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ORIGINAL ARTICLE

Adherence to physical activity in young people with Type 1 diabetes

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Abstract. Regular physical activity plays a key role in the management of children and adolescents with Type 1 diabetes mellitus but it is not considered as a treatment for diabetes. Aim of this study was to investigate time spent exercising, adherence to the programme for a safe exercise and ability of young people with diabetes to take appropriate measures to reduce potential risks. Ninety one Type 1 diabetes mellitus young people (aged from 10 to 18 years, duration of diabetes longer than 6 months) without associated chronic diseases were randomly enrolled in the study. Age, sex, weight, height, BMI, duration of disease, mean HbA1c value over preceding 6 months have been collected. The time weekly spent for physical activity, the type of exercise usually performed, the measures taken to reduce exercise risks have been collected by a structured questionnaire. BMI was 21.6±3.05 in the boys and 21.3±3.63 in the girls. All patients spent exercising 438±221 minutes/week. Boys exercised 71 minutes longer than girls in competitive sports. Children exercising less than 60 minutes weekly showed a mean HbA1c level (8,9±05%) higher than that found in children exercising 120-360 minutes (8,3±0.4 %; p=0.002) or 360-480 minutes (8,0±0.6 %; p< 0.01) weekly. Children attending a competitive sport (at least 360 min per week) had a better glycemic control (HbA1c=7,39±0.6 %; p=0.03) than other active peers. Fifty percent of patients reported to monitor blood glucose levels during exercise; 32 % changed insulin dose according to blood glucose levels; 60 % usually added carbohydrate-based foods before (35%), during (15%) or after (10%) exercise. Hypoglycemic episodes (37.7%) were reported more frequently than hyperglycemic ones (p=0.024), but only twelve percent of them were symptomatic and appeared 30 minutes to 2 hours after the end of exercise. These results must encourage health care professionals to review regularly the ability of their patients in managing physical activity and to check their adherence to the program for a safe exercise.

Key words: Type 1 diabetes, physical activity, adolescents, children

Introduction

In addition to insulin therapy, diet and education, regular physical activity is usually considered to play a key role in the management of children and adolescents with Type 1 diabetes mellitus (T1DM). It improves insulin sensitivity, increases glucose utilization, reduces cardiovascular risk factors, and helps to prevent obesity (1). Despite these benefits, exercise is not considered as a treatment for diabetes, because the controlled studies failed to prove a better blood glucose control due to physical activity (2). However, children and adolescents with T1DM should be encouraged to participate in gym classes, team sports and

other activities in order to improve, first of all, the sense of well-being and their quality of life (3, 4).

Various guidelines exist for physical activity and exercise in the general population. For example, a minimum of 20 minutes of continuous aerobic exercise three days a week is recommended (5). People with type 2 diabetes should perform physical activity at least five to six days a week to maintain improvements in glycemic control (5). In view of insulin adjustments, for children and adolescents with T1DM a daily exercise is recommended (1).

Evidence from the non-diabetic population suggests that a physical activity individually tailored according to age, lifestyle and motivation is a way of enhancing long term adherence (6). Similarly, an individualized exercise could be the key to success in children and adolescents with diabetes.

To maximize adherence in people with diabetes, exercise program should be accompanied by ongoing support which includes specific instructions regarding choice of exercise, glycemic control and meal plan during physical activity and appropriate safety measures to avoid hypoglycemia, and to prevent hyperglycemia and ketosis. The highest degree of adherence in adults with diabetes has been related to the home-based exercise program (7). Sporting habits of children and adolescents with diabetes have been sporadically analyzed (8) and consequently a few information is available on their adherence to exercise. In this paper, time spent exercising, adherence to physical activity and ability of young people with diabetes to take appropriate measures to reduce potential exercise risks have been investigated.

Materials and methods

The study was performed at the Regional Centre for the management of diabetes in childhood of the University of Parma, Parma, Italy. Health care professionals were asked to enroll in the study 100 consecutive children and adolescents followed in out-patients clinic from 1st October 2003 to 31st March 2004, fulfilling the following criteria: chronological age from 10 to 18 years, duration of diabetes longer than 6 months, no chronic disease associated with diabetes (i.e., celiac disease, autoimmune endocrinopathies, cystic fibrosis, etc.) as well as cardiovascular diseases, neuropathy or proliferative retinopathy, and hypoglycemia unawareness. Written informed consent was obtained from the parents and the children, when appropriate.

Age, sex, weight, height, BMI, duration of diabetes, mean HbA1c values over preceding 6 months, number of insulin injections and insulin dose were preliminary recorded. Then, all selected patients, or parents when children were younger than 14 years, were interviewed by one of the Authors (A. B.) using a structured questionnaire concerning the time weekly spent for physical activity at school or in the spare time, the type of exercise usually performed, the measures taken to reduce exercise risks, in particular changes in insulin and food intake before and after exercise.

Physical activities were classified in two categories: "activities in spare time" (i.e. walking, cycling, skating or swimming) and "competitive sports" (soccer, volley-ball, tennis, basket-ball).

All patients received at discharge after diagnosis of diabetes and during the out-patients clinic follow-up the same guidelines to perform a safe exercise, such as: avoid exercise during peak insulin action, consider reducing insulin dose when exercise is anticipated, administer insulin away from working limbs, be alert for signs of hypoglycemia, measure blood glucose levels before and after exercise, eat carbohydrate-containing snack before exercising for blood glucose level < 100 mg/dl, delay exercising if urine ketone test is positive, delay exercising for blood glucose level > 300 mg/dl or inject 2-3 U of fast insulin analog before exercising.

Glycated haemoglobin was measured every 3 months by DCA 2000 (Bayer Corporation, Elkhart, IN, USA). A strong correlation was found between data obtained by DCA 2000 and HPLC methods as previously described (9).

The data were expressed as mean±SD. Numerical differences were calculated using the Student's t-test. The χ^2 test was used to establish differences between proportions. Relationship between metabolic control and time weekly spent for physical activity was calculated by linear correlation coefficient. Results were considered statistically significant at $p<0.05$.

Results

Ninety one consecutive children and adolescents (50 boys, 41 girls) with Type 1 diabetes accepted to be admitted to the study. Their average age was 14.8±2.7 years and the mean diabetes duration was 6.7±3.9 years (range: 1-16 years). Boys and girls had a mean BMI of 21.6±3.05 and 21.3±3.63 respectively, and 21.9% had a BMI >85th centile. The mean of the HbA1c values collected over preceding 6 months was 8.4±0.2% (boys 8.5±1.1 and girls 8.0±0.8%; p=0.15).

Ninety eight per cent of interviewed subjects reported to perform activities in spare time as well as competitive sports. Only 2% referred do not exercise. The grand mean of time weekly spent for exercise was 438±221 minutes/week without difference between boys (470±288 min/week) and girls (396±205 min/week; p=0.903): 186± 155 min/week (43.3%) were devoted to "competitive sports" and 252± 158 min/week (57.0%) to "activities in spare time" (120 min/week spent at school) . Boys and girls devoted the same time to activities in spare time, but boys exercised 71 minutes longer than girls in competitive sports. Eighty one percent of children referred to perform the same exercise they were performing before diabetes diagnosis.

Children exercising less than 60 minutes weekly (22%) showed a mean HbA1c level (8,9±05%) higher than that found in children exercising 120-360 minutes (8,3±0.4%; p=0,002) or 360-480 minutes (8,0±0.6%; p<0.01) weekly (Figure 1). Children attending a competitive sport (at least 360 min per week) had a better glycemic control (HbA1c=7,39±0.6%; p=0.03) than other active peers.

Activities in spare time were homogeneously chosen by both boys and girls (Table 1). In competitive sports category, boys mainly selected soccer and basket-ball; girls' selection was more heterogeneous, although flexibility sports and hand-ball were prevalent activities (Table 2).

Fifty percent of patients referred to monitor blood glucose levels before (29%), after (41%) or before and after (30%) the exercise. Nobody reported to check blood glucose levels during exercising.

Only 32% of patients referred to change insulin dose according to blood glucose levels. When an adju-

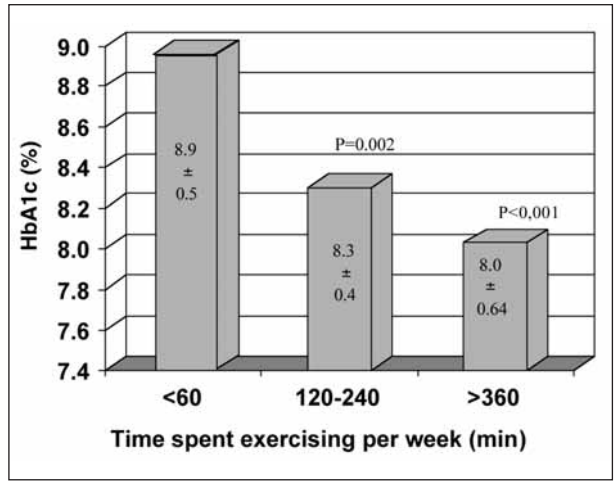

Figure 1. Relationship between HbA1c and time spent exercising per week

Table 1. Activities in spare time performed in a week by 33 boys and 33 girls

Type of activity	Boys	Girls
Walking	11	14
Biking	7	6
Walking & Biking	10	9
Skating	1	1
Skiing	1	1
Walking & Skiing	1	1
Miscellaneous	2	1

Table 2. Competitive sports performed in a week by 37 boys and 32 girls

Type of activity	Boys	Girls
Soccer	13	0
Volleyball	2	6
Basketball	6	2
Gymnastic	2	6
Aerobic dancing	0	7
Tennis	3	1
Classic dancing	0	4
Swimming	2	2
Fencing	2	0
Judo	2	0
Boxing	1	0
Rowing	0	1
Athletics	1	0
Skating on line	0	1
Miscellaneous	3	1

stment was performed, this generally concerned the insulin component corresponding to the period of exercise. Insulin was reduced of 10 to 20% . Twenty seven per cent of patients avoided injecting insulin in the extremity predominantly used for exercise. Abdomen area was preferred (65%).

Sixty percent of patients usually added carbohydrate-based foods before (35%), during (25%) or after (40%) exercise. Only 8% of patients referred to drink regularly liquid with sugar or fluid snacks during exercise.

Hypoglycemia episodes (37.7%) were reported more frequently than hyperglycemia episodes (17.56%; $p <= 0.024$). Twelve percent of hypoglycemic episodes were symptomatic and appeared 30 minutes to 2 hours after the end of exercise. Nine patients referred symptomatic nocturnal hypoglycemic episodes 7 to 12 hours after the exercise. Children exercising in spare time and those exercising in competitive sports had the same number of hypoglicemia episodes. Nobody reported ketosis.

Discussion

Interviewed subjects showed a sufficient adherence to the physical activity prescribed by the health care professionals. Sixty per cent of them reported to spend on average 1 hour daily for exercise, proving so to consider physical activity beneficial in the treatment of diabetes mellitus. Glycate hemoglobin levels in these motivated patients were better than in children exercising sporadically and shortly either in school or in spare time.

About the relationship between physical activity and glycemic control in type 1 diabetes patients conflicting opinions are reported. Some Authors generally found that glycemic control was not associated with physical activity and particularly physical activity did not negatively affect glycemic control (12, 13). Others suggested that patients who exercise in the morning may achieve lower blood glucose and fructosamine levels than their active peers (13). Controlled studies have not been able to show better diabetes control due to physical activity, so exercise can not be considered as a treatment for diabetes (2). On the contrary, the rationale for the use of exercise as part of the treatment program is much clearer in Type 2 diabetes (10). Any way, being exercise an effective method to improve metabolic control and other clinical parameters (11, 13), children and adolescents with T1DM should be encouraged to exercise and to pursue their interest in whichever sport they enjoy.

The key to success in exercise prescription is individualization. Whenever possible, an exercise contract should be arranged with the patient taking into account age, lifestyle and motivation. Following this guideline, the patients enrolled in the present study approached a large range of physical activities, as a confirmation that each one chose the exercise he enjoyed and usually that he was performing before diabetes diagnosis.

All interviewed patients obtained at discharge and in out-patient clinic specific instructions for a safe exercise and information on the risk of hypoglycemia during and after exercise, and on the dangers of physical activity if diabetes was minimally controlled. Although the effort of health care professionals in this field, only half of patients referred to monitor blood glucose levels before (29%), after (41%) or before and after (30%) the exercise. Nobody reported to check blood glucose levels during exercising.

Patients herein studied were instructed to use blood glucose monitoring to identify when changes in insulin or food intake were necessary. Concerning insulin, only one third of patients reported to adjust regularly insulin dosage to own response to physical activity. The things were gone better for adjusting food intake .Two third of patients referred to consume added carbohydrate to avoid hypoglycemia, but a small number of them were used to drink liquid with sugar and salt or fluid snacks during exercise. These results must press health care professionals to review regularly the ability of their patients in managing physical activity and to check their adherence to the program for a safe exercise.

Thanks to the adherence to the guidelines for a safe exercise, reported severe episodes of hypoglycemia were not numerous and appeared at the end of exercise. A few patient experienced hypoglycemia several hours after the exercise, during the night. Post-exercise hypoglycemia and delayed onset hypoglycemia can

occur up to 24 hours after exercise. This is due to increased insulin sensitivity and depleted glycogen stores which occur also after a moderate physical activity (14). Some studies showed that this nocturnal neuroglycopenia reduces the sense of wellbeing, increases subjective determinants of fatigue and affects physical performance the following day (15). To prevent these complications and to identify when changes in insulin or food intake are necessary, it is helpful for patients to monitor blood glucose level before, during and after exercise. In particular the patients who experience late or nocturnal hypoglycemia should have a snack after exercise and/or before going to sleep.

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