

# A Survey on the Current State and the Characteristics of Scoliosis in College Students\*

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## Abstract

126 male and 95 female Korean college students were examined for Scoliosis by using Moire type body observation apparatus, Scoliotic hump measuring instrument, and spinal cord side curvature condition measuring instrument. The prevalence rate of Scoliosis along with identifying its possible causal factors and characteristics were investigated. The results revealed that 5.56% of male and 8.42% of female students(male to female ratio 1:1.47) were suspected as having Scoliosis. There was a significant correlation between the students who have symptoms of Scoliosis and their physiological measurements(e.g., lower breathing capacity of the lungs). There were also close relationships between the suspected cases and their habits(e.g., poor sitting and sleeping posture). It is concluded that the Scoliosis in Korean college students should not be ignored.

Keyword: Scoliosis, Spinal cord side curvature, Moire type body observation

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## 1. Introduction

Human spine consists of 7 cervical, 12 thoracic, 5 lumbar vertebral bones, sacrum and coccyx. A normal spine looks straight when observed from the front and back, but cervical spine shows a gentle curvature anteriorly when viewed from the side. In similar ways, thoracic spine shows a posterior gentle curvature and lumbar spine an anterior gentle curvature. Figure 1 shows normal straight spine in nature demonstrating the normal thoracic kyphosis and lumbar lordosis. However, increased roundback in the chest area is called hyperkyphosis while increased swayback is termed hyperlordosis. Exceeded kyphosis and

lordosis are not pathological by themselves as long as they do not cause any trouble.

In contrast to them, some people have spines that also curve from side to side when the body is viewed from behind. This condition of side-to-side spinal curves is called Scoliosis shown in Figure 2(Scoliosis Research Society, 1997). On an X-ray, the spine of an individual with Scoliosis looks more like an "S" or a "C" than a straight line. This gives the appearance of leaning to one side and should not be confused with poor posture. Some of the bones in a scoliotic spine also may have rotated slightly, making the person's waist or shoulders appear uneven(Goldstein and Wangth, 1973; Bradford et al., 1994).

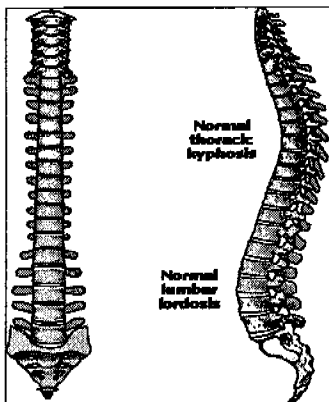


Figure 1. Normal Straight Spine Demonstrating the Normal Thoracic Kyphosis and Lumbar Lordosis

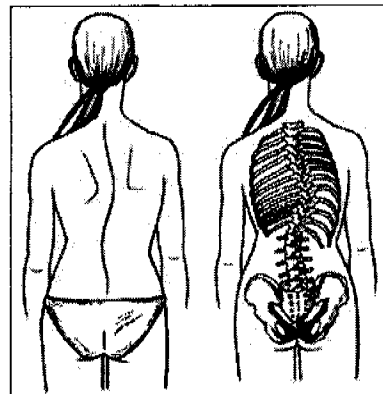


Figure 2. Posterior View of Spine with Scoliosis (Lateral or Side-to-Side Curvature)

Scoliosis is known as the most common spinal deformity of the back that results in gradual collapse and twisting of the spinal column. This occurs relatively frequently in the general population, and its frequency depends upon the magnitude of the curve being described. Usually a mild degree—a lateral curvature of the spine greater than 10 degrees in Cobb's Angle (Figure 3)—of Scoliosis is common, occurring in up to 50 percent of the population. Scoliosis of greater than 25 degrees has been reported in about 1.5/1000 persons in the United States. However, 60% of curvatures in rapidly growing prepubertal children will progress. It appears in children as they begin to walk or, more commonly, in adolescence with a higher rate of incidence with female teenagers.

Most scoliotic curves can be treated non-operatively if they are detected before they become too severe. Therefore, early detection is important to make sure the curve does not progress. With early detection, Scoliosis can be treated and corrected before abnormal bone growth occurs. Severe Scoliosis, a progressively curved spine can cause deformed ribs, which restrict the lungs and cause breathing or heart problems (Bergofsky et al., 1959;

Park et al., 1990). It also can result in severe back pain, acute headaches, chronic fatigue, and mood swings.

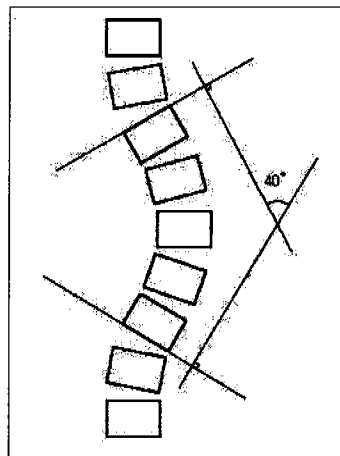


Figure 3. Cobb's Angle

It has been widely understood that early diagnosis before the disease progresses and subsequent onset of treatment are very much important as well. Therefore, it has been strongly suggested that scoliotic boys and girls should be picked up in early stage of the disease whenever they are exposed to any chance of checking up such as yearly physical examination in their schools.

In Korea, the nationwide investigation and physical examination of Scoliosis for adolescence students have not been administered so far. However, some of researchers have conducted the Scoliosis screening test and reported that 2.16% in 1983 and 6.0%

in 1995 of the high school female student diagnosed over 10 degrees in Cobb's angle for Scoliosis(Moon et al., 1995, 1996). Another study reported that 2.3% of high school male students were diagnosed as having Scoliosis. These results support most studies on Scoliosis that the male students have 2 to 3 times lower prevalence rate than the female students. In addition, the causal factors of Scoliosis based on their researches were estimated as is due to the usage of improperly designed study table and chair, sitting and sleeping habits with bad posture, wearing heavy back pack, and lack of exercise.

Unfortunately, none of studies was conducted for college students even though they cannot be entirely excluded future possibility of developing Scoliosis, as there always such possibility until somatic growth stops.

Moreover, the Korean college students are exposed to almost same causal factors as middle and high school students.

The main objectives of this study were thus to investigate problems involved with Scoliosis in Korean college student for identifying its possible causal factors and characteristics. The results of this study will provide guidance for the prevention of Scoliosis.

## 2. Methods and Procedure

### 2.1 Subjects

126 male and 95 female college students between 19 and 28 years of age volunteered to participate in this examination. Table 1 provides a summary of basic subject statistics.

Table 1. Descriptive Statistics for Subject Population

Measure	Male(N=126)	Female(N=95)
	Mean(SD)	Mean(SD)
Age(Years)	23.6(1.85)	21.3(1.13)
Weight(kg)	66.1(9.67)	51.6(4.07)
Standing Shoulder Ht.(cm)	149(6.33)	135(6.9)
Sitting Shoulder Ht.(cm)	111(2.31)	106(3.6)

## 2.2. Equipment

The following equipments were used in this study:

1. Moire type body observation apparatus Model MF-120N made by Yamagami Corporation was used to identify the side-to-side curvature of spine because it is easy to use, takes short period of time to test, has no harm to subject, and most of all it can show the unbalanced spine quickly and accurately.

2. Scoliotic hump measuring instrument Model YS-1 was used to perform forward bending test.

3. Spinal cord side curvature condition measuring instrument was used to identify the difference in shoulder height.

4. Other equipments used in this study were a Martin Type anthropometry measurement kit, a blood pressure monitor with heart rate monitor, and a spirometer.

## 2.3. Procedures

The examination consisted of three sessions and all subjects participated in each session. Figure 4 shows a flow chart of examination procedure performed in this study. Each subject

was given instructions regarding the manner in which the observations and measurements will be taken along with examiner's demonstration. At first session, each subject was asked to fill out the questionnaire. The questionnaire includes the type of shoes they used to wear, the habit of wearing backpack, the habit of sitting and sleeping posture, type of exercise, experiences of low back pains.

At second session, anthropometric measurements were taken including the weight and shoulder height (standing and sitting). Physiological measurements were obtained and recorded at this time, which includes baseline heart rate, blood pressure, and breathing capacity of lungs.

At third session, before the observation begins, subjects were asked to take off upper clothing or at least wearing just a brassiere in female case and instructed to stand in an erect posture with their arm straight to their side of thigh. Moire type body observation apparatus was then set up in dark room and let the subject stand back close to the see-through plate (exact standing position of the foot step was set and drawn on the floor) to identify the side-to-side curvature of spine.

Three cardinal points were checked in attempt to find out any postural imbalance in coronal plane. These points are:

this, Moire type body observation apparatus was used. Viewing from the back of the see-through plate, Figure 5 shows symmetric contours of the normal spine and Figure 6 shows asymmetric contours of the abnormal spine.

(1) Is there any asymmetry between the curved auxiliary lines (contours) in either side? To check

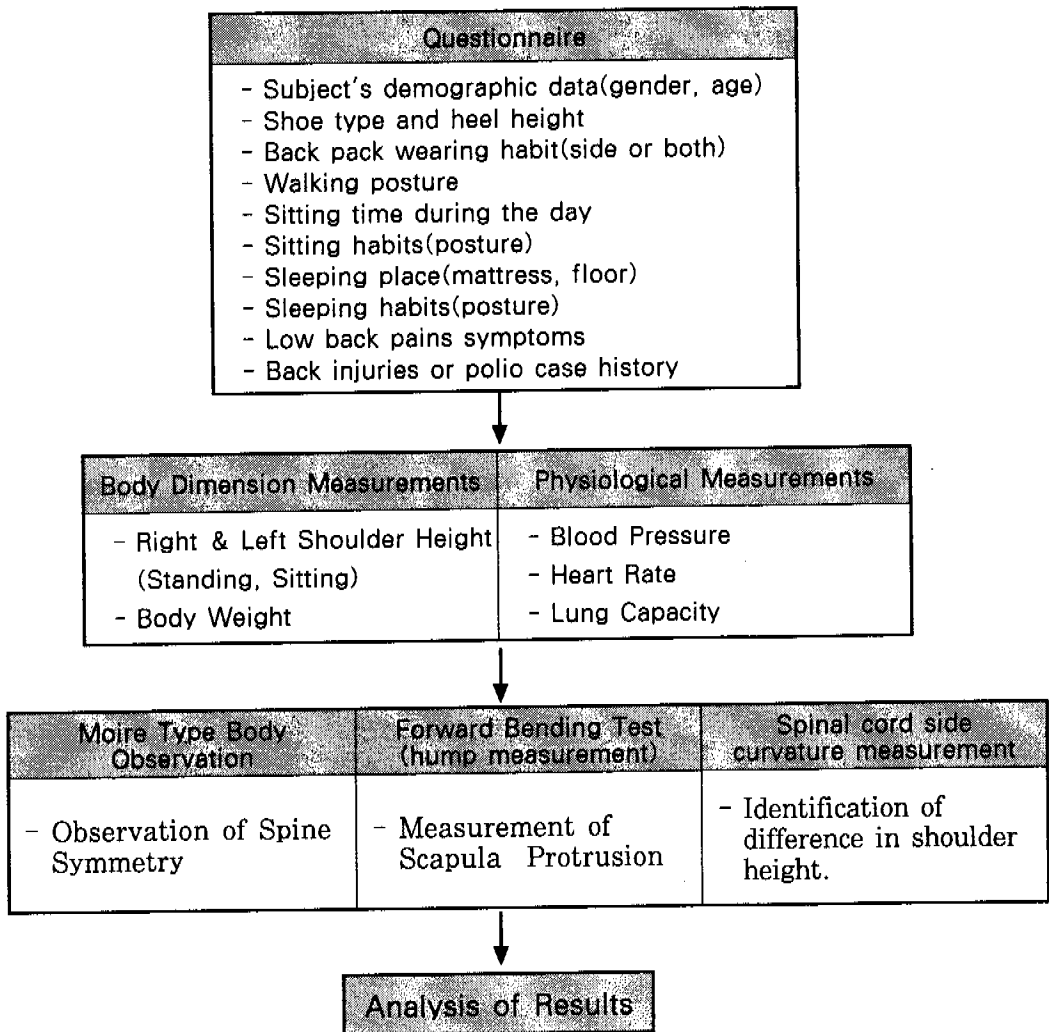


Figure 4. Flow Chart of Examination Procedure

(2) Is there any difference between the scapular height and the way of protrusion in either side? Figure 7 & 8 shows the method of measuring the height difference for both side of scapular. To do this, we let the subject make a gentle bodily bow with hands down in front of him and both palms put together (examination with anterior bodily flexion). Examiner stays in front or in the rear of the examinee, checking the back on its coronal plane to pick up even the slightest imbalance as to the shoulder, back and waist in this order. If any hump is noted in either side of the back to produce a difference in height, Scoliosis will be strongly suspected, as this hump is caused by twisted scoliotic spine. Figure 7 shows a person who has even height scapular and Figure 8 shows a person who has protruded scapular.

(3) Is there any postural imbalance when viewed from behind? To examine this, spinal cord side curvature condition measuring instrument was used to evaluate shoulder levels. The examinee was asked to stand at attention with his back against the acrylic plate with ruled squares. The height of both shoulders level was then ch-

ecked by counting the ruled squares. The size of each ruled square is 10mm(thin line) and 50mm(thick line).

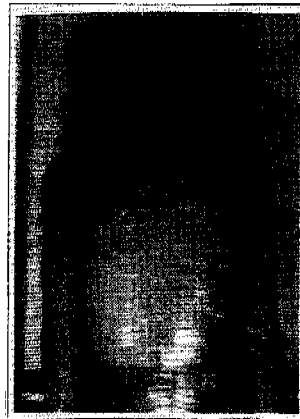


Figure 5.  
Symmetric  
Contours of  
Normal  
Spine

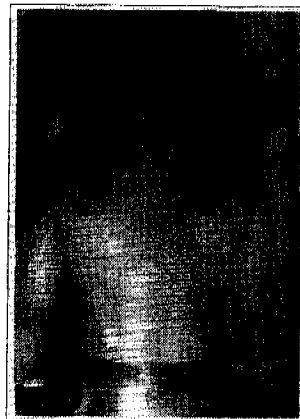


Figure 6.  
Asymmetric  
Contours of  
Abnormal  
Spine

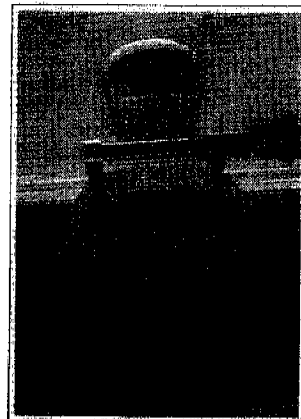


Figure 7.  
A Person  
Has Even  
Scapular  
Height

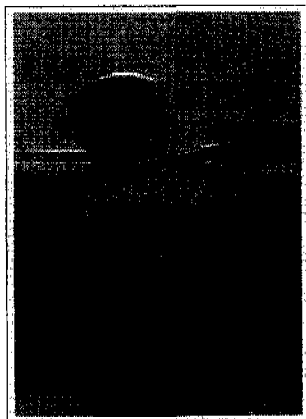


Figure 8.  
A Person  
Has  
Protruded  
Scapular

### 3. Results and Discussion

The results of the Moire type body observation and forward bending test show those 7(5.56%) male students and 8(8.42%) female students were suspected as having Scoliosis. This occurrence rate is little higher than previous studies(approximately 2.0% in male, 6.0% in female)(Moon et al., 1991, 1995, 1996). It can be inferred that some of these subjects with having less than 10 degrees of Cobb' s angle may possibly have been included if we had performed radiological test.

Based on the results of questionnaire, there was no close relationship between the subjects who were suspected for Scoliosis and the type of shoes(tennis shoes, leather shoes, or high-heeled shoes) along with the

height of shoe heel they used to wear as shown in Table 2. Moreover, walking posture, low back pain symptoms, and back injury or polio case history showed no close relationship with suspected cases.

On the contrary, from Table 2, close relationship was found with these variables such as: the habit of sleeping posture(i.e., side sleeping posture in female case) and sitting posture(i.e., lean back or humped posture), the average length of time spending in study table during the day(i.e., longer duration), the habit of wearing backpack(i.e., left or right, not both side in male case).



Table 2. The Comparison between Normal and Suspected Cases in Accordance with Causal Factor and its Nominal Measures

Causal Factor		Nominal Measure	Male		Female	
			Normal Case(%)	Suspected Case(%)	Normal Case(%)	Suspected Case(%)
Shoe Type	Tennis Shoes	36(30.3)	2(28.6)	13(14.9)	2(25.0)	
	Leather Shoes	79(66.4)	4(57.1)	61(70.1)	5(62.5)	
	High-heeled Shoes	0	1(14.3)	12(13.8)	1(12.5)	
	Others	4(3.4)	0	1(1.1)	0	
Shoe Heel Height	2~4cm	98(82.4)	5(71.4)	22(25.3)	2(25.0)	
	5~7cm	20(16.8)	2(28.6)	52(59.8)	4(50.0)	
	8~10cm	1(0.8)	0	13(14.9)	2(25.0)	
	Over 10cm	0	0	0	0	
Sleeping Posture	Supine	65(54.6)	1(14.3)	30(34.5)	1(12.5)	
	Either Side	38(31.9)	3(42.9)	47(54.0)	4(50.0)	
	Prone	12(10.1)	3(42.9)	8(9.2)	2(25.0)	
	Others	4(3.4)	0	2(2.3)	1(12.5)	
Sitting Posture	Upright	24(20.2)	1(14.3)	10(11.5)	2(25.0)	
	Bent Forward	83(69.7)	3(42.9)	62(71.3)	6(75.0)	
	Leaned	10(8.4)	3(42.9)	15(17.2)	0	
	Others	2(1.7)	0	0	0	
Sitting Time on Chair	Average Hours/Day	5.3	6.2	4.8	5.4	
Backpack Wearing Habit	Both Side	51(42.9)	0	37(42.5)	5(62.5)	
	Right Side	41(34.5)	5(71.4)	45(51.7)	2(25.0)	
	Left side	27(22.7)	2(28.6)	5(5.7)	1(12.5)	
Blood Pressure	Diastolic	<60 mmHg	7(5.9)	0	4(4.6)	0
		60-90	91(76.5)	6(85.7)	51(58.6)	8(100.0)
		90-114	21(17.6)	1(14.3)	32(36.8)	0
		>115	0	0	0	0
	Systolic	<110	13(10.9)	0	4(4.6)	0
		110-140	92(77.3)	6(85.7)	43(49.4)	8(100.0)
		140-159	14(11.8)	1(14.3)	40(46.0)	0
	>160	0	0	0	0	

Figure 9 shows the sitting habits of the subjects who were determined as suspected cases. From this figure, it is estimated that the more percentages of leaning or bending forward sitting posture presented in subjects with Scoliosis rather than upright posture as compare to the normal cases.

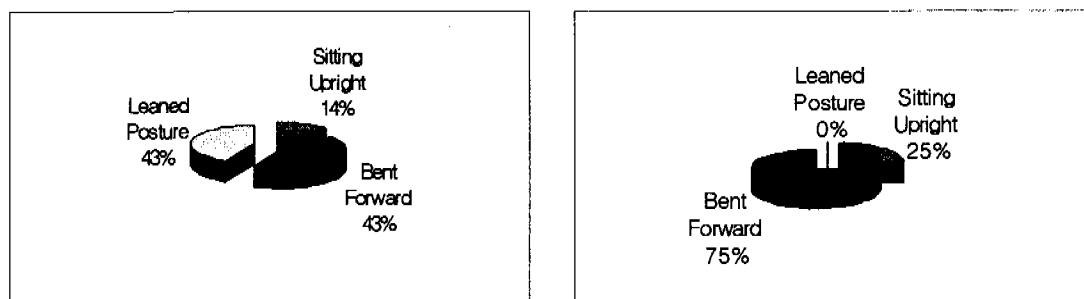


Figure 9. Sitting Habits of the Scoliosis Suspected Cases(Left: Male, Right: Female)

Anthropometric measurements revealed that there existed no correlation between the suspicious cases and subjects' weight and shoulder height. However, most suspicious cases resulted from the Moire type body observation and forward bending test showed more than 1.5cm of the right and left shoulder height difference. The results from the shoulder height measurements are shown in Table 3. In general, Scoliosis may be suspected when one shoulder appears to be

higher than the other. Therefore, when shoulder level difference remain in less than 1.5cm, this may be within normal range, but if it exceeds more than 2cm, Scoliosis should be strongly suspected. Particularly, when the difference is more than 3cm, the diagnosis is decisive, therefore, we should not miss this difference. Next, as a procedure of confirmation, radiological study should be performed on suspicious cases.

Table 3. The Number(%) of Subjects' Right and Left Shoulder Height Difference

Difference	Sitting Shoulder Height		Standing Shoulder Height	
	Male	Female	Male	Female
<1cm	72(57.1)	50(52.6)	75(59.5)	48(50.5)
1-1.5cm	45(35.7)	42(44.2)	43(34.1)	43(45.3)
1.5-2cm	8(6.3)	5(5.4)	7(5.6)	6(6.3)
2cm<	<1(0.8)	1(1.1)	1(0.8)	1(1.1)
Total	126(100.0)	95(100.0)	126(100.0)	95(100.0)

Moreover, the results of forward bending test by using Scoliotic hump measuring instrument showed that the height difference of right and left

scapular was obvious for suspected Scoliosis cases. Table 4. Shows the height difference of right and left scapular in forward bending posture.

Table 4. The Number(%) of Subjects' Right and Left Scapular Height Difference

Difference	Male	Female	Total(Mean %)
<5mm	121(96.0)	92(96.8)	213(96.4)
5-6mm	2(1.6)	2(2.1)	4(1.8)
6-7mm	2(1.6)	0	2(0.8)
7mm<	<1(0.8)	1(1.1)	2(0.9)
Total	126(100.0)	95(100.0)	221(100.0)

When scapular level difference remain in less than 5mm, this may be within normal range, but if it exceeds more than 5mm, Scoliosis can be suspected. Particularly, when the difference is more than 7mm, the Scoliosis should be strongly suspected.

10, the standard lung capacity was estimated by applying Baldwin type standard lung capacity estimation method (Male= $(27.63 - 0.1120 * \text{age}) * \text{stature}$ ; Female= $(21.78 - 0.101 * \text{age}) * \text{stature}$ ). Moreover, by comparing with these suspected cases, blood pressure and heart rate showed no relationship. However, many studies revealed that the Scoliosis may result in heart and lung problems due to decreased lung capacity(Park et al., 1990).

The results from the physiological measurements showed in Figure 10 that the lower breathing capacity of lung for those suspected Scoliosis cases. In Figure

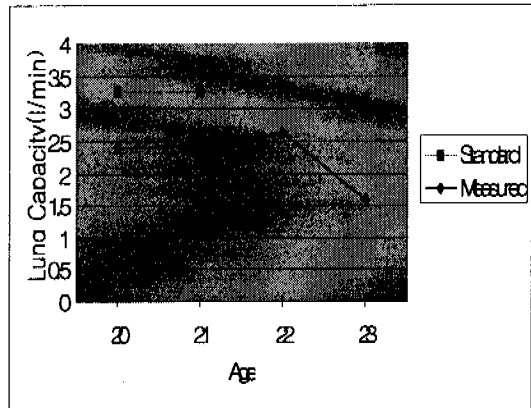
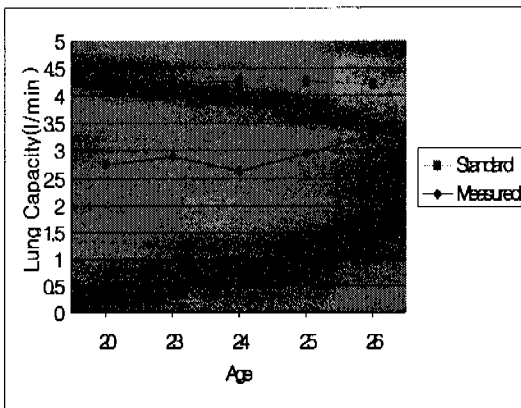


Figure 10. The Comparison between the Standard and Measured Breathing Capacity of the Subjects Having Scoliosis(Left: Male, Right: Female)

It is generally known that the Scoliosis may be caused by one of the following reasons :

1. It may be present at birth. This is called congenital Scoliosis. Studies suggest that if one or more parents have Scoliosis, the possibility of their child inheriting the disease greatly increase.
2. It may be caused by other diseases such as a paralytic or musculoskeletal disorder resulting from paralysis of the muscles due to polio, muscular dystrophy or cerebral palsy.
3. It may be caused from birth trauma.
4. The cause is unknown. This is called idiopathic Scoliosis and it accounts for the majority of cases.

An idiopathic disorder is the most common form and may have a genetic cause(Harrington, 1977; Daruwalla et al., 1985; Bunnell, 1986). Even though many factors examined in this study such as living habits, demographic factors, and physiological factors can affect developing Scoliosis, the exact causal factors are still not known. However, it must note here that the results of this study should not be ignored.

In addition, the diagnosis of Scoliosis can be easily done at home by observing asymmetry of the trunk or pelvis without using any equipment. A better guide to the extent of a Scoliosis can often be obtained by looking at a person from the front. In this view, the asymmetry of the body can be more readily detectable. This view may detect an abnormally shaped chest, or protuberance of some of the ribs on one side. The best way to look for a Scoliosis is to look at the back from behind as the person bends forward. It is then easy to see the curve as one side of the rib cage that will project more than the other.

The following useful tips can be used to diagnose Scoliosis(Calliet, 1975):

1. One shoulder may be higher than the other,
2. One scapula (shoulder blade) may be higher or more prominent than the other,
3. With the arms hanging loosely at the side, there may be more space between the arm and the body on one side,
4. One hip may appear to be higher or more prominent than the other,
5. The head is not centered over the

pelvis, and

6. When the person is examined from the rear and asked to bend forward until the spine is horizontal, one side of the back appears higher than the other side.

## 4. Conclusions

Based on the results of this study suggested that the Scoliosis in Korean college students should not be ignored. As we cannot prevent Scoliosis so far, it is quite logical and also important to detect Scoliosis at its earliest stage and to initiate an adequate treatment before it becomes serious. In order to detect Scoliosis at its earliest stage, it is important to have a simple routine screening tests that are demonstrated in this study. Further, for those who are suspected for Scoliosis from simple screening tests, physician's final review of X-ray films of the spine should be sought to make an accurate diagnosis.

The management of a Scoliosis is determined by the extent of the Scoliosis. A number of methods are used to decide upon the most appropriate treatment. Sometimes the only treat-

ment needed for Scoliosis is doing exercises that stretch the spine and strengthen the muscles of the trunk. In some cases, though, other treatments are necessary to prevent heart and lung problems or back pain later in life. These treatments include a back brace, surgery, or a combination of alternatives(Moon et al., 1991).

The results of this study have shown that the suspected cases for having Scoliosis were closely related to the postural behavior(i.e., sitting, sleeping) of the college students. Genaidy and Karwowski(1993) investigated that the discomfort associated with joint posture which deviated from the neutral position. Therefore, based on the ergonomics view point, it is essential to remember that keeping the posture of the spine neutral is the best method to prevent from the possibility of developing Scoliosis.

It should be noted here that the subjects who have negative result in this study should not be entirely excluded from future possibility of developing Scoliosis, as there always exists such possibility until their somatic growth stops. The Scoliosis screening is being done in schools across the United States and several other countries. Therefore, these sim-

ple screening tests should also be performed to Korean adolescence at least more than once a year so that many very early cases are detected that previously would have gone unnoticed until they were more advanced.

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