

Effect of Therapeutic Exercise on Scoliosis Deviation and Some Biological Variables for Diabetic Children

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Abstract: The purpose of this study was to create a proposed program of therapeutic exercises and to examine its effect on posture variables of scoliosis deviations (chest side bending angle - lumbar side bending angle-shoulder inclination level angle, difference between level of the shoulders and pelvis inclination level angle), strength of back and abdominal muscles, range of motion for working muscles on the vertebral column and some biological variables (pulse rate, respiratory rate, vital capacity, the level of blood glucose) for research children (9-12) years with diabetics and non-diabetics. The study has been conducted on a sample of (30) of female children who were divided into two groups, first group (n = 15) of scoliosis deviation treated with insulin (diabetics) and second one (n=15) of scoliosis deviation of non diabetics or any organic disease or problems. Experimental approach was used of a pre and post measures on both groups. There are statistically significant differences in the study variables between the two groups of pre and post measurement for dimensional measurement and the results of the experimental group (1) was better. The proposed program of therapeutic exercises has a positive effect on the tow groups.

Key words: Vertebral column • Scoliosis • Diabetic children • Therapeutic Exercise • Biological variables

INTRODUCTION

Depending on the importance of upright posture of the human being, where now the interest not only for posture deviations, but also for all upright body and how to protect it, so many examinations should be conducted for children annually at early age to detect the deviations of, so as not to become a difficult problem later [1,2]. The Vertebral column is the central core of the body and the common factor in all daily movements for the people . it is the front and rear level consists of three curves (cervical - thoracic – lumbar) which form the anatomical structure that the upright body very much depends on and to achieve the required balance for the human body by the equivalent torques of opposite curves, which allow to maintain the center of gravity (c.g) in the mid-base balance [3]. Not only the increasing or decreasing of the natural curvatures of the vertebral column that causes deviations of natural body position and loses the body its balance, but also the Vertebral column may be deviated as a whole, or in some vertebral a way of the mid line of the body causing side bending to the Vertebral scoliosis "

This side pending may be occurred to one side accompanied with a rotation of vertebral to the lowest part in pressure (convex side) [4].

Scoliosis is initially simple similar to (C) shaped to the right or left depending on the cause of the problem . As a result of change in the soft tissues (muscles and ligaments) and the tension range of anti - muscles some sequences are occurred in advanced cases in up and down of original curvature. Hence,the vertebral scoliosis becomes complex similar to correct or opposite (S) shaped. Also, rib cage form may be changed, warped and shortened to convex side,where respiratory and digestive processes are affected. Also, some changes might be occurred in spinal cord,heart and lung. So,it would be dangerous to neglect inclined shoulders without treatment [5,6]. Diabetes is affected by the limited range of motion to joints and the lack of movements and also, on collagen - building and consequently the children activity is reduced, reflecting on their efficiency in moving and limiting of joints as a result of lack of Insulin which affects on collagen formation (which plays,an active role in bone mineralization of connective tissues. Also,diabetes leads

to much complications, including serious defect in the meta-bolism of carbohydrates, protein and loss of balance between water and salts [7, 8].

Diabetes means " high level of glucose in blood" and one of the most important causes of this disease is the lack of the ratio between the insulin hormone and anti-insulin hormones, where the portion of glucose level is natural in blood by existence between action of insulin hormone and anti-insulin hormones. These anti-hormones are: Glucagon, Adrenaline and ClucoCorticoid and growth hormone and Thyroxin, where the action of the insulin hormone leads to reduce sugar level in blood, meanwhile anti-hormones lead to high level sugar in blood . Hence, it should be a balance between of two actions for natural sugar, which ranges from 60-110 mg / dl [9]. Sports have many benefits to diabetics, but before practicing any physical program diabetics should be examined carefully by a specialized physician for body in general and for heart in particular to be sure of the heart's ability to with - stand the sudden change of practicing sports that heart might face at any kind sports, this process would help to burn and use the sugar and thereby reduction of sugar level in blood, not only after practicing exercise, but also for the long time. [10, 11].

The old staged (9-12) is considered the beginning of a critical stage, so long as the scoliosis deviation is existed and therefore it would be difficult to be treated, in addition to the great spread of this deviation in this stage.

Research Aims: Identify "the effect of the suggested therapeutic exercise program on posture variables of scoliosis deviations (chest side bending angle - lumber side bending angle- shoulder inclination level angle, difference between level of the shoulders and pelvis inclination level angle), strength of back and abdominal muscles, range of motion for working muscles on the vertebral column and some biological variables (pulse rate, respiratory rate, vital capacity, the level of blood glucose) for research children (9-12) years with diabetics and non-diabetics."

Research Procedures

Method: Experimental method for two experim-ental group design was used.

Participants: It was selected purposively from old stage (9-12) years of simple scoliosis of one curved (C) shaped of chest convexity and left lumber (right body inclination). Participants included (30) of female children who were divided into two groups, first group (n =15) of scoliosis deviation treated with insulin (diabetics) and second one (n =15) of scoliosis deviation without diabetics or any organic disease and problems . It was noted that the whole research sample free from any other deviations, glucose level was measured three times a day, to modify the dose of insulin according to results of the analysis, under the supervision of a doctor.

The First Pilot Study: The Participants was determined by previous conditions and by conducting the following initial posture measurements that experts and researchers agreed : Bank raft scale -Screen posture test (Panel squares).And also detecting Adam's Position.

- (Hanging position), if the scoliosis is disappeared in this position, it indicates to first degree deviation and if not disappeared, it would be of second degree.
- Forward trunk inclination with hands on knees, where prominence next to back up to Convex arc of the third degree, this prominence occurs as a result of scapula rotation to this side in addition to prominence of thorax to convex arc which are observable and apparent [12, 13]. The sample was determined by health insurance unit, connecting with parents and medical examination, also there is no Significant differences between two groups of par measurements to all research variables, where it means that two groups are equivalent.

Research Variables

Measurements and Collection of Data Tools:

- According to the views of scientists and researchers [13-15].
- Metal anthropometer to measure height of body and weight scale for the weight.
- Bank raft scale, Screen posture:
- Genometer : to measure the angles.
- Scoliometer Sabia: to measure shoulder in height level and difference between shoulders height levels and also the level of pelvic inclination (degrees).

Table 1: Description of the research sample

Variables	Experimental group(1) (n=15)		Experimental group (2) (n=15)	
	M	SD	M	SD
Age (year)	10.1	1.84	10.47	1.04
Body height (m)	130.07	6.34	129.13	6.41
Weight (kg)	34.27	5.28	31.8	2.68

- Polar CIC Inc : to measure heart rate (C/m).
- Dry Spiro meter: to measure the vital capacity(mL)
- Measure the rate of respiration (per /minute).
- Dynamometer: to measure the strength of back muscles and Sit up test:to measure the strength of abdominal muscles.
- Measuring range of motion test on three axes of vertebral column.
- Measuring analysis of blood glucose- using commercial kits (mg/dl).

The Proposed Program

Aims: The proposed program of therapeutic exercise aims to rehabilitating the working muscles on both sides of vertebral column, developing strength and range of motion and to promote some biological variables for children (9-12) years of simple scoliosis deviation with diabetes and non-diabetics.

Program Content: The proposed program included (36) training units for (12) weeks, where each unit included:

- Warm-up (5 m)
- The main part (50-70 m)
- Final exercises (5 m): relaxation-Where each unit included (12-20) exercises.

Standardization Load of Proposed Program:

Therapeutic exercises program consisted of three stages, where first stage (3 weeks) with intensity of (60 %) to maximum repetitions for each exercises, the second stage (4 weeks) started with intensity of (70 %) to maximum repetitions of at end of first stage and the third stage (5 weeks) started with intensity of (90 %) to maximum repetitions OF at end of second stage.

The Second Pilot Study: It was conducted on sample of (10) children, to make sure of the property of exercises for the sample level.

Program Application: From 23/5/2009 to 12/8/2009

Statistical Treatments: (mean,standard deviation, Wilcoxon, Mann - Whitney test and percentages).

RESULTS AND DISCUSSION

Results presented in Table 2 indicated that the first group for children with diabetes were significant differences between pre and post measurements for post measurements to research variables. The researcher referred the significant to effectiveness of proposed training therapeutic exercises program.

Table 2: Wilcoxon test of significant differences between pre and post measurements of first experimental group (n = 15)

No	Variables	Measurement	Mean Ranks	Difference			N	Variables	Measurement	Mean Ranks	Difference			Z
				±	N	Z					±	N	Z	
1	Thorax angle (degree)	Pre	8.39	-	14	*	10	Strength of abdominal muscles(kg)	Pre	8.17	-	3	*	
		Post	2.5	=	1	2.5			-	+	11	24.5		
2	Lumber Angle (degree)	Pre	7.25	-	12	*	11	Trunk bending forwar (Cm)	Pre	2	-	1	*	
		Post	4	=	1	4			-	+	13	2		
3	Inclination of shoulder angle (degree)	Pre	6	-	11	*	12	Trunk bending Backward (Cm)	Pre	0	-	0	*	
		Post	0	=	4	-			-	+	15	0		
4	Differences of Shoulder height (Cm)	Pre	8.85	-	13	*	13	Trunk bending to right side (Cm)	Pre	7.17	-	3	*	
		Post	2.5	=	2	5			-	+	10	12.5		
5	Pelvis angle (degree)	Pre	8.08	-	13	*	14	Trunk bending to left side (Cm)	Pre	4	-	2	*	
		Post	7.5	=	2	15			-	+	8	8		
6	Respiratory Rate (per /minute)	Pre	8.91	-	11	*	15	Trunk rotation to right (Cm)	Pre	5.88	=	5	*	
		Post	2.33	=	3	7			-	+	12	0		
7	heart rate (C / m)	Pre	8	-	15	*	16	Trunk rotation to left (Cm)	Pre	6.5	-	0	*	
		Post	0	=	0	-			-	+	4	0		
8	Vital capacity (ml)	Pre	3.5	-	3	*	17	Glucose blood level (mg / dl)	Pre	5	-	10	20	
		Post	9.13	=	12	10.5			-	+	1	-		
9	Strength of back muscles (kg)	Pre	3.5	-	3	*	-	-	Pre	8	-	15	*	
		Post	8.59	=	11	10.5			-	+	0	0		

* Note : all variables are significant where : (Z) Table value (0.05) = 25

Table 3: Wilcoxon test of significant differences between pre and post measurements of second experimental group (n = 15)

No	Variables	Measurement	Mean Ranks	Difference			N	Variables	Measurement	Mean Ranks	Difference			Z
				±	N	Z					±	N	Z	
1	Thorax angle (degree)	Pre	8.46	-	14	*	10	Strength of abdominal muscles(kg)	Pre	3.67	-	3	*	
		-	-	+	1	1.5			-	+	11	11		
		Post	1.5	=	0	-			Post	8.55	=	1	-	
2	Lumber Angle (degree)	Pre	7.88	-	13	*	11	Trunk bending forwar (Cm)	Pre	1	-	1	*	
		-	-	+	1	2.5			-	+	14	1		
3	Inclination of Shoulder angle (degree)	Pre	8.07	-	15	*	12	Trunk bending Backward (Cm)	Pre	5.33	-	3	*	
		-	-	+	0	0			-	+	12	16		
4	Differences of Shoulder height (Cm)	Pre	7.5	-	15	*	13	Trunk bending To right side (Cm)	Pre	0	-	0	*	
		-	-	+	0	0			-	+	14	0		
5	Pelvis angle (degree)	Pre	8	-	15	*	14	Trunk bending to left side (Cm)	Pre	2.5	-	2	*	
		-	-	+	0	0			-	+	11	5		
6	Respiratory Rate (per /minute)	Pre	7.5	-	14	*	15	Trunk rotation to right (Cm)	Pre	0	-	0	*	
		-	-	+	0	0			-	+	14	0		
7	heart rate (C / m)	Pre	8	-	15	*	16	Trunk rotation to left (Cm)	Pre	3.5	-	4	*	
		-	-	+	0	0			-	+	11	14		
8	Vital capacity (ml)	Pre	0	-	0	*	17	Glucose blood level (mg / dL)	Pre	3.5	-	0	*	
		-	-	+	14	0			-	+	14	0		
9	Strength of back muscles (kg)	Pre	5.67	-	3	*	-	-	-	-	-	-	-	
		-	-	+	11	17	-	-	-	-	-	-	-	
		Post	8.58	=	1	-	-	-	-	-	-	-	-	

* Note : all variables are significant where :(Z) Table value (0.05) = 25

Table 4: Significant differences between the two groups in post measurements by Man-Whitney non parametric test (n1=n2 = 15)

No	Variables	Groups	Rank		U	Sig.	N	Variables	Groups	Rank		U	Sig.
			Average							Average			
1	Thorax angle (degree)	First	18.33	-1.76	NS	10	Strength of abdominal muscles (kg)	First	14.8	-0.43	NS		
			Second	12.67					16.2				
2	Lumber angle (degree)	First	17.8	-1.43	NS	11	Trunk bending forward (Cm)	First	11.63	-2.4	S		
			Second	13.02					19.37				
3	Inclination of shoulder angle (degree)	First	20.7	-3.23	S	12	Trunk bending backward (Cm)	First	10.96	-2.82	S		
			Second	10.3					20.03				
4	Differences of shoulder height (Cm)	First	19	-2.17	S	13	Trunk bending to right side (Cm)	First	10.43	-3.15	S		
			Second	12					20.56				
5	Pelvis angle (degree)	First	21.7	-3.85	S	14	Trunk bending to left side (Cm)	First	11.6	-2.57	S		
			Second	9.3					19.93				
6	Respiratory rate(per/minute)	First	19.63	-2.57	S	15	Trunk rotation to right (Cm)	First	8.46	-4.37	S		
			Second	11.37					22.53				
7	heart rate (c/m)	First	16.23	-0.45	NS	16	Trunk rotation to left (Cm)	First	9.16	-3.94	S		
			Second	14.77					21.83				
8	Vital capacity (ml)	First	12.63	-1.78	NS	17	Glucose blood level (mg /d L)	First	24.16	-3.94	S		
			Second	18.36					21.83				
9	Strength of back muscles (kg)	First	12.67	-	NS			--					
			Second	18.33									

S = significant NS = non- significant

(U) table value (0.05) = ± (1.96)

Table 5: Percentage of improvement between two experimental groups (1) and (2) of research variables (n1= n2 = 15)

No.	Variables	Experimental group (1)			Experimental group (2)			Diff %	For
		Pre	Post	%	Pre	Post	%		
1	Thorax angle (degree)	8.06	6.1	24.32	8.47	5.1	39.79	15.47	Exp. group(2)
2	Lumber angle (degree)	4.67	3.2	31.5	4.47	2.6	41.83	1.33	Exp. group(2)
3	Inclination of shoulder angle(degree)	6.4	4.7	26.6	6.73	3.4	49.48	22.87	Exp. group(2)
4	Differences of shoulder height(Cm)	1.8	1.12	37.7	1.75	0.92	74.43	9.73	Exp. group(2)
5	Pelvis angle (degree)	5.7	3.6	36.8	5.53	2.5	54.79	17.9	Exp. group(2)
6	Respiratory rate (per /minute)	20.2	17.4	13.9	19.67	15.3	22.22	8.3	Exp. group(2)
7	heart rate(c/ m)	112.67	89.3	12.8	110.8	86.9	21.57	8.9	Exp. group(2)
8	Vital capacity (ml)	1803.33	2033	12.74	1901.33	2155	13.34	0.6	Exp. group(2)
9	Strength of back muscles(kg)	11.2	13.3	18.75	11.6	14.5	25	6.25	Exp. group(2)
10	Strength of abdominal muscles (kg)	9.8	12.3	25.5	10.27	13.3	29.5	4	Exp. group(2)
11	Trunk bending forward (Cm)	-4.4	1.2	109.1	-4.07	5.1	219.4	110.3	Exp. group(2)
12	Trunk bending backward (Cm)	8.3	9.7	16.87	8.53	1.03	44.2	27.33	Exp. group(2)
13	Trunk bending to right side (Cm)	6.07	9.1	49.9	7.87	13.5	71.5	21.7	Exp. group(2)
14	Trunk bending to left side (Cm)	4.2	4.8	14.29	4.53	7.5	65.56	51.27	Exp. group(2)
15	Trunk rotation to right (Cm)	9.7	12.13	25.1	10	16.1	61	35.7	Exp. group(2)
16	Trunk rotation to left (Cm)	7.6	8.8	15.79	7.8	10.9	40.9	25.1	Exp. group(2)
17	Glucose blood level (mg /d L)	197.52	156.33	20.85	91.43	85.28	6.73	14.12	Exp. group(1)

This is consistent with what was noted by Calliet [10]and Boule *et al.* [16] that sports exercises help diabetics in reduction of sugar level in blood and also in increasing the strength, flexibility and range of motion to working muscles on vertebral column and led to treatment of diabetic children with scoliosis and also to raise the body's ability to fight disease and add sense of vitality and activity, added to increasing the efficiency of card respiratory system and improving the metabolism. Table 3 illustrated the second group of children of scoliosis, it is evident that these were significant differences between pre and post measurements for all research variables.

The researcher referred that to effectiveness of training impacts of proposed therapeutic exercises program, as well as to used method in standardization of load training program (intensity and rest of interval periods). So, the response of the vital body organs to program contents is considered true reflection to additional burden of program contents, in addition to the involvement of research sample in regular training. Table 4 indicated that the comparison between both groups of post measurements. The results showed that there was no statistical significance in measuring thoracic scoliosis and lumber scoliosis angle, where it seems that equivalent improving on both groups which led to no significance between them. Meanwhile, there were statistical significance to measurements of should height level inclination angle difference between shoulder height level and in pelvis level angle, where the active working muscles around shoulders are affected and as a result of this, shoulder level height is inclined and may

one shoulder would be lower than other. As shown in Table 5 it is obvious that the degrees of shoulders inclination angle or pelvic obliquity are high. Also, the difference between shoulder level height of two groups (between pre and post measurements) is considered of obvious difference compared with the second group of post measurement. Also, the table shows that the inclination of shoulder is clear more than pelvic level, where simple scoliosis on one side, gradually leads to synchronized rotation of vertebra to spinal curvature of the convex side and then the functional bending is gradually to structure formation. The rotation of vertebra may be mild (in the middle), but the fixed ribs in thoracic vertebra are affected and becomes clear circular deformities. In view of many researchers indicated that scoliosis is the most common deviation which widely spreads among girls more than boys, where the rate is almost one male against six of females who are deviated by simple scoliosis which ofte starts to occur in one side(deviation) and when person is trying to keep on or maintain his body position in balance, the other side is affected by leaning to opposite direction and complex scoliosis of correct or opposite(s)shaped is occurred [17]. Also, Table 4 indicated that the measurements of static muscles of two groups in pre measurement of strength of back and abdominal muscles, and range of motion to working (active) muscles of vertebral column, where there were no significant differences between post measurements in back and abdominal muscles strength of two groups. The researcher referred that to impact of proposed therapeutic exercises program which applied on both groups.

Table 5 showed that the rates of improvement of maximum strength, whose there were significant differences between post and pre measurements for both groups and for pre measurement to strength of back and abdominal muscles, but the improvement was better to non-diabetic children group. That is consistent with Shinabarger [7] who pointed that the lack of general activity and muscular endurance dues to the change of enzymes activity and metabolism of carbohydrates, fats and protein. Also, the lowest improvement of diabetic group may be interpreted to defect of collagen formation, which affects seriously in reduction of children activity and reflects on their efficiency in moving their joints. The researcher referred this improvement to the proposed therapeutic exercises program which included stretching, flexibility and strength exercise, which led to developing these abilities.

Table 5 also indicated that there was improvement in measurements of range of motion to working active muscles of vertebral column of both groups and for second group with significant differences on three axes. The researcher referred this improvement to the loss of natural flexibility of vertebral column in side bending "scoliosis" of children in general and on diabetics in particular to more degree, where results indicated that the reduction of averages were significantly for diabetics children. That defect is occurred as a results of non-similarity of muscles of both sides because of lateral scoliosis, where muscles become short and stiffened especially for diabetics. Also, ligaments are long in side (convexity), and become short in another one (concavity) these reasons cause significant difference in range of motion of vertebral column of right and left sides [18]. Also Table 5 indicated that range of motion of the vertebral column is affected by deviation, which by sequence led to improvement for second experimental group, where the vertebral column loses some degrees of flexibility as a results of defect of discs that acquire natural flexibility to the vertebral column, hence, it would be a reduction of movements in this region.

These sequences referred to defect of working muscles that act according to opposite direction, where as a set of muscles shrink, the other ones should relax and that what exactly happen in wrong continuous position on both sides of the body causing scoliosis [4,19]. Also, Table 5 showed percentage rate of improvements were for both groups before and after program, but it was lower to diabetics. The researcher referred that to response of no-diabetic group, because of applying the proposed exercises program, and also because of lack of insulin that affects on collagen of

connective tissues. Also, results point out that improvement of flexibility (range of motion) of the vertebral column to both groups after applying therapeutic exercises program. These results are consistent with studies of Calliet [10], Stone and Beekman [20] and Casella and Hall [21], who indicated that strength and flexibility exercises of back and abdominal muscles is reduced because of increasing of side bending "scoliosis" of vertebral column to diabetic children.

Table 4 illustrated the comparison between research group in post measurements to some biological variables, there was statistical significance for respiratory rate for second experimental group, meanwhile there was no statistical significance for pulse rate and vital capacity, meanwhile Table 5 showed an increase for both groups and the improvement percentage to biological variables which was for second group in post measurement. The researcher referred this improvement to the obligation of research sample with training program and by sequence, there were no differences between them in these variables. And there were also significant in the measurement of Glucose blood level in both groups. Also, Table 5 showed percentage rate of improvements were for both groups before and after program, but it was more to diabetics and it is consistent with studies of Costil and Cleary [11] and Boule *et al.* [16] who indicated that the reduction of blood glucose level dues to the impact of physical exercises which led to increasing enzymes activity which affects on formation of carbohydrates, fats and protein. The exercise-training program improved whole-body insulin sensitivity and whole-body non oxidative glucose metabolism in children.

The most striking finding was that exercise training resulted in a twofold increase in insulin-stimulated muscle glycogen synthesis in both groups. Because exercise, Therapeutic that improve the action of insulin. In this regard and found that physical training increased insulin sensitivity and exercise has the additional advantages of improving skeletal muscle, cardiovascular and respiratory performance and averting the possible side effects of long-term drug therapy.

CONCLUSION

- Spreading of simple scoliosis to children of (9-12) years.
- Effectiveness of proposed therapeutic exercises program on research variables, where it improved:
- Degrees of deviations of thoracic, lumber, shoulder inclination angles and the difference between shoulder level (height).

- Maximum strength for both back and abdominal muscles.
- Range of motion to working muscles of the vertebral column.
- Some biological variables of research.
- Reduction and improvement of blood glucose level to diabetic children.

RECOMMENDATION

- Applying the proposed therapeutic exercises program for treatment of scoliosis, especially for diabetic children.
- Conducting regular medical examinations, posture, biological and physical tests on children. 3- Conducting similar researchers on other old stages.
- Providing the appropriate healthy school environment in kindergartens and primary schools. 5- Spreading the posture, physical and healthy awareness among children and urging them to practice sports activity .

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