Effects of a home-based aerobic exercise program on glycosylated hemoglobin and the peak oxygen uptake in children and adolescents With Type 1 DM

Abstract

Aims and objective. To explore the effects of a home-based aerobic exercise program on glycosylated hemoglobin and the peak oxygen uptake with type 1 diabetes mellitus.

Background.

Type 1 diabetes mellitus is a growing national and international public health concern. Besides, glycemic control not only by diet nutrition but also by medicine. Regular exercise has been shown to be effective in glucose control, including: improved glucose tolerance, increased sensitivity to insulin, decreased glycosylated hemoglobin levels, and decreased insulin requirements, and improving cardiorespiratory fitness.

Design. A quasi-experimental design with the twelve weeks of the home-based aerobic exercise program.

Method. In total, 28 participants completed the study: 12 were in the intervention group (IG); 11 were in the control group 1 (CG1, didn’t take part in any exercise program) and 5 were in the control group 2 (CG2, engaged in self directed exercise). Participate at the intervention group completed 3, 30 minutes sessions of guided exercise (at 40-60% heart rate reserve) each week for 12 weeks. A mixed model using the MIXED Procedure in SAS was used to capture the longitudinal outcome measures (modeling covariance across time).

Results.

At post-intervention assessment and 3 months follow up, patients who had exercise had more decreased HbA1c value (mean change = −0.38, at the IG; mean change = −0.40, at the CG2)than patients without exercise (mean change = −0.09, at the CG1). However, at post-intervention assessment, patients who had exercise had increased the mean VO₂ peak
(ml/kg/mins) of the peak oxygen uptake (mean change = 0.13, at the IG) than patients at the CG2 (mean change = 0.42) and the CG1 (mean change = 0.01). For the change of the outcome variable HbA1c value, the mixed model neither dietary intake, exercise groups, nor baseline, post-intervention, and three-month followed were statistically associated with HbA1c. It indicate these factors were not to affect the home-based aerobic exercise program on glycosylated hemoglobin and the peak oxygen uptake in children and adolescents with Type 1 DM.

**Conclusions.** Twelve weeks of home-based aerobic exercise program have no significant effect on the glycemic control but increase the VO$_2$ peak value of the cardiorespiratory fitness response to periodical aerobic exercise.

**Relevance to clinical practice.** Studies are needed to examine the effectiveness exercise program over time for patients with type 1 diabetes mellitus. As well as indicating glycemic control consists complicated life style behaviors and a comprehensive program is needed in addition to exercise only.

**Key Words:** home-based aerobic exercise, children and adolescents, type 1 diabetes mellitus, cardiorespiratory fitness
**Introduction**

Type 1 Diabetes Mellitus (DM) is the most common endocrine disease in children and adolescents (Robert et al. 2007). The goals for treatment of children and adolescents with type 1 DM are twofold: first to achieve stable glycemic control and then to prevent or delay the occurrence of life-threatening complications associated with ketoacidosis (Robert et al. 2007). Glycosylated hemoglobin (HbA1c) provides the average blood glucose level for the past three months (American Diabetes Association 2008). Exercise increases the ability of insulin to activate glucose transport into the muscles that have been exercised, this effect can persist for many hours after physical activity has ceased (Gulve 2008). Aerobic exercises in particular, are recommended as a model for an exercise program that the parents can follow with their children because it has been shown to improve glycemic control in diabetes. However, motivating children and adolescents to adhere to an exercise program, is a tremendous challenge (Vanelli et al. 2006). Individualization of the prescription for the exercise program is vital to its’ success (Vanelli et al. 2006). Therefore, the purpose of this study was to examine the feasibility of examining the effects of a home-based aerobic exercise program on HbA1c and cardiorespiratory fitness in children and adolescents with type 1 DM in Taiwan.

**Method.** In total, 28 participants completed the study: 12 were in the intervention group (IG); 11 were in the control group 1 (CG1, didn’t take part in any exercise program) and 5 were in the control group 2 (CG2, engaged in self directed exercise). Participate at the intervention group completed 3, 30 minutes sessions of guided exercise (at 40-60% heart rate reserve) each week for 12 weeks. A mixed model using the MIXED Procedure in SAS was used to capture the longitudinal outcome measures (modeling covariance across time).

**Measures**

**Glycosylated hemoglobin (HbA1c)**
HbA1c provided the average blood glucose level for the previous three months at each measurement point. In this study, we used the Primus type of Biochemistry Laboratory at the Chang-Gung Memorial Hospital with the affinity HPLC method. The following levels as indicators of good diabetes control: < 8.0% for school age and < 7.5% for adolescents (ADA 2008). HbA1c concentrations were measured prior to two days of starting exercise, and following completion of exercise two days.

**The peak oxygen uptake (VO₂ peak)**

The cardiorespiratory fitness assessment of the peak oxygen uptake (VO₂ peak; ml/kg/min) was conducted by using the Modified Bruce Treadmill Test. It was examined during the participant’s peak exercise. It is closely related to the functional capacity of the heart. Oxygen uptake was calculated from the measurements of oxygen and carbon dioxide in the expired air the rate of respirations per minute. This treadmill test was conducted before and after the twelve weeks of intervention. The VO₂ peak was the product of the peak cardiac output (L blood per min) and arterial-venous oxygen difference (ml O₂ per L blood) (ACSM 2006).

**The Children's OMNI-walk/run Scale of Perceived Exertion**

The Children’s OMNI (Utter et al. 2002) was used to assess the perceived exercise exertion during the exercise process. It includes three descriptors: pictorial, semantically consonant verbal (from “not tired at all” to “very, very tired” and a numerical category response. These descriptors were positioned together so that children could report their perceived exertion responses defined by pictorial, verbal or numerical responses simultaneously without the difficulty of interpretation of verbal descriptor (Utter et al. 2002).

**Statistical analyses**

A mixed model using the MIXED Procedure in SAS (SAS Institute Inc 2006) was used to capture the longitudinal outcome measures (modeling covariance across time).
Results

Characteristics of participants
In total, 28 patients, including 8 boys (29%) and 20 girls (71%) participated in the study. Twelve were in the intervention group with adherence to the prescribed video exercise program, eleven were in the CG1 and five were in the CG2. The average age of children and adolescents was 12.21 (SD = 2.31) years with the age range between 6.9 and 16.42 years. Most patients (n = 20, 71%) were enrolled in elementary school, followed by junior high school (n = 5, 18%), and senior high school (n = 3, 11%). The mean duration since DM was diagnosed was 4.22 (SD = 2.80) years. The mean BMI of in the IG was 17.43 kg/cm² (SD = 2.61) and was not significantly different from the mean in the CG1 and CG2. The least square means HbA1c at baseline in the intervention group was 8.40% and was not significantly different from the mean change for either CG1 (8.33%) or CG2 (8.54%) (see table 2).

Change of HbA1c value
At post-intervention assessment, patients who had exercise trend had more decreased HbA1c value (at the IG, mean change = −0.38, from 0.54 to 0.16; at the CG2 (mean change = −0.40, from 0.68 to 0.28) than patients in the CG1(mean change = −0.09, from 0.57 to 0.48). At 3 month follow-up assessment, patients who had exercise trend had more decreased HbA1c value (at the IG, mean change = 0.13, from 0.16 to 0.29; at the CG2, mean change = 0.42, from 0.28 to 0.70) than patients at the CG1(mean change = 0.01, from 0.48 to 0.49).

The peak oxygen uptake (VO₂ peak)
For the VO₂ peak, there are no intervention effects or time differences on VO₂ peak among three groups before and after the twelve weeks of the intervention. At post-intervention assessment, patients who had exercise had increased the largest mean VO₂ peak (ml/kg/mins)
of the peak oxygen uptake (at IG, mean change = 1.69; from 36.31 to 38.00 than patients at 
the CG2 with exercise (mean change = 0.44; from 34.51 to 34.07) and CG1 (mean change 
= -1.05, from 35.51 to 34.46).

Factors related to HbA1c and the peak oxygen uptake (VO_{2peak})

For the change of the outcome variable HbA1c (the observed HbA1c – the expected HbA1c) 
value, the mixed model neither dietary intake, groups, nor time was statistically associated 
with HbA1c. It show these factors weren’t effect the home-based aerobic exercise program 
on glycemic control.

Conclusions

It was shown in this study that the glycosylated hemoglobin couldn’t improve through 
regular exercise at post-intervention, but this effect did not last until the 3 month follow up 
for the glycemic control. And then, it also finding indicated that patients who had exercise 
regularly had better VO_{2peak} value, which suggested referred to that they had better 
cardiorespiratory fitness. How to adhere an exercise program is a big challenge for youth 
with type 1 DM. It is important to comply with the exercise log and recording regularly. 
Patients can improve the HbA1c levels and control diabetes care. Moreover, studies are 
needed to identify factors related to diabetes control in this populations and providing the 
best possible care for patients with these diabetes mellitus.
<table>
<thead>
<tr>
<th>variables</th>
<th>Intervention Group</th>
<th>Control Group 1</th>
<th>Control Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>N ( % )</td>
<td>Mean (SD)</td>
<td>N ( % )</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Age (yr) a</td>
<td>1/2 (43) 11.62 (2.12)</td>
<td>11 (39) 12.77 (1.79)</td>
<td>5 (18) 13.44 (2.2)</td>
</tr>
<tr>
<td>Gender b</td>
<td>Boys 4 (33) 2 (19) 2 (40)</td>
<td>Girls 8 (67) 9 (82) 3 (60)</td>
<td></td>
</tr>
<tr>
<td>Education b</td>
<td>elementary 1 (83) 7 (64) 3 (60)</td>
<td></td>
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</tr>
<tr>
<td>Junior 1 (8)</td>
<td>3 (27) 1 (20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>senior 1 (8)</td>
<td>1 (9) 1 (20)</td>
<td></td>
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<tr>
<td>The duration since DM diagnosed (yr) a</td>
<td>12 (43) 4.42 (2.58)</td>
<td>11 (39) 3.82 (2.87)</td>
<td>5 (18) 3.42 (3.4)</td>
</tr>
<tr>
<td>BMI (kg/cm^2) a</td>
<td>12 (43) 17.43 (2.61)</td>
<td>11 (39) 18.84 (2.67)</td>
<td>5 (18) 19.66 (1.1)</td>
</tr>
<tr>
<td>Mean HbA1c (%) at baseline a</td>
<td>12 (43) 8.06 (1.06)</td>
<td>11 (39) 8.33 (1.69)</td>
<td>5 (18) 8.54 (0.9)</td>
</tr>
</tbody>
</table>

a Analysis Of Variance
b Chi-square test
c Control Group 1(CG1): patients did not take part in any exercise program
d Control Group 2 (CG2): patients engaged in self-directed exercise