Screening of Adolescent Idiopathic Scoliosis Among High School Students in Tanauan City, Batangas, Philippines

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Abstract: Scoliosis is the lateral curvature of the spine accompanied by axial rotational changes in the body of vertebrae. Due to the progressive nature of the condition that can severely affect the physical and psychological health of the patients, early detection and referral to appropriate healthcare providers is important. Several countries had advocated screening for scoliosis and numerous studies were conducted in accordance to such protocols but as per the researchers' knowledge, no study was published in the Philippines. The present studyaims to describe possible relationships between age of the participants; gender of the participants and; the type of school the participants go; and the measured degree of curvature using the Cobb's Method of Measurement via a schoolwide screening using the Adam's Forward Bending Test and AP-L thoracolumbar radiographs. The study was implemented in selected high school institutions in Tanauan City, Batangas, Philippines. Using percentile ranking to organize the data and chi-square to determine if relationships exist between the said variables, findings showed that there are no relationships between the type of school, age and gender, and the degree of curvature of the participants who are positive for scoliosis.

Key words: *scoliosis, prevalence, spine, posture*

INTRODUCTION

Scoliosis is the lateral curvature of the spine that can be considered as pathologic when it is >10° using the Cobb's Method of Measurement (Janicki & Alman, 2007; Trobisch, Suess & Schwab, 2010 and Adobor, Rimeslatten, Steen and Brox, 2011) and when viewed in Anterior - Posterior(AP) thoracolumbar radiographs. It is accompanied with rotational changes that can viewed on lateral thoracolumbar radiographs of the spine and is frequently associated

ISSN: 2094-5906

with back pain at the side of the convexity (Weiss et al., 2006; Sato et al., 2011), and prominent, trunk, back and waist asymmetry (Janicki & Alman, 2007). Scoliosis can be a sequelae of neuromuscular diseases, congenital conditions or tumor. If the mentioned causes were ruled out, the scoliosis is an idiopathic type (Janicki & Alman, 2007). Most cases of scoliosis were undiagnosed until obvious symptoms are present (Aulisa, Guzzanti, Perisano, Specchia, Marzetti et al., 2010 and Nery et al., 2010) and such symptoms had already progressed into more serious complications that can be life threatening. If insufficient medical attention was given, several complications might be including progression of the deformity that may affect the patient's quality of life (Lenssinck et al., 2005 and Aulisa et al., 2010) from pain, physical discomfort to societal stigma, stress and even serious pulmonary problems may arise (Alves, Stirbulov, and Avanzi, 2006).

Scoliosis has been a common problem in school children particularly those who are in adolescence as cited by Nery et al. (2010) from the growth spurt they undergo with an incidence of 0.5% - 3%. The said incidence still can be broken down into point prevalence, depending on the sex, age and degree of curvature using the Cobb's Method of measurement (Adobor, Rimeslatten, Steen and Brox, 2011). It is an alarming condition that needs to be addressed by the patients, their families and the school during its earliest stages for early referral to appropriate health personnel. Treatment has always been oriented on stopping the progression of the deformity(Weiss, 2012);therefore, an early detection and diagnosis is imperative.

Screening for scoliosis has been a practice in different parts of the world for early detection and intervention (Yong, Wong and Chow, 2009 and Adobor, Rimeslatten, Steen and Brox, 2011). Depending on the degree of the curve, the patient may be referred to physical therapists (Trobisch et al., 2010), orthotists for the prescribed orthosis or be referred for surgery (Janicki & Alman, 2007). The most common methods to screen scoliosis are the following: 1) the use of the Adam's Forward Bending Test (AFBT) (Janicki & Alman, 2007; Trobisch et al., 2010), 2) the use of a scoliometer - a type of an inclinometer that measures the gibbosity of the convex side of a scoliotic curve or 3) a combination of the two methods (Yong, Wong & Chow, 2009). These methods were found to be cost-effective yet very sensitive (Sabirin et al., 2010)

A study in Norway that seek to determine the point prevalence of scoliosis together with a screening model evaluation showed low referral rates from previous studies with the screening model used giving acceptable sensitivity grades (Adobor, Rimeslatten, Steen & Brox, 2011).

ISSN: 2094-5906

Another study of Adobor and colleagues (2012) conducted in Norway following the referral patterns without a school wide screening for scoliosis had revealed greater incidence of increased measured degrees of curvature using the Cobb's Method of Measurement, most of them were at the upper limit for bracing treatment. The study also found increased referrals for surgical intervention compared to previous years wherein there was scheduled screening for scoliosis.

An epidemiologic study in Tokyo, Japan showed a slight increase in prevalence of mild scoliosis in comparison to the last reports of screening for scoliosis during 1988 (Ueno et al., 2011).

Several studies tried to correlate various variables, prevalence of scoliosis and its effects to patients. In Brazil a schoolwide screening study that aimed to determine prevalence of scoliosis and its possible relationships with body weight and school things reported no relationship between presence of scoliosis and the said variables (Nery et al., 2010). In the paper of Sato and collegues (2011), they studied the correlation of back pain and idiopatic scoliosis in Japan that showed the presence of more prolific, more intense and greater pain values in comparison to those who have no scoliosis. In a South Korean study by Seung-Woo Suh (2011) and colleagues showed that there is progressive increase in prevalence of scoliosis in females compared in males with the prevalence greater in early adolescent age group of 10-12 years. Similar to this is study is the one conducted in Singapore by Yong, Wong and Chow (2009) that showed a trend regarding the increment of prevalence of scoliosis with increasing age, advocating routine screening follow-ups from age ten to age thirteen especially in the female population. A systematic review that focused the effectiveness and cost-effectiveness of school based screening for scoliosis in Malaysia suggested scoliosis screening for high-risk populations particularly in females aged twelve years old (Sabirin et al., 2011). However as per the researchers' knowledge, there were no published scoliosis screening studies anywhere in the Philippines.

The present study aims to determine the incidence of scoliosis in selected High Schools in Tanauan City in Batangas using a school-wide screening method. The researchers will also attempt to document and find possible relationships between the following factors and the measured degree of curvature using the Cobb's Method of Measurement:

1. The participants' age.
2. The participants' gender.
3. The type of school the participants go in as to public or private institutions.

ISSN: 2094-5906

MATERIALS AND METHODS

Design

The present study is a cross sectional analysis that described the incidence of scoliosis in selected High Schools in Tanauan City, Batangas, Philippines using a school-wide screening method.

Participants

A total of 399 high school students, both male and female students, ages 12-18 years old from Mabini Educational Institution and Wawa National High School were recruited in the study. The parents of the students were also informed of the possible need for chest or thoracolumbar radiograph if their child qualified for the first part of the screening.

Students diagnosed withback problems such as herniated nucleus pulposus, fractured vertebrae or any neurologic condition that may result to scoliosis, were excluded as participants in the study. In order to lessen the exposure of students to radiation, students who had an AP- L radiograph within six months who do not present lateral curvature of spine were also excluded in this study.

A. Forward Bending test

After a short introduction about scoliosis, presentation and explanation of the study protocols and procedures, students were then tested with the Adam's Forward Bending test (Adobor, Rimeslatten, Steen & Brox, 2011) by the researchers. The Adam's Forward Bending test increases the distinction of the gibbus at the side of the convexity of the spine (Trobisch et al., 2010). It was administered with the patients positioned orthostatically. They were asked to bend forward with knees straight, the feet slightly apart, with the upper extremities relaxed and the palms of the hands facing each other. The researchers viewed the participant's back in the midline and then compared the contours of the right and left side of the back. Positive findings show truncal asymmetry or presence of a gibbus at the side of the convexity that means vertebral rotation is present (Trobisch et al., 2010).

B. Patient Data Gathering

A structured questionnaire was provided to get the pertinent variables needed in the study including the personal data and brief medical history of the participants which will eliminate those with back and spinal pathologies. Theywere asked about the common symptoms of scoliosis such as back pains or noticeable asymmetries, especially in shoulders, chest, back and lower extremities.

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C. Radiographic screening

Antero–Posterior–Lateral (AP-L) radiographic imaging of the thocolumbar spine is the gold standard in the diagnosis of scoliosis as it will show the lateral curvature of the spine as well as the rotational changes that accompany it (Trobisch et al., 2010). The participantswho returned the letters of consent signed by their parents or guardians weresubjected to thoracolumbar or chest radiographs. Cobb's angle measurements were done by the researchers after they were instructed by an orthopedic surgeon.

Statistical Tool

To describe the incidence of scoliosis, percentile ranking was used as the statistical tool. On the other hand, chi-square was used to determine the relationships between age, gender and the type of school of the participants and the measured degree of curvature.

Scope and Delimitations of the Study

The present study focusedonly on the adolescent idiopathic scoliosis screening and did not describe the extraneous contributing causes of scoliosis such as handedness and the Body Mass Index (BMI).

Also, the study did not tackle the sensitivity and specificity of the Adam's Forward Bending Test, as this test is used for gross screening only and does not determine the presence of scoliosis. The radiograph findings of the participants who qualified for the first part will only be the basis if they indeed have scoliosis as well as the degree of their Cobb's angle. The classification of scoliosis as to the type of curve (C-curves or S-curves) was also excluded in the present study's scope.

Another limitation of the study is the relatively small population where the study was implemented due to the lack of approval and support from other secondary schools in Batangas.

Lastly, the compliance on the last part of the screening which needed the AP-L radiographic imaging of the participants who qualified at the first part and their parents or guardians hindered the researchers in increasing the sample size thatmight have affected the outcome of the study.

RESULTS AND DISCUSSION

Demographic Profile of the Participants

Table 1 shows the demographic profile of the screened participants. From the 399 recruited students, 84.71% (338/399) were screened for the first part of the study.

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Table 1
Demographic Profile of the Screened Participants
N=338

Profile Variables	Frequency	Percentage (%)
Age		
12	40	11.83%
13	46	13.61%
14	89	26.33%
15	79	23.37%
16	75	22.19%
17	5	1.48%
18	4	1.18%
Gender		
Male	182	53.85%
Female	156	46.15%
School		
Private	152	44.97%
Public	186	55.02%
AFBT		
(+)	39	11.54%
(-)	299	88.46%

The 61 (15.54%) students – 45 from Wawa National High School and 16 from Mabini Educational Institution were not screened because they were absent during the day of the screening and therefore excluded in the population group.

In terms of age, majority of the screened students were 14 years old taking more than a quarter of the screened population (26.33%). This was followed by age 15 with 23.37%, then age 16 with 22.19%. Age 12 has 11.83% while age 17 has 1.48% and lastly, age 18 has 1.18%. This means that most of the screened students were age 14 which is still under the adolescent age bracket and therefore a high-risk age group for adolescent idiopathic scoliosis (Marcell, 2007).

In terms of gender, more than half (53.85%) of the screened students where male; with the rest (46.15%) of the screened students were female.

In terms of the type of school, majority of the screened students go to the public high school with 55.02%. The remaining 44.97% attend the private institution.

With the result of the AFBT, most of the screened students (88.46%) are screened were negative. The remaining 11.54% of the screened students who were positive with AFBT then qualified for the second part of the screening and was subjected to AP thoracolumbar

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radiographs for confirmation if they have scoliosis. The researchers had decided to correlate data after they obtained and measured the curves of the scoliosis using Cobb's angle method.

B. Demographic Profile of Students who were Positive with AFBT

Table 2
Demographic Profile of Students who were Positive for AFBT
N = 39

Profile Variables	Frequency	Percentage (%)
Age		
12	1	2.56%
13	8	20.51%
14	13	33.33%
15	8	20.51%
16	4	10.26%
17	4	10.26%
18	1	2.56%
Gender		
Male	19	48.71%
Female	20	51.29%
School		
Private	20	51.28%
Public	19	48.71%

Table 2 summarizes the demographic profile of students who were positive with AFBT. In terms of age, most of the participants who were positive with AFBT were 14 years old with 33.33%. This was followed by 13 and 15 years old, 16 and 17 years old and 12 and 18 years old with 20.51%, 10.26% and 2.56% respectively. Because AFBT is not a diagnostic tool for scoliosis (Sabirin et al., 2010), the deviation from the literatures' (Yong, Wong and Chow, 2009; Sabirin et al, 2010 and Seung-Woo Suh et al., 2011) number of the positive cases as per the age group remained to be unjustified, as the participants' possible scoliosis is to be confirmed by the AP-L thoracolumbar radiographs.

In terms of gender, more than half of the positive group in AFBT were female (51.29%). The remaining 48.71% who were positive were male. Although the presence of scoliosis cannot still be determined, the results concur with past literatures that scoliosis has a female gender predisposition.

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In terms of type of school, more than half (51.29%) of the positive group attended the private institution while the remaining 48.71% went to the public institution.

The 39 students were subjected to AP thoracolumbar radiographs for confirmation if they have scoliosis. Of 39 students who were tested, only 19 were granted of the parent's consent. The other 20 students were then eliminated as participants of the study. The demographic profile of the students who underwent the AP-L thoracolumbar radiograph was also determined for correlation of variables.

C. Demographic Profiles of Participants who were Subjected to AP-L Thoracolumbar Radiographs.

Table 3
Demographic Profile of Participants who were Subjected to Thoracolumbar Radiographs
N = 19

Profile Variables	Frequency	Percentage (%)
Age		
12	0	0
13	3	15.79%
14	7	36.84%
15	2	10.53%
16	4	21.05%
17	2	10.53%
18	1	5.26%
Gender		
Male	7	36.84%
Female	12	63.16%
School		
Private	9	47.32%
Public	10	52.63%

As shown in Table 3, many (36.84%) of the participants who underwent the AP-L Thoracolumbar radiographs were 14 years old. The 16 year old age group had 21.05% of the participants and the 13 year old group had 15.79%. Age 17 and 15 both have 10.53% of the participants. Lastly, 5.26% of the participants were under the 18 year old age group. No participant from the 12 year old age group was subjected to AP-L thoracolumbar radiographs. This means that 14 year old age group has the highest rate of being the determinant of the results when age is correlated to the degree of curvature.

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In terms of gender, most (63.16%) of the participants were females and the remaining 36.84% were males. Therefore, the female participants of this study have higher rate of being the determinant of the results when gender is correlated to the degree of curvature.

In terms of type of school, more than half (52.63%) of the participants were enrolled in public high school while 47.32% attend in the private institution. It means the students who were in the public institution have the higher rate of being the determinant of the results when the type of school is correlated to the degree of curvature.

To summarize the demographic profile of the all the screened students, only 10% (39/399) were found to be positive of AFBT. From this 49% (19/39) were subjected to AP thoracolumbar radiographs for confirmation of the presence of scoliosis. The degree of curvature was then measured by the researchers using the Cobb's angle method.

II. Demographic Profile and Degree of Curvature of the Participants

Scoliosis is not pathologic as long as the curvatures are <10°. Depending on the degree of curvature, clinicians can categorize scoliosis as mild, moderate or severe. This grading is usually the basis for the management of scoliosis. Curves that are <25° are observed for further progression and are referred to physical therapists for exercises and postural training; and are categorized as mild scoliosis. Those who are >25° but <40° or 45° are referred to orthotists for spinal bracing for prevention of progression of the curve. They fall under the moderate category. If the size of the curve is <45°, they are categorized as severe scoliosis and are referred for surgery, as this is the group where the deformities are the greatest and respiratory compromise and death is associated (Glanzman, 2009). The researchers grouped the scoliotic curves using this method.

Table 4 shows the distribution of the curvatures measured by the researchers using the Cobb's method of measurement in relation to the participants' demographic profile.

Both pathologic and non-pathologic curves were observed in the participants. In terms of age, two 13-year old participants have non-pathologic curves which were also seen in five 14 year olds; two in 15-year old and three in 16-year old age group. Age groups 17 and 18 had one participant each that had a non-pathologic curve. One participant was found to have pathologic curves in the 13-year old age group as well as in the 16-year old age group and the 17-year old age group. The two participants were found with the largest curves in the study belonged in the 14-year old age group unlike the previous studies

ISSN: 2094-5906

(Yong, Wong and Chow, 2009 and Seung-Woo Suh et al., 2011) that showed larger frequency of curves in ages 10-12 years.

Table 4
Degree of Curvature and Demographic Profile of Participants

	Degree of Curvature									
	Non – Pathologic					**Pathologic**				
	1°	3°	4°	5°	**Total**	11°	12°	15°	16°	**Total**
Age (N = 19)										
12	0	0	0	0	0	0	0	0	0	0
13	1	0	0	1	2	1	0	0	0	1
14	2	1	0	2	5	0	0	0	2	2
15	0	0	1	1	2	0	0	0	0	0
16	1	0	0	2	3	0	0	1	0	1
17	1	0	0	0	1	0	1	0	0	1
18	0	1	0	0	1	0	0	0	0	0
Gender (N = 19)										
Male	2	1	0	3	6	1	0	0	0	1
Female	3	1	1	3	8	0	1	1	2	4
School (N = 19)										
Public	3	0	1	3	7	0	1	1	0	2
Private	2	2	0	3	7	1	0	0	2	3

In terms of gender, six out of seven male participants were found to have non-pathologic curves while eight out of twelve female participants have non-pathologic scoliosis curves. Most (4/5) of the pathologic curves belong to the female gender. This is in conformity with literatures stating that scoliosis have a female gender predisposition (Yong, Wong and Chow, 2009, Sabirin et al., 2010 and Seung-Woo Suh et al., 2011).

In terms of the type of school, seven out nine participants attending the public highschool have non-pathologic curves. Likewise, seven out of ten students who attended the private institution have non pathologic curves. Majority (3/5) of the pathologic scoliosis were found present in those participants attending the private institution. Researchers have observed that the students who attend the private institution tend to carry more school things compared to those who go to the public institutions. However, a study had shown that the weight of the school things has no relationship with the occurrence of scoliosis (Nery et al., 2010).

ISSN: 2094-5906

In summary, out of the 338 screened student-participants, there were 5.62%(19/338) confirmed cases of scoliosis; 26.32% (5/19) of which were considered pathologic as per Cobb's Measurement.

Table 4 shows that most (14/19) of the curvatures found belonged to the non-pathologic group. The measured pathologic curves that were found fall under the mild scoliosis stage. This means that AFBT alone as a screening tool is indeed an unreliable tool in screening for pathologic scoliosis (Adegoke, Akinpelu and Taylor, 2011).

III. Correlation for Possible Relationship Between the Degree of Curvature with the Variables

Table 5 shows the correlation of the age, gender and the type of school to the degree of curvature of the participants who underwent the AP-L radiographs.

Table 5
Relationship Between Degree of Curvature and Variables

	λ^2_c	λ^2_t	df	p-value	Decision	Interpretation
Degree of Curvature vs. Age	41.272	55.758	35	0.215	Accepted	Not Significant
Degree of Curvature vs.Gender	6.556	14.067	7	0.476	Accepted	Not Significant
Degree of Curvature vs.Type of School	4.28	14.067	7	0.681	Accepted	Not Significant

Legend: Significant at p-value < 0.05; HS = Highly Significant; S = Significant; NS = Not Significant

As to age and degree of curvature, the computed chi-square value (41.272) is less than the critical value (55.758) and the resulted p-value is greater than 0.05 level of significance; thus, the hypothesis of no significant relationship between the degree of curvature as per Cobb's angle and age of the participants is accepted. This means that there is no relationship exists and implies that the degree of curvature is not correlated to the age of participants and indicates that the patient's degree of curvature is not affected by the age of the participants; opposing literatures thatscoliosis is more common in adolescents' stage (Nery et al., 2010 & Yong, Wong & Chow, 2009).

ISSN: 2094-5906

As to gender and the degree of curvature, the computed chi-square value (6.556) is less than the critical value (14.067) and the resulted p-value is greater than 0.05 level of significance, thus the hypothesis of no significant relationship between the degree of curvature as per Cobb's angle and gender is accepted. This means that there is no relationship that exists and implies that the degree of curvature is not correlated to the gender. This is also a deviation from past study of by Seung-Woo Suh (2011) and colleagues that showed progressive increase in prevalence of scoliosis in females compared in males.

As per to the type of school and the degree of curvature, the computed chi-square value (4.827) is less than the critical value (14.067) and the resulted p-value is greater than 0.05 level of significance, thus the hypothesis of no significant relationship between the degree of curvature as per Cobb's angle and type of school is accepted. This means that there is no relationship exists and implies that the degree of curvature is not correlated to the type of school.

CONCLUSION

With the results gathered, the researchers were able to come up with the conclusion that the present study is conformant of the other incidence studies conducted on other countries. Screening for scoliosis has been a valuable tool that can be cost and time- efficient using the simple Adam's Forward Bending Test and AP thoracolumbar radiograph imaging.

The researchers also concluded that there are no relationships between the degree of the curvature of scoliosis and the studied variables – type of school, gender and age of the participants.

RECOMMENDATIONS

The researchers recommend for the screening of scoliosis in bigger population not just in selected secondary schools in Tanauan but in the whole of Batangas province in general, preferably during the start of school year as a part of admission requirements for early referral and management.

Adam's Forward Bending Test alone as a screening tool is put into controversy as it is said to have high sensitivity yet very low specificity resulting to very high false-negative results (Adegoke, Akinpelu & Taylor, 2011); thus, further screening programs must include a scoliometer to assess if there are rotational changes in the spine which is one of the criteria in diagnosing scoliosis.

Most of the pathologic curves are observed in the participants enrolled in the private institution although the present study showed no

ISSN: 2094-5906

relationship exists between the type of school and the degree of the scoliosis curve. A detailed study on this matter is also advised.

Lastly, since the majority of the gathered results of Cobb's Angle fall to mild scoliosis, an action research following this study to address the conditions of the patients can be implemented together with the referral to orthopedic surgeons of the participants who were confirmed to have scoliosis.

ACKNOWLEDGEMENT

The researchers are profoundly moved in gratitude by the unceasing support, faith and motivation of the research advisers Dr. Carina Magbojos and Dr. Ma. Simplicia Flores. The researchers also extend their deepest thanks to the respective principals of Mabini Educational Institution, Mrs. Liwayway Ramos and Wawa National High School, Mrs. Norma Sumagi for their approval to conduct the first part of the study in their respective institutions and unceasing support in order for the present study to materialize. This study will never materialize with the help and support of these people.

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ISSN: 2094-5906