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# Effect of Regular Physical Activity on Metabolic Control in Pediatric Age Group with Type 1 Diabetes Mellitus

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## Abstract

**Background and aim:** Regular physical exercise (RPA) have a great role in management of type 1 diabetes mellitus (T1DM). We aimed from this study to correlate between regular physical activity and glycaemic control in pediatric age group with T1DM.

**Patients and methods:** This is a cross-sectional study, includes 243 T1DM children and adolescents visiting pediatric diabetes clinic at King Abdul-Aziz University Hospital (KAUH). Clinical and laboratory characteristics of patients were all recorded. Patients were divided into two groups, good glycemic control (HbA1c<8%) and poor glycemic control (HbA1c ≥ 8%). The collected data used to examine cross-sectional association between glycaemic control (HbA1c) and physical activity

**Results:** There was no significant difference between two groups regarding age, gender, mother education, father education, family history of type 1 diabetes and duration of RPA ( P value>0.05 ), while there was significant difference between two groups regarding RPA and frequency of RPA /week( P value<0.05 ). We found. Lower level of HbA1c in patients with more frequent RPA (P<0.05). Patients with no RPA were at 3.5 times risk of poor glycemic control (HbA1c ≥ 8%). Patients with long duration of diabetes had higher HbA1c.

**Conclusion:** Children and adolescents with T1DM should be encouraged to participate regularly in physical activity which results in better glycaemic control.

**Keywords:** Glycemic control; Type 1 diabetes; Physical activity; Regular

## Introduction

Diabetes Type 1 (T1D), is one of the commonest chronic diseases that affect children and adolescents. The rate of T1D incidence among children under age 14 is estimated to increase by three percent annually worldwide [1]. The reported prevalence of T1DM among Saudi Arabian children and adolescents in 2008 was 109.5/100,000 [2].

T1DM is known as autoimmune disease that results in destruction of insulin producing beta cell of the pancreance and impaired glucose homeostasis. Because of the increase in the understanding of the pathogenesis of type 1 diabetes, it has become possible to consider interventions to slow or even prevent hyperglycemia. Most complications of type 1 diabetes developed when the risk increases with age and maturation, hence it is important to consider such an interventions at early age as in childhood and adolescence.

Regular physical exercise has been recommended as one of the three cornerstones of management of diabetes for decades. According to American Diabetes Association (ADA) guidelines, "As is the case for all children, children with diabetes or prediabetes should be encouraged to engage in at least 60 min of physical activity each day"[3].

All kind of physical exercise, including competitive sports, should be allowed to children with diabetes. Exercise plays a crucial role in management of diabetes. Many studies of type 1 diabetes children or adolescent have demonstrated that exercise have a beneficial effect in type 1 diabetes. It lowers blood pressure [4], improves lipid profile [5,6], endurance capacity [7], body composition of fat to muscle mass ratio [8-11], physical fitness[7], insulin sensitivity [12], bone mineral density [11], vascular function [7], antioxidant capacity [13] and overall quality of the life [10,14].

We aimed from this study to correlate between regular physical activity and glycemic control in pediatric age group with T1DM.

## Patients and Methods

A cross-sectional questionnaire-based study design was used. A set of standardized data collection sheets entailing a series of questions with multiple answer-choices was utilized. The study population was formed of 243 children and adolescents (147 females and 96 males) between the ages of 1 and 18 and diagnosed with T1DM.

The participants were recruited from the young patients seeking specialty diabetic care in the pediatric endocrinology outpatient clinics in King Abdulaziz University Hospital (KAUH), a tertiary health care center in Jeddah, Saudi Arabia. Verbal consent was taken from all patients during time of data collection with permission to use their personal information. Each patient was assessed at one point in time in a single clinic visit. The questionnaires were collected over the course of one year from (January, 2013) until (January, 2014). They were filled in by the care providers or the patients themselves. The inquiries made pertained to overall diabetic health of the patients. For the purpose of this research, the segments involving duration of illness, home glucose monitoring, insulin therapy, hypoglycemic episodes and metabolic control in addition detailed exercise history were obtained. For physical

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exercise, 2 questions about the frequency per week (1/w, 2/w, 3or more /w) and duration of exercise (< or > than 30 min) were asked.

Regular Physical Activity (RPA) is defined as physical activity performed regularly at least once a week for at least 30 minutes. Aerobic exercises either passive for those below 5 years or active for those above 5 years.

Active aerobic exercises include running, walking, swimming, dance. Anaerobic exercises include weight bearing and resistance exercises such as sprinting and weight training jumping for those from 12-18 years.

### Inclusion criteria

Age 1-18 years patients with a diagnosis of Hashimoto's thyroiditis were included if they had a longstanding history of being clinically and biochemically euthyroid.

### Exclusion criteria

Patients with any renal, respiratory, or cardiac disease and chronic disease were excluded.School sports are excluded. At KAUH, HbA1c is measured using the SEIMENS Dimension clinical chemistry system using a GLU Flex reagent cartridge. Hexokinase method is laboratory test utilized. Patients with major data insufficiency due to incomplete questionnaires were excluded. Patients with secondary or monogenic diabetes as well those with polyendocrinopathies were also excluded. Approval from the hospital's ethical committee was obtained.

## Definitions

We have categorized our cohort patients into pre-pubertal group of less than 10 years of age and pubertal group (above 10 years of age) using Tanner staging. Then the participants were divided into Patients were divided into two groups, good glycemic control (HbA1c<8%) and poor glycemic control (HbA1c ≥ 8%). Patients were also grouped by the frequency of RPA as follows: RPA0 defined by occasional with no specific frequency or timing, RPA1 defined by 1-2 times per week and / or duration of less than 30 minutes, RPA2 defined by at least 3 times or more per week and duration of minimum 30 minutes. Regarding hypoglycemia, Hypoglycemic attacks were recognized by having blood glucose level ≤ 70 mg/dL (3.9 mmol/L) with or without symptoms,and patients were asked about the frequency per week (1->3/w) and symptoms of hypoglycemia.

## Statistics

Data entry and analysis was done using Microsoft Excel 2010. The data were compiled from the collected questionnaires. SPSS version 16.0 software was used for analysis. Quantitative data expressed as mean ± SD and qualitative data expressed as number and percent Pearson Chi-square test was used to analyze data of qualitative categorical variable and Chi-square trend for ranked data. Data were categorized into good control (HbA1c<8%) and poor control (HbA1c ≥ 8%). Stepwise regression analysis of factor predectivity for poor control was used. P value<0.05 was considered significant.

## Results

### Sociodemographics

The study includes 243 children and adolescents (mean age, 10.8 years; 38.6% males; 61.4% females) Mean HbA1c was 8.8 ± 2.96%. The majority of patients (66.3%) were above 10 years. While, the pubertal age group patients represented 48% of the total. The percentage of good control was 58.4% (Table 1). There was no significant difference between two groups regarding age and sex but 61.8% of females were in good control group in comparison to 53.2 for males in the same group (Table 2).

Regarding number of patients doing daily exercise, the Total number was 203 (82.6%). 40 (17.4%) of participants were RPA0, 98 (39%) RPA1and 105 (43.6%) RPA2 (Table 3).

### HbA1C

60.9% of the pre-pubertal age group patients had HbA1c level <8%, 39.1% had a HbA1c level ≥ 8%. Of pubertal group, 64.7% had a HbA1c <8% and 68.3% had a HbA1c ≥ 8% (Table 2). There was no significant difference between two groups regarding mother education, father education and family history of type 1 diabetes (Table 2)

In RPA2 69.5% had HbA1c <8 while, 30.5% had HbA1c ≥8 but in RPA1 59.1% had HbA1c <8 while, 40.9% had HbA1c ≥8. Meanwhile, in RPA0 17.5% had HbA1c <8 while, 82.5% had HbA1c ≥8 (Table 3). We found that frequency of RPA/week affects HbA1c P value<0. 05 but duration of RPA had no significant difference in diabetes control (Table 3). Correlation coefficient between duration of diabetes and HbA1c revealed that the more the duration the more HbA1c r=0.18 and P=0.006 (Table 4).

### Hypoglycemia

Total number of patients experienced at least one attack of hypoglycemia during RPA was 65 out of 203 (32%). Finally, patients with T1DM not practicing RPA are at 3.5 times risk of poor control of diabetes (HbA1c ≥8%) while, other variables did not add to model of prediction of control of diabetes ( mother education, father education and duration of RPA) (Table 5).

## Discussion

Regular exercise has been shown to have a beneficial effect on T1DM by improving the glycemic control, especially when children and adolescents followed the recommendations about diet control, insulin therapy and glucose monitoring in addition to the training program [15].

| Variable | N=243 |
|---|---|
| Age (years) Mean ± SD | 10.8 ± 4.6 |
| ‹10 | 82 (33.7%) |
| 10- | 80 (32.9%) |
| 15- | 81 (33.4%) |
| Duration of diabetes | |
| Range(years) | 1-10 |
| Median (years) | 3 |
| HbA1c | |
| Range | 5-18.1 |
| Mean ± SD | 8.8 ± 2.96 |
| ≥ 8 % | 101 (41.65) |
| ‹ 8 % | 142 (58.45) |
| Gender | |
| Male | 94 (38.6 %) |
| Female | 149 (61.4 %) |
| RPA | |
| Yes | 203 (83.5%) |
| No | 40 (16.5%) |
| Hypoglycemia during exercise (203) | 65/203 (32%) |

**Table 1:** Some sociodemographic data, duration of diabetes, practice of exercise and glycemic control By HBA1

| | HbA1c | ≥ 8 (101) | HbA1c | < 8 (142) | P |
|---|---|---|---|---|---|
| Family history of diabetes | | | | | |
| Yes | 45 | 36.8% | 77 | 63.2% | 0.13 |
| No | 56 | 46.2% | 65 | 53.8% | |
| Age (years) | | | | | |
| <10 82 | 32 | 39.1% | 50 | 60.9% | * |
| 10-80 | 35 | 43.8% | 45 | 56.2% | 0.7 |
| 15-81 | 34 | 42.0% | 47 | 58.0% | |
| Sex | | | | | |
| Male 94 | 44 | 46.8% | 50 | 53.2% | |
| Female 149 | 57 | 38.2% | 92 | 61.8% | 0.18 |
| Mother education | | | | | |
| Post graduate 7 | 3 | 42.9% | 4 | 57.1% | |
| Collage 52 | 14 | 26.9% | 38 | 73.1% | * |
| High school 75 | 38 | 50.7% | 37 | 49.3% | |
| Preparatory school 46 | 18 | 39.2 % | 28 | 60.8% | 0.23 |
| Elementary school 22 | 8 | 36.4 % | 14 | 63.6% | |
| Non 41 | 20 | 48.8% | 21 | 51.2% | |
| Father education | | | | | |
| Post graduate 23 | 13 | 56.5% | 10 | 43.5% | |
| Collage 60 | 21 | 35.0% | 39 | 65.0% | |
| High school 50 | 26 | 52.0% | 24 | 48.0% | 0.95 |
| Preparatory school 57 | 15 | 26.3% | 42 | 73.7% | |
| Elementary school 26 | 12 | 46.2% | 14 | 53.8% | |
| Non 27 | 14 | 51.8% | 13 | 48.2% | |

*Chi-sequare for linear trend

**Table 2:** Relation between some risk factors and diabetic control

| | HbA1c | ≥ 8 (101) | HbA1c | <8 (142) | P |
|---|---|---|---|---|---|
| RPA | | | | | |
| 2 Three times/week (105) | 32 | 30.5% | 73 | 69.5% | * |
| 1 One to two times/week (98) | 40 | 40.9% | 58 | 59.1% | 0.000 |
| 0 No specific frequency (40) | 33 | 82.5% | 7 | 17.5% | |
| RPA/week | (N=72) | | (N=131) | | |
| Once 117 | 53 | 46.3% | 64 | 54.7% | * |
| Twice 28 | 12 | 42.9% | 16 | 57.1% | 0.000 |
| More than Twice 58 | 7 | 12.1% | 51 | 87.9% | |
| <30 minutes 119 | 39 | 32.8% | 80 | 67.2% | 0.33 |
| ≥ 30 minutes 84 | 33 | 39.4% | 51 | 60.7% | |

*Chi-sequare for linear trend.

**Abbreviations:** (RPA); Regular Physical Activity; RPA0, occasional with no specific frequency or timing(n=40 or 17.4%); RPA1, 1-2 times per week and/or duration of less than 30 minutes (n=98 or 39%); RPA2, at least 3 times or more per week and duration of minimum 30 minutes (no=105 or43.6%).Good control ,HbA1c <8% and poor control, HbA1c ≥ 8%, *P<0.05 significant

**Table 3:** relation between RPA and HbA1c.

Our study shows that regular physical activity was associated with lower HbA1c level P value<0.05 and frequency of RPA was associated with lower HbA1c level. This comes with Herbst et al. [16] who studied the relation between frequency of RPA and glycemic control and revealed that HbA1c level was higher in the groups with less frequent RPA ( 8.4% in group RPA0 vs. 8.1% in group RPA2). Also, he stated that multiple regression analysis revealed RPA was one of the most important factors influencing glycemic control which comes with our results.

A meta-analysis by Tonoli [17], studied the effect of deferent types of exercise on metabolic control in patients (aged from 8-48 years) with T1DM, this meta-analysis showed that regular exercise have a significant effect on acute and chronic glycemic control (HbA1c). Studies of training program on group of adolescents with T1DM revealed that regular physical exercise significantly decrease HbA1c [8,18]. Other studies revealed similar significant results [4-6,9,19,20],

| | |
|---|---|
| r=0.18 | P=0.006 |

r: Regression Coefficient.
**Table 4:** Correlation coefficient between duration of diabetes and HbA1c.

| RPA | β | SE | Wald | P | OR 95% CI |
|---|---|---|---|---|---|
| 0 No specific frequency | | | 6.23 | 0.04 | |
| 1 One to two times/week | 0.74 | 0.39 | 3.5 | 0.06 | 2.1 (0.9-4.6) |
| 2 Three times/week | 1.27 | 0.60 | 4.43 | 0.03 | 3.5 (1.09-11.5) |

**Abbreviations:** RPA: Regular Physical Activity; RPA0: Occasional with No Specific Frequency or Timing; RPA1: 1-2 Times per Week and/or Duration of Less than 30 Minutes; RPA2: At least 3 Times or More per Week and Duration of Minimum 30 Minutes.SE: Slandered Error or Odd Ratio. CI: Confidence Interval, β: Regression Coefficient.

**Table 5:** Significant predictor of diabetes control.

which showed that improvement was associated with the frequency of physical activity [4,20]. Slight decrease in HbA1c was observed with combination of aerobic and muscle strength exercise training program [10,14] and was better with competitive sport [21].

Other meta-analysis [22], when combining the results of both young and adult T1D, demonstrated reduction HbA1c but this was not significant and didn't reveal evidence for glycemic benefit of exercise, however sub-analysis suggest that exercise may confer a glycemic benefit in the young, and when undertaken for longer periods. The reasons for this finding could be explained by increased calorie intake, insulin dose reduction around the time of the exercise or lack of power.

The occurrence and the frequency of hypoglycemic attacks were more in good control, but no significant correlation was found between metabolic control and hypoglycemic attack, and thus the frequency of regular exercise. Similar result was found in previous study [20], in which severe hypoglycemia was independent risk and not related to frequency of exercise.

Patients with no RPA were at 3.5 times risk of poor glycemic control (HbA1c ≥ 8%) and this comes with data talking about the possible protection of physical activity performed at childhood and adolescence could offer to these sample during their adulthood [23]. Recent studies have reported a protective effect on adulthood, which is offered by early sport practice and is maintained even when considered the physical activity performed at adulthood [24-26].

We had some limitations in our study, there was no time for our study, effect of diet, effect of exercise intensity and level of energy expenditure is multifactorial and often cannot be well captured by use of a questionnaire [27]. We did not take consideration of racial and ethnicity effects. Also, we did not have a healthy control group to compare physical activity. Moreover, the potential for recall bias with the use of self-reported questionnaires. However, similar physical activity questionnaires have also been found to be valid, reliable, and suitable to use for the purpose of data collection in child and adolescent populations [28].

## Conclusion

This study confirms that Regular physical activities lower HbA1c and results in better glycemic control. According to our results we strongly advise for more physical activity in order to have better glycemic control for T1D, in addition to diet and insulin.

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