

CHAPTER IV

RESULTS

Twenty two adolescent females with AIS voluntarily participated in this study. They were aged between 11 and 18 years. None of them had back pain history within three months prior to the study. Their thoracic Cobb angles were ranged from 13° to 68°. According to SRS guidelines, they were divided into three groups: mild (n=8), moderate (n=8), and severe (n=6) group. Within 22 subjects, five of them had C-curve at thoracolumbar level and 14 of them had S-cure involving both thoracic and lumbar level or known as double major curve. Only three subjects had C-curve at thoracic level and their severity was stratified as moderate scoliosis (Table 1). There were no statistically significant differences on demographic data, cardiopulmonary variables, and 6 MWD among mild, moderate, and severe group.

Table 1. Demographic data

Variables	Total (N = 22)	Scoliosis severity			p-level
		Mild (n = 8)	Moderate (n = 8)	Severe (n = 6)	
Age (yrs.)	14.05±1.62	14.00±2.20	13.75±1.17	14.50±1.38	0.71
Weight (kg.)	42.85±6.29	43.23±6.58	41.71±5.47	43.87±7.76	0.82
Height (cm.)	153.89±7.67	155.75±7.50	154.59±6.75	150.48±9.19	0.44
Cobb angle (°)	36.64±14.69	22.50±5.63	36.25±5.18	56.00±7.38	0.00*
Scoliosis Diagnosis cases					
Thoracic curve	3	0	3	0	
Thoracolumbar curve	5	3	1	1	
Double major curve	14	5	4	5	

Note: Data were presented as mean ±SD.

* = Significant at $p < 0.05$

The ventilatory pump was indicated by flow volume loop, maximal voluntary ventilation, and respiratory muscle strength (see Table 2). There were no statistically significant differences in the ventilatory pump among mild, moderate, and severe group. All subjects had no restrictive and obstructive lung disease. The mean of 12-sec MVV of all subjects was 98.59 ± 18.83 L/min. This variable tended to decrease as the severity of scoliosis was advanced (mild = 103.75 ± 21.38 , moderate = 99.63 ± 17.65 , and severe = 90.33 ± 16.93 L/min, $p > 0.05$).

There were no statistically significant differences on MIP and MEP across the severity. The mean of MIP of all subjects was 71.86 ± 15.80 cmH₂O. MIP tended to decrease as the severity was increased (mild = 73.75 ± 21.98 , moderate = 71.50 ± 9.87 , and severe = 69.83 ± 15.00 cmH₂O, $p > 0.05$). However, MEP tended to increase when the AIS was advanced (mild = 82.38 ± 15.49 , moderate = 83.63 ± 16.73 , severe = 90.33 ± 15.71 cmH₂O, $p > 0.05$).

Table 2. Pulmonary variables in adolescent females with AIS

Variables	Total (N = 22)	Scoliosis severity			p-level
		Mild (n = 8)	Moderate (n = 8)	Severe (n = 6)	
pred FVC (%)	88.77±11.15	92.75±9.41	83.88±12.44	90.00±10.77	0.28
pred FEV ₁ (%)	77.36±8.67	81.50±7.41	73.75±8.51	76.67±9.34	0.20
FEV ₁ /FVC (%)	90.23±5.08	90.58±4.25	90.82±3.97	88.98±7.64	0.79
MVV (L/min)	98.59±18.83	103.75±21.38	99.63±17.65	90.33±16.93	0.43
MIP (cmH ₂ O)	71.86±15.80	73.75±21.98	71.50±9.87	69.83±15.00	0.91
MEP (cmH ₂ O)	85.00±15.61	82.38±15.49	83.63±16.73	90.33±15.71	0.63

Note: Data were presented as mean ± SD.

pred FVC, predicted forced vital capacity; pred FEV₁, predicted forced expiratory volume in 1 sec; FEV₁/FVC, the ratio of forced expiratory volume in 1 sec and forced vital capacity;

MVV, maximum voluntary ventilation; MIP, maximum inspiratory pressure; MEP, maximum expiratory pressure.

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Table 3 presented HR and BP during the 6 MWT. No significant differences were found on the cardiovascular variables and 6 MWD among mild, moderate, and severe group. The preHR and postHR were 91.32 ± 12.35 and 129.77 ± 17.17 bpm, respectively. The end test HR was 63 percent of predicted maximum heart rate (HR_{max}). During the test, the SBP was changed from 102.27 ± 11.42 to 121.55 ± 14.39 mmHg. Also, the DBP was increased from 69.64 ± 6.46 to 74.36 ± 11.36 mmHg. There were 13 out of 22 subjects (59.09 %) had rising DBP immediately after the test. The 6 MWD was 561.16 ± 46.34 m.

Table 3. Cardiovascular responses during 6 MWT

Variables	Total (N = 22)	Scoliosis severity			p-level
		Mild (n = 8)	Moderate (n = 8)	Severe (n = 6)	
preHR (bpm)	91.32±12.35	91.63±15.22	94.13±11.05	87.17±10.59	0.60
postHR (bpm)	129.77±17.17	125.75±21.08	132.50±16.34	131.50±16.73	0.74
preSBP (mmHg)	102.27±11.42	99.75±12.53	101.25±12.46	107.00±8.46	0.45
postSBP (mmHg)	121.55±14.39	121.75±11.78	115.50±17.13	129.33±11.57	0.21
preDBP (mmHg)	69.64±6.46	67.75±7.67	70.25±5.90	71.33±5.89	0.58
postDBP (mmHg)	74.36±11.36	76.75±15.42	71.25±8.35	75.33±9.27	0.63
6 MWD (m.)	561.16±46.34	570.12±29.19	547.67±43.41	567.21±68.74	0.61

Note: Data were presented as mean ±SD.

preHR, pre-test heart rate; postHR, post-test heart rate; preSBP, pre-test systolic blood pressure; postSBP, post-test systolic blood pressure; preDBP, pre-test diastolic blood pressure; postDBP, post-test diastolic blood pressure; 6 MWD, six minute walk distance.

The positive correlation between 6 MWD with MVV was found ($r = 0.49$, $p < 0.05$) (see Figure 3). Also, 6 MWD was negatively correlated with preDBP ($r = -0.397$, $p < 0.05$) (see Figure 4). There were no correlation among 6 MWD, demographic data (age, weight, and height), Cobb angle, the flow volume loop variables, and the respiratory muscle strength (Table 4).

Multiple linear regression was analyzed by using the demographic data, Cobb angle, pred FVC, pred FEV₁, FEV₁/ FVC, MVV, MIP, MEP, preHR, preSBP, and preDBP. There were four predicted equations for 6 MWD as following:

Equation 1:

$$6 \text{ MWD} = 422.237 + 1.206 \text{ MVV}$$

$$(r = 0.49, r^2 = 0.24, p < 0.05, \text{SEE} = 41.3926)$$

Equation 2:

$$6 \text{ MWD} = 447.351 + 1.401 \text{ MVV} - 3.508 \text{ preDBP}$$

$$(r = 0.688, r^2 = 0.473, p < 0.05, \text{SEE} = 35.3586)$$

Equation 3:

$$6 \text{ MWD} = 744.220 + 1.583 \text{ MVV} - 3.186 \text{ preDBP} - 1.284 \text{ preHR}$$

$$(r = 0.763, r^2 = 0.582, p < 0.05, \text{SEE} = 32.3673).$$

Equation 4:

$$6 \text{ MWD} = 734.762 + 1.889 \text{ MVV} - 4.112 \text{ preDBP} - 1.233 \text{ preHR} +$$

$$1.067 \text{ Cobb angle}$$

$$(r = 0.818, r^2 = 0.669, p < 0.05, \text{SEE} = 29.6328).$$

Table 4. The correlation between the Cobb angle, the cardiopulmonary variables and the 6 MWD

	Age (yr)	Weight (kg.)	Height (cm)	Tx-Cobb angle (degree)	FVC (l)	FEV1 (l)	pred FVC (%)	pred FEV1 (%)	FEV1/FVC (%)	MVV (l/min)	MIP (cm.H2O)	MEP (cm.H2O)	PreHR (bpm)	PostHR (bpm)	PreSBP (mm.Hg)	PostSBP (mm.Hg)	PreDBP (mm.Hg)	PostDBP (mm.Hg)	6 MWD (m.)		
Age (yr)	1.000	.033 .442	.084 .355	.117 .302	-.005 .492	-.064 .388	-.108 .317	-.188 .201	-.135 .275	-.203 .183	-.368* .046	-.345 .058	-.225 .157	-.088 .349	-.310 .080	-.062 .392	-.099 .351	-.058 .359	-.103 .325		
Weight (kg.)		1.000	.278 .106	.101 .328	.465* .015	-.275 .108	-.212 .171	.037 .436	-.487* .011	-.221 .161	.247 .134	-.037 .435	.083 .357	-.107 .374	-.240 .106	-.042 .141	-.136 .426	-.136 .426	-.136 .426	-.136 .426	
Height (cm.)			1.000	.217 .166	.562* .003	-.574* .003	-.473* .013	-.407* .030	-.082 .358	-.183 .207	-.305 .084	-.395* .033	-.161 .237	-.114 .307	-.035 .439	-.049 .235	-.327 .069	-.162 .235	-.163 .234	-.163 .234	
Tx-Cobb angle (degree)				1.000	-.310 .080	-.387* .038	-.107 .318	-.188 .201	-.081 .361	-.315 .076	-.182 .209	-.182 .209	-.084 .353	-.064 .335	-.235 .077	-.235 .076	-.316 .368	-.076 .368	-.076 .368	-.076 .368	
FVC (l)					1.000	.910* .000	.455* .017	.423* .025	-.376* .042	.360* .050	.038 .434	-.099 .330	-.237 .145	-.046 .419	-.381* .171	-.038 .040	-.488* .450	-.010 .010	-.010 .010	-.010 .010	
FEV1 (l)						1.000	.338 .062	.506* .008	.039 .432	.548* .004	.045 .421	-.063 .390	-.159 .239	-.137 .271	-.278 .165	-.056 .106	-.462* .402	-.189 .015	-.189 .015	-.189 .015	
pred FVC (%)							1.000	.882* .000	-.327 .068	.149 .254	.391* .036	.345 .058	-.030 .447	-.046 .420	-.359 .091	-.295 .054	-.334 .323	-.295 .054	-.334 .323	-.334 .323	
pred FEV1 (%)								1.000	.121 .296	.392* .035	.380* .040	.414* .028	-.029 .449	-.094 .338	-.276 .107	-.238 .143	-.295 .091	-.374* .495	-.003 .495	-.003 .495	
FEV1/FVC (%)									1.000	.350 .055	.015 .474	-.093 .341	-.238 .191	-.196 .191	-.270 .112	-.058 .257	-.147 .126	-.058 .257	-.147 .126	-.147 .126	
MVV (l/min)										1.000	.206 .179	-.080 .362	.237 .144	.276 .106	.286 .098	.162 .236	.217 .166	.450* .150	.217 .166	.450* .150	.450* .150
MIP (cm.H2O)											1.000	.502* .009	-.270 .113	-.015 .474	-.020 .466	-.020 .466	-.127 .139	-.242 .124	-.257 .124	-.257 .124	
MEP (cm.H2O)												1.000	-.058 .400	-.057 .474	-.006 .399	-.325 .166	-.257 .166	-.257 .166	-.257 .166	-.257 .166	
pre HR (bpm)													1.000	.615* .001	.608* .001	.449 .001	.498 .001	.498 .001	.498 .001	.498 .001	
post HR (bpm)														1.000	.660* .000	.608* .000	.449 .000	.498 .000	.498 .000	.498 .000	
pre SBP (mm.Hg)															1.000	.452 .131	.452 .131	.452 .131	.452 .131	.452 .131	
post SBP (mm.Hg)																1.000	.452 .131	.452 .131	.452 .131	.452 .131	
pre DBP (mm.Hg)																	1.000	.280 .005	.280 .005	.280 .005	
post DBP (mm.Hg)																		1.000	.280 .005	.280 .005	
6 MWD (m.)																			1.000	1.000	

*. Correlation is significant at the 0.05 level (1-tailed).

Note: pred FVC, predicted forced vital capacity; pred FEV1, predicted forced expiratory volume in 1 sec; FEV1/FVC, the ratio of forced expiratory volume in 1 sec and forced vital capacity; MVV, maximum voluntary ventilation; MIP, maximum inspiratory pressure; MEP, maximum expiratory pressure; preHR, pre-test heart rate; postHR, post-test heart rate; preSBP, pre-test systolic blood pressure; postSBP, post-test systolic blood pressure; preDBP, pre-test diastolic blood pressure; postDBP, post-test diastolic blood pressure; 6 MWD, six minute walk distance.

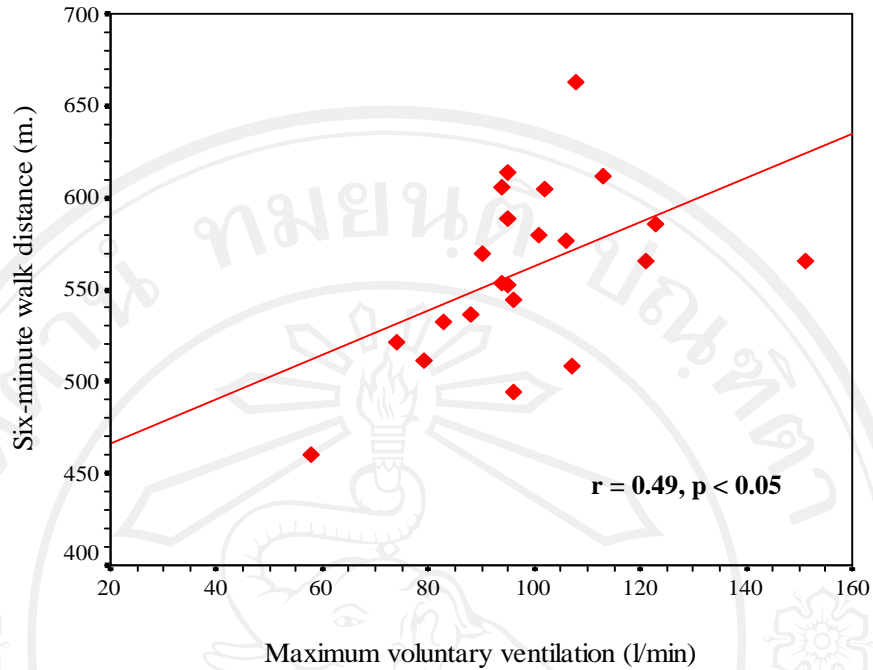


Figure 3. Relationship between 6 –minute walk distance and maximum voluntary ventilation in scoliosis subjects (N=22)

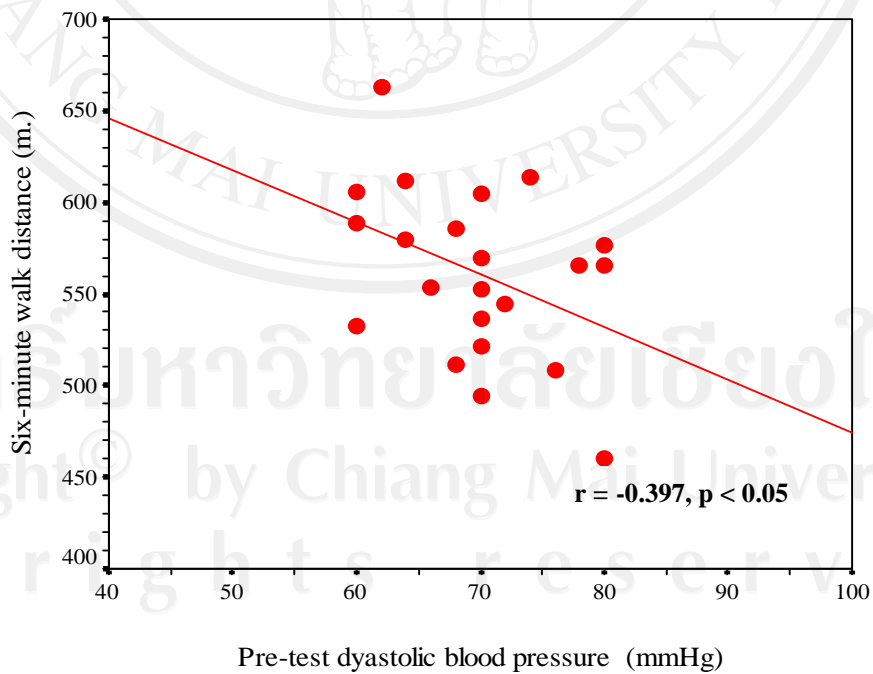


Figure 4. Relationship between 6-minute walk distance and pre-test diastolic blood pressure in scoliosis subjects (N=22)