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Physical activity and glycemic control in a cohort of adolescents with type 1 diabetes: a pilot study

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BACKGROUND: Even today physical activity is not considered as a real treatment for diabetes but the literature suggests that regular physical activity is of great importance in the management of type 1 diabetes mellitus. Moreover a regular physical activity has been associated with weight control, improved blood lipid profile, reduced cardiovascular risk and improved sense of well being. Several studies have suggested that elevated levels of glycated hemoglobin (HBA1C) are associated with cardiovascular disease (CVD); the objective of the present pilot was to evaluate the relationship between HBA1C levels and physical activity.
METHODS: The subjects were recruited during regularly scheduled clinic visits. Seventeen youths (12 girls and 5 boys) with type 1 diabetes and disease duration of at least 24 months and were recruited from a university-based outpatient diabetes specialty clinic, without any other known disease. We required the dosage HBA1C to patients that, subsequently, came to their regular outpatient visit having the HBA1C test. Moreover, we administered a short questionnaire in order to evaluate the total physical activity time carried out in one week.
RESULTS: Seventeen subjects were enrolled in this study (age: 14,43 ± 2,83 yrs; weight: 58,79 ± 15,68 kg; height: 159,91 ± 12,99 cm; BMI: 22,72 ± 4,78). Through the Pearson correlation index, the data analysis demonstrated that HBA1C levels (9.98 ± 2.18 %) exhibited a significant reverse correlation (r = -60) with total physical activity time carried in one week (432, 05 ± 214,58 min).
CONCLUSIONS: In conclusion, our data support the hypothesis that regular exercise can improve long-term glucose control, according to HBA1C levels and ultimately, improve metabolic control in subjects with type-1 diabetes. If confirmed by future studies, our findings propose physical activity as a accompanying treatment for type 1 diabetes. Larger numbers are necessary to confirm these hypothesis but these results are very encouraging.

Keywords: Physical activity, Adolescents, Glycated hemoglobin, Type 1 Diabetes Mellitus.

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Introduction

Type 1 diabetes (T1DM), once known as juvenile diabetes or insulin-dependent diabetes, is a chronic condition in which the pancreas produces little or no insulin, a hormone needed to allow glucose to enter cells (Daneman, 2006). Various factors may contribute to type 1 diabetes, including genetics and exposure to certain viruses. The specificity of each type of diabetes is related to the etiologic mechanism and the speed of this apoptosis. In type 2 diabetes mellitus (T2DM), apoptosis is progressively favored mainly by glucotoxicity and lipotoxicity; whereas in type 1 diabetes mellitus (T1DM), apoptosis is rapidly induced by irreversible autoimmune process (Cnop et al., 2005). Although T1DM typically appears during childhood or adolescence, it also can develop in adults. With proper treatment, people who have T1DM can expect to live longer, healthier lives than they did in the past (Sun et al., 2011), even if this disease is associated with risks for multi-system failure, poor academic performance, lower life satisfaction, and early cardiovascular disease (CVD). Insulin, despite improvements in its delivery systems during the last decades, still remains a potential contributor to morbidity and mortality since patients on current conventional therapies are exposed to some risks such as hyperglycemias, ketosis, hypoglycemic episodes. Hyperglycemia is a major cause of vascular and neuropathic complications that are seen in patients with T1DM (Nathan et al., 2005). Several specific risk factors have been suggested in the pathophysiology of cardiovascular risk in T1DM: Nephropathy, cardiac autonomic neuropathy, hyperglycemia, hypoglycemia, low high-density lipoprotein (HDL)-cholesterol, insulin resistance and also genetic factors (Zgibor et al., 2006, Orchard et al., 2006). Low levels physical activity during adolescence are problematic, particularly for those with T1DM who have an added risk for future CVD and an increased incidence of hypertension (Kodama et al., 2013). Regular exercise, a known intervention for combating premature heart disease, has multiple benefits including decreasing risk factors for macrovascular disease, increasing life expectancy, decreasing insulin requirements, lowering blood pressure, improving glucose control, improving fitness and improving overall quality of life (QOL) (Berlin and Colditz, 1990, Riddell et al., 2013, Kumareswaran et al., 2013).

However, there are limited studies on exercise or physical activity interventions in children and adolescents with T1DM, with inconsistencies in the reported outcomes of glucose control and fitness levels. Reports that physical activity might improve chronic glucose regulation for persons with insulin dependent diabetes mellitus (IDDM), are grounded in studies showing a glucose-lowering effect but in type 1 diabetes mellitus, however, the benefits of physical activity are less clear (Laptev et al., 2012, Chimen et al., 2012). Laaksonen showed no changes in fasting glucose in twenty patients with type-1 diabetes after 12 week training program (Laaksonen et al., 2000). In contrast, decreased fasting blood glucose and glycosylated hemoglobin (HBA1C) were reported by Campaigne in 11 adolescent subjects with IDDM after 12 weeks of vigorous games and recreational activities (Campaigne et al., 1984). Mosher et al. showed beneficial effects on glycated hemoglobin in eleven type-1 diabetes patients after a 12 week period of both aerobic exercise and resistance training (Mosher et al., 1998). Rowland et al. and Zinman et al. showed improvements in maximal oxygen uptake (VO2~max) without accompanying changes in glycemic control after 12 weeks of bicycle and treadmill exercise (Rowland, 1981, Zinman et al., 1984). The aim of the present study was to investigate whether the glycated hemoglobin concentration is influenced by amount of physical activity

practiced and, then, if the physical activity is associated with improved glycemic control in adolescents with T1DM.

Methods

Seventeen youths (12 girls and 5 boys) with type 1 diabetes and disease duration of at least 24 months were recruited from a university-based outpatient diabetes specialty clinic, without any other known disease. Adolescents were recruited during their regularly scheduled clinic visits. Written informed consent was obtained from the parents and assent from the youth prior to their participation. Only adolescents who received parental permission and gave assent participated in the study. The principles of the Italian data protection act (196/2003) were observed. The study was performed in compliance with the Helsinki Declaration. Height and weight were measured through the stadiometer (Seca 22 ± 1 mm approximation, Hamburg – Germany). The majority of patients who attend our clinic begin their diabetes education in the hospital during the time of their diagnosis. All subjects were assigned to a certified diabetes educator (CDE) and then have continued follow-up with the CDE in clinic during regularly scheduled outpatient diabetes appointments, approximately every 3-4 months. The CDE may meet with the patient and family to discuss various diabetes management issues, including insulin injection teaching and techniques, blood glucose monitoring, etc.

Patients and their parents come to their regular outpatient visit having the HBA1C test. Physical activity was assessed between April 2012 and June 2012, using a short form questionnaire for the adolescents that included two questions: the first one regarding the time spent per week for sport (soccer, dance, swimming, and so on) and for how many minutes a week, and the second one regarding the time spent walking for day.

Statistical analysis

All data were coded on Excel file. To evaluate the correlations between glycosylated hemoglobin levels and the weekly physical activity practiced, we used the index Pearson correlation. To perform the analysis the STATISTICA software (Windows, Vers 8.0) was adopted.

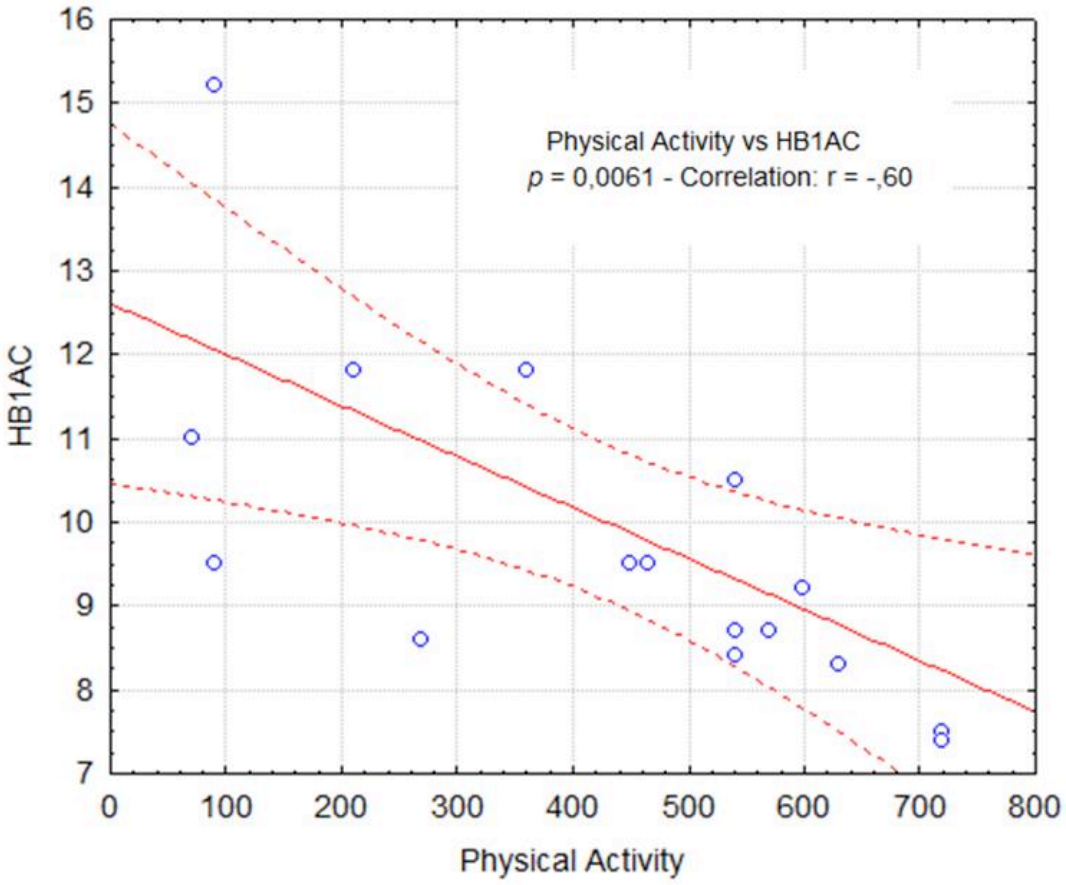
Results

As previously mentioned, 17 subjects were enrolled in this study. A description of participants' anthropometric characteristics is provided in Table 1. The dosage of HBA1C showed a value of 9.98 ± 2.18 %. Average weekly physical activity time of all participants was 432, 05 ± 214,58 min. Through the Pearson correlation index, the data analysis showed a inversely proportional correlation of r = - 0,60 between the physical activity time and HBA1C (Fig. 1).

Table 1: The anthropometric characteristics.

	Adolescents with type 1 Diabetes
Subjects, n	17
Age, years (yrs)	14,43 ± 2,83
Weight (kg)	58,79 ± 15,68
Height (cm)	159,91 ± 12,99
BMI	22,72 ± 4,78

Figure 1: The Pearson correlation index between HB1AC and the physical



Discussion

The glycosylated hemoglobin levels (HBA1C) provide an index of an individual's average glycemia over the past 2 to 3 months. HBA1C levels are characterized by a low intra-individual variability and also reflect both fasting and postprandial glycemic states (Selvin et al., 2010). Therefore, HBA1C levels are considered to be a useful indicator of dysglycemia (Selvin et al., 2007, Nathan et al., 1984). Recently, several studies have suggested that elevated HBA1C levels are associated with CVD in diabetic adults, and may be a risk indicator for the development of CVD (Gerstein et al., 2008, Selvin et al., 2010, Selvin et al., 2005, Silbernagel et al., 2011). Our data support the hypothesis (Wallberg-Henriksson et al., 1982, Wallberg-Henriksson et al., 1986) that regular exercise can improve metabolic control in type-1 diabetes. The study showed an improvement in long-term glucose control, according to HBA1C levels. Most studies that evaluated the effect of exercise on metabolic control in type-1 diabetes used aerobic exercise. Some of them showed an improvement in metabolic control (Campaigne et al., 1984, Mosher et al., 1998, Laaksonen et al., 2000), but others did not (Ligtenberg et al., 1999). In this study, improvement in glycated hemoglobin was found, but this seems to be related to the total amount of physical activity practiced. This hypothesis is confirmed by Ligtenberg et al., that showed a significant decrease in glycated hemoglobin in type-2 diabetes patients, but

only after 1 year of training, and not within 6 months (Ligtenberg et al., 1997). Furthermore, a recent review showed that structured exercise training of more than 150 minutes per week is associated with greater HBA1C declines than that of 150 minutes or less per week (Umpierre et al., 2011). In conclusion, our results indicate that the amount of moderate and intense physical activity or sports participation is associated with better metabolic control. Subjects with type-1 diabetes should therefore be targeted by educational programmers promoting a more active lifestyle. On the other hand, we highlight that these conclusions need to be supported by future studies with different cohorts and a larger population scale.

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