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The effects of Pilates on metabolic control and physical performance in adolescents with type 1 diabetes mellitus☆

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ABSTRACT

Physical activity is a substantial method in the management of children and adolescents with Type 1 diabetes mellitus but it is not considered as a treatment for diabetes. The aim of this study was to investigate the effects of Pilates exercises on metabolic control and physical performance in patients with type 1 diabetes mellitus. Thirty one sedentary patients with type 1 diabetes mellitus, ranging in age from 12 to 17 (experimental group, $n=17$ and control group, $n=14$) were submitted to 12 weeks of Pilates training. Participants underwent tests to determine the physical performance and metabolic control before and after 12 weeks of Pilates session. At the end of study, there were significant alterations in physical performance of the study group. Peak power, mean power, vertical jump and flexibility of study group increased. There were no alterations for this parameters in the control group. There was no significant difference for glycated hemoglobin (HbA1c) in both groups. Conclusions: Physical performance increased via Pilates exercises in the patients with type 1 DM. However there were no changes in metabolic control. In the present study, the positive effects of exercise on metabolic control could not be shown in patients with Type 1 DM.

1. Introduction

Exercise is generally recommended for individuals with type 1 diabetes for the same reasons as the rest of the population. Regular physical activity has been associated with weight control, increased lean mass, improved blood lipid profile, reduced cardiovascular risk and improved sense of well being. The benefits for children with diabetes may also include blood glucose control and enhanced insulin sensitivity. For some people participation in physical exercise is somewhat sporadic and related to leisure, school or work. For others, daily exercise is part of an overall training or conditioning program (Hanas et al., 2009). Among diabetic adolescents physical activity levels are particularly low. There is a need to find innovative ways to increase their physical activity. It seems likely that diabetic patients will participate more frequently in activities that they enjoy.

The effects of exercise on metabolic control are controversial. Some investigators denote that there is a limited effect of exercise on HbA1c levels (Ligtenberg et al., 1999; Roberts, Jones, & Fournier, 2002). Conversely, some studies showed positive correlation between physical activity and better metabolic control (Bernardini et al., 2004; Herbst et al., 2006). Diabetic patients, before starting exercise sessions, must be carefully educated about the effects of physical activity on their blood glucose, alteration of dietary regimen and insulin therapy (De Feo et al., 2006).

Pilates was developed by Joseph Pilates in the early of 1900s. Controlled speed, emphasizing quality and precision of movement, is the key point of this exercise model. Pilates focuses on improvement of strength and flexibility. Exercise repetitions rarely exceed 10, with resistance usually in the form of body weight or springs (Keays et al., 2008; Kloubec, 2010). Pilates is used medically in patients who have back and waist pain and also for improvement of strength and rehabilitation of athletes (Donzelli et al., 2006; Khan et al., 1995). Pilates is an exercise method that is easy to practice at home by the help of visual devices (CD player, computer etc) or short education. No study so far has assessed whether diabetic adolescents like to engage in Pilates or if participation in Pilates has positive effects on their body mass, metabolic control and exercise capacity. Pilates is not a typical aerobic exercise. Nevertheless, Pilates exercise enhances the energy expenditure and changes the cellular metabolism like all exercise models. The positive effects of Pilates on body composition and physical performance level have been reported in healthy people (Kloubec, 2010; Jago et al., 2006).

The aim of this study was to determine the effect of 12 week Pilates training on anthropometric measurements, metabolic control and exercise capacity in patients with type 1 diabetes mellitus.

2. Methods

A three month, single center, open, randomized clinical trial in type 1 diabetes patients was conducted. The study protocol was

☆ Conflict of Interest: None.

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approved by the ethics committee of the Dokuz Eylul University Medical Faculty. Written informed consent was obtained from the parents or from participants old enough.

A total of 31 type 1 diabetic children were recruited from three hospitals within Izmir, Turkey in spring. One site was randomly assigned to intervention (group I) ($n=17$) and the others to control (group II) ($n=14$). A questionnaire (International Physical Activity Questionnaire) was given to determine the weekly exercise time of both groups.

Mat based Pilates classes were offered 3 days/week for 12 weeks at the intervention site. Each class was scheduled to last for 45 min and was led by a certified Pilates instructor. Control group participants engaged in their usual activities. Control and study groups underwent metabolic control and physical performance tests before and after the training period. All measurements of both of the groups were recorded at baseline and immediately after the study. Glucose levels were checked at least 8 times/day with Accu check go glucose meter (Roche Diagnostics GmbH, Mannheim) that was provided by the study to both of the groups. Either short-acting insulin or oral carbohydrate was given if indicated, in order to titrate the blood glucose prior to exercise and physical performance tests between 100 mg/dl and 200 mg/dl. The participants with 80–100 mg/dl blood glucose level consumed 15 g carbohydrate supplements before the session. If the blood glucose level was <80 mg/dl, participants consumed 15–30 g carbohydrate supplements. The session was delayed 15–20 min for the participants whose blood glucose levels were not in the target range. Participants with pre-exercise self-monitored blood glucose levels higher than 200 mg/dl, had their urine examined for the presence of ketones, and if positive, the exercise session was canceled. In the pump users the insulin pump was turned off at the beginning of the exercise session.

HbA1c was measured by a spectrophotometric method on venous specimens. Total cholesterol, HDL, LDL and triglyceride levels were measured by Beckman Coulter, Synchron CX9 auto analyzer. In addition, all participants recorded their daily insulin doses. Daily insulin doses (DID) were calculated per kilogram of body weight (units/kg/day).

Height was measured without shoes with a wall mounted Harpenden stadiometer. Weight was measured without shoes on a standard balance nearest to 100 g. BMI SDS was calculated.

To assess the physical performance level of the participants, sit and reach flexibility test, vertical jump test and modified Wingate test were performed before and after 12 weeks of Pilates training period. A pediatric endocrinologist was in the laboratory during physical performance tests to supervise and manage the tests.

Flexibility was evaluated by the sit-and-reach trunk forward flexion test. After two consecutive trials, the best score was recorded (Artioli et al., 2009).

All participants applied modified Wingate anaerobic test, which is a 30-s all-out test at maximal speed against resistance on a cycle ergometer. In this test, cycle sprint was limited to 10 s because of the hypoglycemia risk. Resistance was determined as 75 g/kg. The power generated during 10 s was called “mean power”. The highest power reached within 10 s was called “peak power” (Van Brussel, Lelieveld, & Van Der Net, 2007).

The squat jump was performed on a platform specifically designed for this test (Takei, Japan). The vertical jump score was the highest jump of two consecutive trials. A short recovery time (60 s) was allowed for each jump (Artioli et al., 2009).

The study group exercised three times a week for 12 weeks. Every training session lasted for 40 min. Pilates period was planned and conducted by an expert Pilates trainer. Training sessions included 8 Pilates exercises. Participants performed three sets of 6–10 repetitions with 30 s active rest (stretching) for each Pilates exercise. In the first and last 5 min of training sessions, stretching exercise was done for warm-up and cool-down. A pediatric endocrinologist was at the gym during the training sessions for medical intervention in case of hypoglycemia.

All data are presented as means and ± SD. Wilcoxon Signed Rank(s) Test was used to evaluate the differences within one group. “SPSS 11.0 for Windows” was used for statistically analysis.

3. Results

The intervention group consisted of 11 female and 6 male diabetic patients with a mean age of 14.2 ± 2.2 years. The control group consisted of 5 female and 9 male patients with a mean age of 14.3 ± 1.8 years. Duration of diabetes was 5.3 ± 4.1 and 6 ± 4.2 in the intervention and control groups respectively. None of the subjects used to participate in vigorous or moderate physical activity. Average weekly walking time of all participants was 51.6 ± 22 min.

No significant difference was found at the end of 12 week Pilates exercise period between the body mass index SDS of the intervention and control group (0.04 ± 1.2 vs. 0.18 ± 1.22 kg/m^2). There were no significant changes in HbA1c and daily insulin dose of the patients in both groups. At the end of the study, there was no significant change in blood lipid profile of study group. Total cholesterol, triglyceride and LDL levels of control group did not change while HDL level increased significantly ($P=.046$) at the end of 12 weeks. The results of metabolic control measurements are shown in Table 1.

At the end of the study period, peak power, mean power, flexibility and vertical jump height values increased significantly in the study group ($P=.02$, $P=.000$, $P=.000$, $P=.003$) respectively. Physical performance parameters of control group were not changed. The result of pre and post training physical performance tests of the groups are shown in Table 2.

4. Discussion

Exercise is the third essential component in blood glucose regulation for persons with Type 1 diabetes after insulin and dietary management. The goal of exercise should be to increase insulin sensitivity and to improve the overall cardiovascular and psychological profile of the child with Type 1 DM regardless of the benefits on blood glucose (Hanas et al., 2009).

A positive association between glycemic control and aerobic fitness or reported physical activity exists in youth with type 1 diabetes, suggesting that either increased aerobic capacity may improve glycemic control or good metabolic control maximizes exercise (Komatsu et al., 2005). Despite the positive associations between VO2 max and glycemic control in cross sectional studies, the influence of regular exercise on glycemic control is based on a limited number of small studies. Indeed the influence of chronic exercise on improving blood glucose control in children and adolescents with

Table 1
Results of metabolic control for pre and post measurements of two groups (means ± sd).

	Study group ($n=17$)		Control group ($n=14$)	
	pre	post	pre	post
HbA1c (%)	8.9 ± 1.6	8.8 ± 1.5	9.2 ± 2.1	8.7 ± 1.8
DID (u/kg)	1.1 ± 0.3	1 ± 0.2	1 ± 0.2	1 ± 0.2
HDL (mg/dl)	53.9 ± 11.5	56.9 ± 9.6	58 ± 12.8	64 ± 17.1[a]
LDL (mg/dl)	87.4 ± 18.1	85.3 ± 14.6	94.8 ± 25.9	99.1 ± 32.8
T Col (mgl/dl)	167.4 ± 23.4	167.5 ± 25.8	195.6 ± 62.3	196.1 ± 62.1
TG (mg/dl)	85.9 ± 40.2	89.9 ± 46.8	104.1 ± 80.2	95.1 ± 57.5

DID, Daily insulin dose; HDL, High density lipoprotein; LDL, Low density lipoprotein; T Col, Total cholesterol; TG: Triglyceride.
[a] Significant difference of 1. and 2. measurements ($P<.05$).