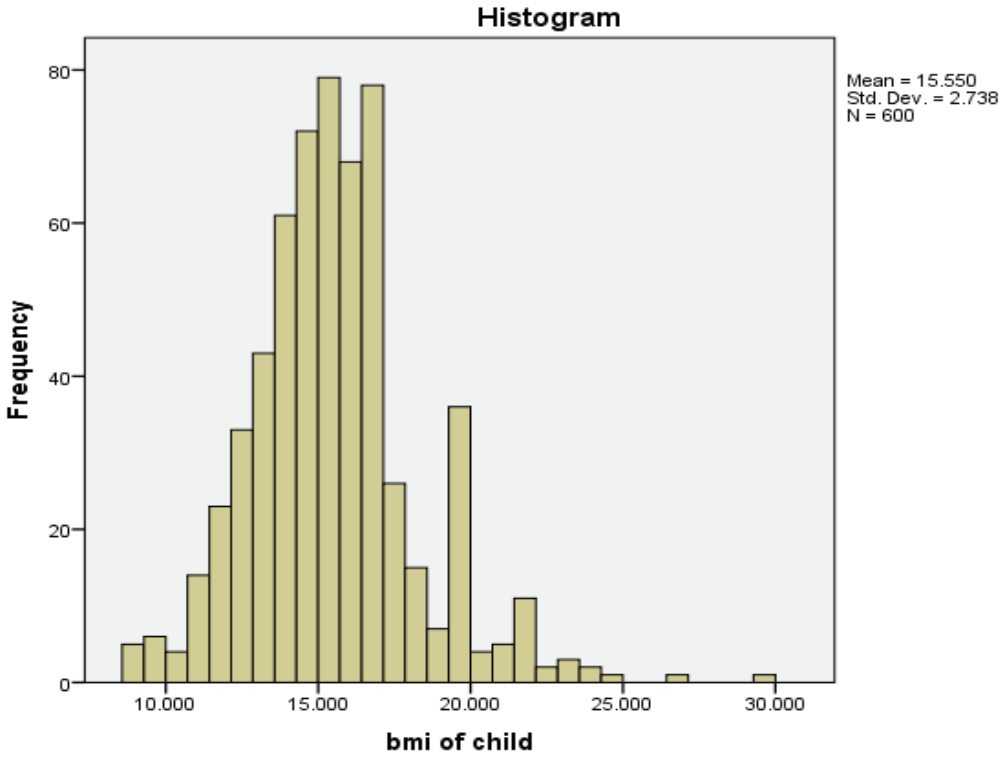

Figure 1: Body Mass Index (BMI) of 600 girls.

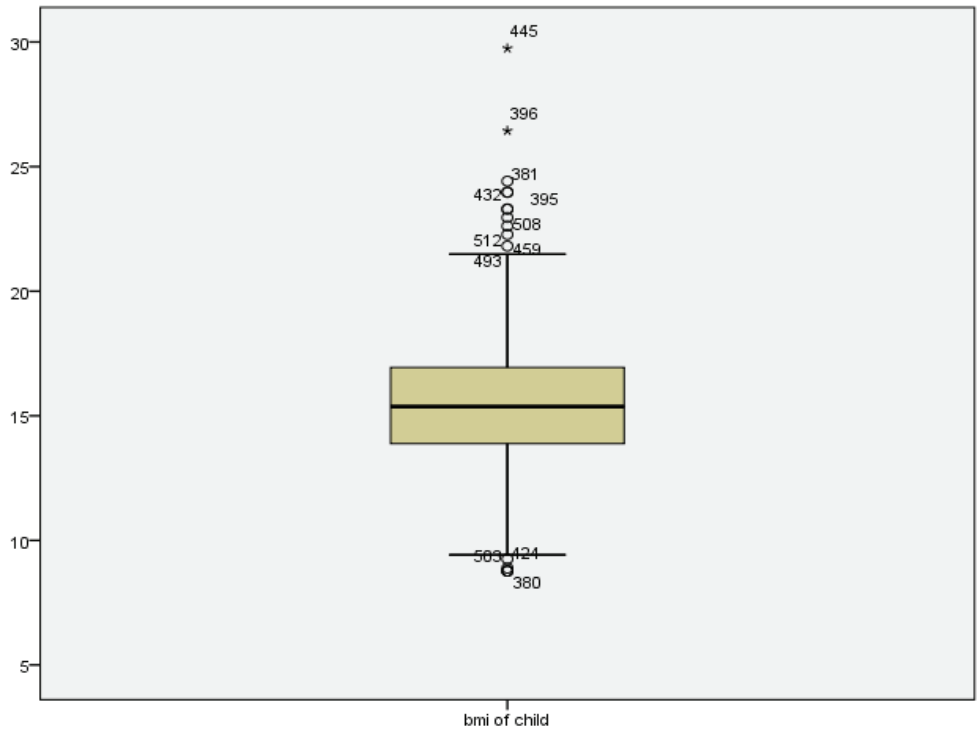

Figure 2: Body Mass Index (BMI) was increased in few of the positive cases.

Discussion

The overall prevalence of positive scoliosis cases among pre-menarche girls in the current study was 4%. The curvatures of 5°, 10° & 12° were witnessed at the thoracic level, inclined towards the right side when viewed from the backside. These findings are consistent with the epidemiological study from chongming island (china), which showed thoracic curves towards the right 60.3 %.[24] Another epidemiological study from Greece found that 75.5 % of thoracic curves were to the right side.[25] The current study showed increased BMI in some of the positive cases, in contradiction with a study by Chen JCY et al., (1999), which showed a significant relationship between severity of scoliosis and the BMI [26], while another study found no relationship between scoliosis and BMI.[27] American Academy of Orthopaedic Surgeons released a position statement that screening for spinal deformity should be part of the medical home preventive services visit. The screening is considered valuable in these domains: technical efficacy, clinical program, and treatment effectiveness. In order to identify high risk cases, scoliosis screening should be carried out and potential cases referred for further evaluation .[21] Screening is defined as 'the presumptive identification of unrecognised disease or defect by application of tests, examination or procedures, in a rapid manner.[28] The use of Scoliometer for the measurement of ATR is non-invasive, with no radiations and a cheap method of screening. It can be easily implemented and it has been proven to have a good correlation with radiological analysis ($r=0.7$, $p<0.05$) and a very good intra-rater reliability.[29,30] In this study a $>7^0$ scoliometer reading was taken as cut off which is in accordance with a study done by Raphael et al., in Norway.[31] The present study showed ATR $>7^0$ in the thoracic scoliotic curves. Similar findings >7 ^{0}application reading for thoracic scoliotic curves. The readings of the Sociometer device and Scoliometer HD application which are therefore similar. This is in agreement with a study done by Franko et al wherein the findings of the smart phone application were compared to those of the scoliometer device and thereby the application was validated as an efficient and cost effective tool for screening of scoliosis.[32] Therefore, the application was found to be more convenient due to its greater availability and cost effectiveness. We therefore suggest making the combination of FBT, scoliometer and scolioguage app as a screening tool.

Limitations of the study: The sample size was small and did not include both the genders. To obtain national prevalence rate, the authors suggest a regular nationwide screening of AIS. The data collected from a large population based screening could be used to

perform longitudinal study with minimum bias.

Conclusion

The prevalence rate of AIS in school going girls of age group10-13 years was evaluated in Dakshina Kannada region of India. The study also found that the inclination of 5° or greater is more acceptable in early detection ATR before the skeletal maturity of the spine. This predictive value was satisfactory to advocate the school screening programme for early detection of scoliosis.

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

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