



Original Research Article

Stress management among families of children and adolescents with diabetes mellitus type 1 with physiotherapeutic techniques

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Diabetes Mellitus Type 1 (TD1) is an autoimmune disease and concerns the overwhelming majority of children and adolescents with diabetes. It is a chronic illness that disrupts family functioning and causes anxiety for both parents and children by affecting their physical and mental health. The purpose of this study is to evaluate the effectiveness of a physiotherapeutic stress management program (active therapeutic exercise, pressure therapy, diaphragmatic breathing and progressive muscle relaxation) in reducing stress symptoms in children and adolescents with Diabetes Mellitus Type 1 and their parents. This was a pilot, randomized controlled survey that was carried out in C' pediatric endocrinology clinic of Aristotle University of Thessaloniki at the Hippokrateion General Hospital of Thessaloniki. A total of 107 individuals, an intervention group of 26 children (7 - 17 years old) and 28 parents (n = 54) and a control group of 28 children and 25 parents (n = 53) participated. The measurement tools included the questionnaires STAIC1,2 for children and DASS 21 for parents with a view to assessing the perceived stress, the perception of health, the quality of life and depression. The price of glycosylated hemoglobin and hypoglycemic episodes of children was checked before and after intervention. After 12 weeks of intervention, the trait anxiety of children was reduced about 5.2 units (p = 0.001) and the state anxiety about 4.4 (p = 0.000) Significant difference was not observed in the glycosylated hemoglobin levels between the two groups, but was observed a significant reduction in hypoglycemic episodes of the class (42%, p = 0.028), with an average reduction of 2.25 hypoglycaemic episodes in the children of the intervention group. The symptoms of depression, anxiety and stress in parents of intervention group were significantly reduced about 2.94 units (p = 0.010), 1.89 (p = 0.019), 2.14 (p = 0.048), respectively. The physiotherapy program was associated with changes in the physical and psychological symptoms of children and adolescents with TD1 and their parents. It turned out to have had a positive impact on depression and stress and a significant improvement on their quality of life.

Key words: Diabetes Mellitus Type 1, family, children, adolescents, stress management, physical therapy, physiotherapeutic techniques.

INTRODUCTION

Chronic health problems on children are on the increase. Recent estimates suggest that 7-18% of US children have a chronic health status (National Health Care Statistics,

2006; Perrin et al., 2007; Van Cleave et al., 2010). The chronic childhood illnesses often affect the entire family system. Juvenile diabetes mellitus or TD1 is a chronic

illness that disrupts family functioning and causes anxiety for both parents and children by affecting their physical and mental health. Parents must deal with the disastrous news about their child's diagnosis, the medical dangers associated with the diagnosis and, in some cases, the probability of reducing their life expectancy. Although, some families can show resistance to these stressors, treatment regimens and changes in roles, and the responsibilities may have a negative impact on family functioning. In a study that compared parents of children with cancer, asthma, cystic fibrosis and TD1, the parents of children with TD1 and asthma reported greater parental anxiety but fewer concerns about their child's health comparable to other parents (Hullmann et al., 2010).

In another research it appeared that general anxiety of maternal behavior was associated with the adolescents' stress who considered that their mothers were very overprotective towards them (Cameron et al., 2007). Parental involvement in diabetes management leads to good results (Helgeson et al., 2008) but parental stress can also harm the child psychologically and physically. Numerous studies have shown that parental discomfort leads to more negative and less positive interactions with children (Jaser and Grey, 2010). In a nine-month study of parental depression in relation to diabetes management, it showed that there was poor glycemic control (Cunningham et al., 2011).

TD1 is a chronic disease requiring adaptations to the daily routine of child and his family, causing family disorder and anxiety for parents and children (Delamater et al., 2014; Hessler et al., 2016; Sikteoeboen, 2017). Intensified insulin regimens for children and adolescents as the most effective way to deal with better glycemic control require frequent insulin measurements and injections or use of an insulin pump. Continuous engagement and care of parents and children and adolescents with TD1 may affect their physical and mental health (Mitchell et al., 2009; Hilliard et al., 2011; Whittemore et al., 2012; Moghaddam et al., 2016). The daily routine of children with diabetes includes 5-7 blood glucose measurements and 5-6 daily insulin injections, a complete healthy and balanced diet with all the essential ingredients (carbohydrates, fats, proteins and fiber) to ensure a normal child development, divided in 24 - hour meals, to ensure smooth fluctuations in blood glucose. The daily routine of weighing food, calculating the quantity of carbohydrates and insulin doses is a new reality for the life of a person with TD1, which is additionally burdened by the regular reassessment of insulin requirements when new factors appear such as illness, exercise, anxiety, etc. Finally, everyday physical activity (Iughetti et al., 2015) contributes to better regulation of the blood glucose of children and adolescents with TD1 (Liakopoulou et al., 2010). The children with TD1 is necessary to adjust in the continuous taking carbohydrates and insulin dose in order to achieve euglycemia before, during and after exercise. Strong glucose fluctuations beyond the risk of immediate complications, cause a psychological burden as an additional metabolic stressor. It is clear that good

regulation and treatment of children and adolescents with TD1 requires proper training in the management of the above components, distinct roles of responsibility and continuous engagement.

Psychological support of family is considered to be necessary and ways of psychological empowerment should first be sought for the acceptance of the disease and then for training of everyday management skills (Helgeson et al., 2012). Further research has shown that the application of strength, balance and flexibility aerobic therapeutic exercises improve the physical capabilities, health and the quality of individuals' life in order to deal better with their everyday activities (Yiapitzakis et al., 2013; Mendes et al., 2016; Ermidou et al., 2016). Recent researches indicate that the diaphragmatic breathing applied throughout the program of this study improves respiratory function and blood circulation, reduces blood pressure, oxygenates the body better, stimulates the internal organs and the lymphatic system, brings relaxation and calmness (Sasaki et al., 2005; Witt et al., 2007; Bradley and Esformes, 2014). According to the western medicine the pressure therapy at points along the meridians path, achieves a balance between sympathetic and parasympathetic system (Wang et al., 1991; Hristara - Papadopoulou, 2015) reduces the cortisol levels and strengthens the immune system. Also, researchers estimate that relief from massage is based on a similar biological mechanism such as the anti-inflammatory drugs (Harris, 1997; Field, 2002).

In Greek populations they applied methods of diaphragmatic breathing and gradual relaxation of muscles in order to ameliorate anxiety, stress and depression on children's parents with Diabetes mellitus type 1. Cortisol (anxiety hormone) measurements were performed to evaluate the efficacy of the methods. There was no statistically significant difference in cortisol levels between the two intervention and control groups in both studies. However, there was a decrease on the emotional pressure and anxiety of the parents of the intervention team. Parents in the intervention group also reported a significant improvement in their quality of life (Tsiouli et al., 2014; Pateraki et al., 2015). Based on the above studies we conducted the current research using multiple physiotherapy techniques (everyday therapeutic active exercise, diaphragmatic breathing, pressure therapy, self-massage) in children, adolescents with TD1 and their parents, with the aim of drawing conclusions that will help to improve lifetime parameters, family relationships, reduction of hypoglycemic episodes and glycemic control.

MATERIALS AND METHODS

Subjects

Two groups were formed, an intervention team and a control group. 26 children (20 girls and 6 boys) and 28 parents (24 mothers and 4 fathers), therefore the intervention group was a total of 54 persons. The control

group also consisted of 28 children with TD1 and 25 parents, thus the control group was a total of 53 people. The vast majority of participants in the intervention group implemented the program almost daily or day by day for 3 months (12 weeks). This study was morally approved by the committee of Alexander Technological Institute of Thessaloniki and also was approved by the scientific department of Hippokrateion General Hospital of Thessaloniki.

Exclusion and inclusion criteria in research

Children and adolescents who suffered exclusively from TD1 are involved in the study. Children who at the same time had another health problem were excluded, newly diagnosed cases, as well as children who had already done some sports. For parents of children, the criterion for participating in the survey was to have children with TD1. For the parents, exclusion criteria were not treated in the last month with anti-inflammatory and anti-depressant drugs and not practiced with other methods of relaxation such as yoga etc. All participants in the survey were individuals from the wider Region of Macedonia (Central, West, East) who are attended by the Pediatric Endocrinology Clinic.

The measurement tools

For children, was used the questionnaire State-Trait Anxiety Inventory for Children (STAIC1, 2) that consists of two scales: the A-State scale and the A-Trait scale. The A-Trait scale includes 20 questions that children respond according to how they generally feel, in their everyday life. This scale measures individual differences in the way that children experience anxiety in their daily lives. It also assesses the degree of intensity they react to social and difficult situations. The A-State Scale contains 20 questions, and is designed to control the subjective feelings of fear, nervousness and anxiety at the time of examination, which vary in intensity and fluctuate depending on the situation. For parents, the DASS 21 (Depression, Anxiety, Stress Scale) questionnaire was used. The purpose of the questionnaire, which includes 21 questions is to evaluate the negative emotional state (depression, anxiety, stress) of the individual. The questionnaires were completed by the children and parents of both groups before and after the intervention. All the questionnaires are weighted for the Greek population. Also, the glycosylated hemoglobin and hypoglycemic episodes of the children were measured in both groups before and after the intervention.

Intervention and procedure

The questionnaires were answered at the beginning of the survey in February 2018. Immediately after this, the researcher showed the physiotherapy protocol. The demonstration of the protocol was held as a personal interview for each family. Also on the first day of the

update, participants were given a brochure containing the exact description of the program and a cd with 3 videos. The first two videos were related to the morning and evening exercise program and the third video described the diaphragmatic breathing, points of pressure as well as practical tips for dealing with daily stress. Also, children were given the trifflo a breathing device to practice diaphragmatic breathing and improve the pulmonary function. Then, in 2 weeks, the people who participated in the survey were re-examined to clarify and solve the questions that arose during the implementation of the physiotherapy program. At the same time every two weeks there was telephone communication and support to the children and the parents of both groups. In one and half month of the survey, we rechecked the individuals of intervention group. They were asked to complete an intermediate evaluation questionnaire of eight questions, based on bibliographic data and aimed at investigating the frequency and the number of repetitions that applied the physical therapy program during the day and the week. Towards the end of the research process, that is, at the end of May 2018, children and parents completed the same questionnaires they had completed at the beginning of the survey.

Physiotherapy protocol

The children and parents who participated in the study applied a 10-minute physical therapy exercise program (Mckenzie, Bobath, PNF, Pilates) in the morning, aiming at creating pleasant emotions and preventing musculoskeletal problems. All the major joints and large muscle groups of the body were mobilized, emphasizing the alternation between intensity and relaxation. Exercises were always applied in conjunction with diaphragmatic breathing. Before learning the diaphragmatic breathing, it was necessary to teach the correct posture of the body. The children also practiced daily with trifflo, breathing device. During the day or even in the evening before sleep, when they were feeling anxious, they were applying pressure and self-massage with prolonged pressure or with small circular movements with one or two finger. They were applying pressure and self-massage on palms and soles and along the way of meridians at specific acupuncture points that was helping relaxation from stress. The major advantage of pressure therapy is that the technique can be applied by themselves. In the evening also before sleep, they applied a progressive muscle relaxation program combined with relaxation breathing (RB-PMR). Patients and their parents did the same exercises with the same number of repetitions for 12 weeks on their own every morning and evening. There was telephone support from the researcher every 2 weeks and a personal interview every month with the subjects of intervention group to attend the progress of the program and if applied by the participants. In addition, the researcher had arranged a re-check-up appointment in the hospital, for the participants of the intervention team within one and a half months from

Table 1. Comparison of State and Trait averages rate (range of rates) per group before and after intervention

	Before		After		<i>t</i>	<i>p</i>
	Mean	SD	Mean	SD		
State						
Control(n=28)	29.5	4.3	30.8	6	-0.947	0.348
Intervention(n=26)	30	3.6	25.6	3	4.706	0.000
Trait						
Control(n=28)	35.8	6.7	34.9	6.2	-0.083	0.934
Intervention(n=26)	34.7	5.7	29.5	4.6	3.684	0.001

the start of the survey. They completed an intermediate evaluation questionnaire of eight questions about the frequency and the number of repetitions that applied the physical therapy program during day and week. The goal was the reduction of symptoms of anxiety as well as muscles and joints relaxation and stretching from daily pressure. So the program aims to improve and stabilize the glycemic control to reduce the number of hypoglycemic episodes of children in order the body maintains in good physical condition.

Statistical methods

For the questionnaires processing and the outcome of useful conclusions, methods of descriptive statistics and statistical tests (t-tests) were applied. In all cases the checks on the conditions for the application of the statistical tests were preceded. Checks for regularity of the distribution of variables (Kolmogorov - Smirnov) and Levene's test were carried out. There were no cases of rejection of the zero hypothesis for the regularity of distributions, and for this reason parametric methods were used to control our hypotheses. Tests were initially carried out on the STAIC questionnaire and after that, on the DASS 21 questionnaire. Additionally, because of the large number of our data, especially for children (STAIC questionnaire), a Bootstrap test for 10,000 similar samples was used to outcome safe conclusions. All statistical tests were performed with IBM SPSS Statistics Version 23. A Cronbach's Alpha reliability test was also done which showed satisfactory values for STAIC1, 0.821, STAIC2, 0.838, and DASS 21, 0.937.

RESULTS

In our study for children, in addition to STAIC questionnaire, various demographic characteristics such as children's age, weight, height, body mass index (BMI) and disease duration were recorded. 20 girls and 6 boys participated in the intervention group. There were no statistically significant differences between both groups ($p > 0.05$) from the control of differences in demographic characteristics.

Then, we notice that the intervention group is

experiencing a significant improvement in both State and Trait. The two parts of the questionnaire were graded and in the Table below, we see the distribution of the total score before and after the intervention. Regarding the 1st part of the STAIC-State questionnaire, especially for the intervention group, it is characteristic that at the beginning of the program the scores range from 24 to 35 with an extreme value of 39. Half of the children have a score of more than 30. Just after only three months, only 25% of the children have a score over 27.5, with a higher to be 32. Correspondingly, the minimum score is between 20 and 25% and the lowest rates are below 24. The average score for the State questionnaire for the intervention group decreased by 4.4 points. There are no significant differences in control group about STAIC-State questionnaire after three-month program. There was no increase in children's positive feelings but a small increase in negative feelings from 29.5 points to 30.8 points. The average score of the State questionnaire increased by 1.3 points for the control group (Table 1).

The STAIC-Trait questionnaire assesses their positive and negative feelings and how they deal with stress situations in their daily routine. Here is a positive improvement in the score after three-month implementation of the program. We notice a decrease of 10 points of maximum score, from 47 moved to 37 with the exception of 2 extreme rates. At the beginning of the program half of them were over 34 points and after three months they moved below 29. We also find that at the beginning of the program we have children with very low score which was maintained and finally improved by 2 points. The average score for the STAIC-Trait questionnaire for the intervention team was reduced by 5.2 points. Also about the control group, we observe that the average score for the STAIC-Trait questionnaire decrease by 0.9 points, from 35.8 units to 34.9 (Table 1).

The scores of the DASS 21 questionnaire for parents, as recorded before and after the intervention, are presented in the Table below. As higher is the score so more serious problem there is. From the statistical control test of the average rates among the repetitions, we find that we have statistically significant differences between the control and intervention groups (Table 2).

The average score of depression in the intervention group decreased from 5.86 to 2.89, almost 3 points. Stress and

Table 2. DASS21 scores between the control and intervention groups before and after intervention

	Before		After		<i>t</i>	<i>p</i>
	Mean	SD	Mean	SD		
Intervention group(n=28)						
Depression	5.86	4.59	2.89	3.65	2.675	0.010
Anxiety	3.82	3.32	1.93	2.48	2.416	0.019
Stress	6.71	4.3	4.57	3.6	2.023	0.048
Control group(n=25)						
Depression	5.04	5.36	4.76	5.06	0.19	0.850
Anxiety	3.04	3.6	3.2	3.32	-0.163	0.871
Stress	6	3.85	6.36	3.87	-0.33	0.743

Table 3. Comparison of HbA1c average scores between the control and intervention groups among repetitions

	HbA1c before		HbA1c after		<i>t</i>	<i>p</i>
	Mean	SD	Mean	SD		
Control (n=28)	7.73	0.98	7.39	0.72	2.489	0.020
Intervention (n=26)	7.50	0.87	7.20	0.49	2.225	0.035

Table 4. Comparison of average rates of hypoglycemic episodes for both groups before and after intervention

	Before		After		<i>t</i>	<i>p</i>
	Mean	SD	Mean	SD		
Control group (n=28)	3.62	2.6	3.24	1.8	0.551	0.585
Intervention group (n=26)	5.4	3.3	3.15	2.9	2.288	0.028

anxiety also showed a significant decline of 1.89 and 2.14 points respectively. No statistically significant differences were observed in the control group. Depression is reduced by a minimum of 0.28 while stress and anxiety are also slightly increased by 0.16 and 0.36 respectively. Regarding the levels of glycosylated haemoglobin (HbA1c) no statistically significant differences were found in the rates between both groups before and after the intervention.

HbA1c measurement was held before and after three months of intervention program on both groups of children (control and intervention). In the Table below we observe that both groups do not show statistically significant differences before and after the intervention. Both teams improved about 0.3 units. There are no differences between the two groups before and after the intervention. (Table 3).

Another measurement which taken in both stages (before and after three months of intervention program) was the hypoglycaemic episodes on both groups of children (control and intervention). The following Table shows that the children of the intervention group had a statistically significant difference, whereas the control group children did not show any difference. Measurements in pre- and post-intervention children showed an average reduction of 2.25 hypoglycaemic episodes with statistically significant difference ($p = 0.028$) and a decrease of 0.38 in the control group ($p = 0.585$), not statistically significant. It should also be noted that the children of the intervention group at baseline had already had an average of 1.78 hypoglycaemic

episodes over the control group children. Therefore it is observed a significant reduction in hypoglycemic episodes of the class (42%, $p = 0,028$), on the children of the intervention group (Table 4).

As we mentioned before, the children and their parents completed intermediate questionnaire in the middle of intervention program. Its evaluation showed that the program was adapted to everyday life of children and parents. The participants did therapeutic program almost day by day or twice a week. The majority of participants replied that they took benefit of the program.

DISCUSSION

It is undeniable the benefits of stress management in psychological wellbeing of diabetic patients and also their families. Parents, children and young people who attended the program described improved family relationships, knowledge and understanding, greater confidence and increased self-confidence in managing diabetes. Older children took more responsibility for managing their treatment over time³¹. In the intervention group, parental behavior in conflict situations improved significantly. There was no statistically significant difference between two groups at levels of glycosylated hemoglobin (Grey et al, 2011).

There was a beneficial effect on the intervention team, as

evidenced by the reduction of anxiety in the management of children and the increased tendency for social support and adjustment (Monaghan et al., 2011). Practitioners felt physiologically and psychologically more powerful to deal with stressful situations (Nascimento et al., 2014). The increased physical strength, energy and endurance of daily exercise, helped them to perform many activities without being distressed or tired. Usually the good mood and euphoria that people feel, lasts from 2 to 4 hours after an exercise program. Therefore, in ideal situations, the frequency of exercise should be daily so that euphoria is lasting. Systemic physical therapeutic aerobic exercise plays an important role in improving the physical condition and general health of the person (Zerbas et al., 1993). People with a good physical condition have more positive responses to psychosocial stress than people who are not fit enough (Crews and Landers, 1987). Anxiety decreases after exercise because it facilitates the release of β -endorphin and β -lipoprotein, substances that are natural painkillers and are normally produced in the brain and cause a feeling of euphoria and well-being (Farrell et al., 1987). Exercise brings permanent changes to the most basic brain monoamines (dopamine, serotonin, noradrenaline) resulting in the creation of pleasant emotions (Nabkasorn et al., 2006). "Thermogenesis" the increase in body temperature observed during and after the exercise has a therapeutic affect and reduces muscle tension and the activity of c' motor neurons. In addition, it increases the frequency of the brain waves which are responsible for the concentration and improvement of intellectual and mental functions resulting in a reduction in physical and cognitive anxiety (Petrouzello et al., 1991).

The program was evaluated by the majority of participants as useful and interesting (Robinson et al., 2017). The intensive interest (telephone support) and care of the researcher showed that it reduces anxiety and improves parental effectiveness in glycemic control (Christie et al., 2014; Ridge et al., 2014). It is also very important that in the intervention group there has been a reduction in hypoglycemic episodes and a better stabilization of the glycemic index compared to the control group (Gupta et al., 2017). The vast majority of participants reported that the trainer had inspired them to continue their efforts with more interest and dedication and to see life positively (Morgan-Trimmer et al., 2016). Depression and parental anxiety rates were reduced (Yi-Frazier et al., 2017). Parents declared more calm and concentrated and this helped them to manage better with diabetes daily (Sassmann et al., 2012). Finally, the findings of our study agree with the results of similar surveys which were held in Germany, England and the United States of America and concerned organized programs, involving many specialties. In addition, parents said that there was an improvement in the symptoms of depression and in their quality of life, results that are consistent with these of two studies were done in the Greek population using diaphragmatic respiration and relaxation techniques, as we had already mentioned before.

It is acknowledged that this study has a number of limitations. Firstly, our entire primary outcome measures were based on subjective self-reports of the individuals who participated in the intervention group, as opposed to objective clinical considerations. Furthermore, in order to increase the likelihood of the program being performed by the intervention group and to have the most objective results, we had organized every two weeks a telephone communication with the patients of both groups. Thus the sense of offer was fostered in all patients. Also, the subjects of intervention group had a personal interview every month with the researcher. In addition, the time limit set for the intervention was twelve weeks, which is a reasonable time to investigate psychological symptoms, but quite restrictive. There are no relevant studies with similar therapeutic program results in healthy children to get comparative results.

The physiotherapy program for Diabetes Mellitus Type 1 children needs to be initiated by a dedicated staff, but then it has to become a mode of everyday behavior to have beneficial effects on children and parents by improving the quality of life. The research is part of the current efforts to improve the quality of life of a large number of children with Diabetes Mellitus Type 1 and their parents. The paper is useful and interesting to many children who have chronic illness and is a guide for their parents to reduce depression and stress and anxiety in their families.

CONCLUSION

The intervention program worked positively for both children and their parents. The rates of depression, anxiety and parental stress have decreased and children have been experiencing a decrease in negative emotions, better management of illness and improved quality of life. This program can work in an auxiliary way and be part of everyday life of individuals, children and parents, once it has been found to be beneficial. It is obvious that parents of children with TD1 and the children as illustrated in this study and in previous studies too, experience severe symptoms of stress, anxiety and depression and are trying to find ways to manage them.

Conflict of Interest

All the authors declare that they have no conflict of interest.

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