

**Table G3.A10. Physical Activity Effects on Glycemic Control and Cardiovascular Risk Factors in Type 1 Diabetes: Intervention Studies**

Author, Year	Subjects	Groups, Intervention	Outcome(S)	Main Results
Peterson et al., 1980 (1)	n=10, T1D All exercise	Home program of exercise and carbohydrate control	A1c Fasting glucose Muscle biopsy	<b>A1c:</b> Improved <b>Fasting glucose:</b> Improved <b>Muscle biopsy:</b> Decreased basement membrane thickness in 6/7, biopsied
Wallberg-Henriksson et al., 1982 (2)	n=9 Male T1D	1 hour jogging, running, gymnastics, ball games 16 weeks	VO <sub>2max</sub> A1c Insulin sensitivity Total cholesterol %HDL	<b>VO<sub>2max</sub>:</b> Improved by 8% <b>A1c:</b> 11.3 ± 0.5% to 10.4 ± 0.7%; NS <b>Insulin sensitivity:</b> Improved 20% <b>Total cholesterol:</b> 14% decrease <b>%HDL:</b> From 24 to 30%
Campaigne et al., 1984 (3)	n=19, T1D Children 9 exercise 10 no exercise	30 minutes vigorous exercise 3x each week 12 weeks	VO <sub>2max</sub> A1c Fasting glucose	<b>VO<sub>2max</sub>:</b> Improved in exercise group: -47.14 ± 1.94 to 50.69 ± 1.30 <b>A1c:</b> Improved in exercise group <b>Fasting glucose:</b> Improved in exercise group <b>All P &lt; 0.05.</b> No effect in control group
Zinman et al., 1984 (4)	n=13, T1D 7 non-Diabetic controls	45 minutes bike 2-3 x each week 3 months	VO <sub>2max</sub> Plasma glucose Fasting glucose A1c	<b>VO<sub>2max</sub>:</b> Increased in both groups <b>Plasma glucose:</b> Decreased in T1DM (225.8 ± 16.1 to 148.5 ± 16.8 mg/dL) <i>P</i> < 0.001 <b>Fasting glucose:</b> No change: pre: -193.7 ± 27.5 6 weeks: 192.5 ± 27.1 mg/dL 12 weeks: -202 ± 30.1 mg/dL <b>A1c:</b> No change: pre: -10.7 ± 0.3% 6 weeks: -10.7 ± 0.03% 12 weeks: -10.3 ± 0.8%
Wallberg-Henriksson et al., 1986 (5)	n=13 (6 exercise 7 control)	5 months 20 minutes bicycle daily	A1c Cholesterol TGs	<b>A1c:</b> No change <b>Cholesterol:</b> No exercise effect <b>TGs:</b> No change
Bak et al., 1989 (6)	n=7, T1D	"Physical training" 6 weeks	VO <sub>2max</sub> A1c Insulin dose	<b>VO<sub>2max</sub>:</b> Improved <b>A1c:</b> Improved: -7.9 ± 1.4% to 7.7 ± 1.5% ( <i>P</i> < 0.05) <b>Insulin dose:</b> Decreased: -43 ± 9 to 38 ± 8 U/day ( <i>P</i> < 0.05)

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Author, Year	Subjects	Groups, Intervention	Outcome(S)	Main Results
Huttunen et al., 1989	n=32 Mean age, 12 years	"+/-" exercise intervention 1 hour/week physical activity 3 months	HbA1c VO <sub>2max</sub>	<b>HbA1c:</b> worse in exercise group: 9.8 to 10.5% ( $P < 0.01$ ) no exercise group: 9.4 to 9.7% (NS) <b>VO<sub>2max</sub>:</b> improved in exercise group (40.0 to 43.8 mL·min <sup>-1</sup> ·m <sup>-2</sup> ) ( $P < 0.01$ )
Durak et al., 1990 (7)	n=8, male T1D	Randomized crossover design. No exercise vs. resistance training 3x each week, 10 weeks	A1c TGs	<b>A1c:</b> Improved: HbA1c 6.9 ± 1.4 vs. 5.8 ± 0.9% ( $P = 0.05$ ) <b>TGs:</b> Improved: 5.044 ± 1.06 vs. 4.628 ± 0.88 mM ( $P = 0.01$ )
Lehmann et al., 1997 (8)	n=20, T1D	Biking, running, hiking >135 minutes/week or increase baseline 3 months	Active time VO <sub>2max</sub> Steady-state glucose LDL cholesterol HDL HDL3 fraction SBP DBP Weight height ratio Severe hypoglycemic	<b>Active time:</b> Increased: 195 ± 176 to 356 ± 164 min/week, $P < 0.001$ <b>VO<sub>2max</sub>:</b> Increased: 2,914 ± 924 to 3,092 ± 905 mL/min, $P < 0.001$ <b>Steady-state glucose:</b> Decreased: 10.5 ± 4.8 to 7.0 ± 3.3 mM, $P < 0.01$ <b>LDL cholesterol:</b> Decreased by 14%, $P < 0.05$ <b>HDL:</b> Increased by 10%, $P < 0.05$ <b>HDL3 fraction:</b> Increased by 16%, $P < 0.05$ <b>SBP:</b> Decreased: 127 ± 9 to 124 ± 8, $P < 0.05$ <b>DBP:</b> Decreased: 80 ± 5 to 77 ± 5, $P < 0.01$ <b>Weight height ratio:</b> Decreased: 0.882 ± 0.055 to 0.858 ± 0.053, $P < 0.001$ <b>Severe hypoglycemic:</b> Reduced: 0.14 to 0.10 per patient year
Fuchsjahger-Mayrl et al., 2002	n=26, T1D 18 exercise 8 sedentary control	1 hour moderate cycling 2-3 x each week Supervised	Brachial artery flow mediated dilation	Improved from 6.5 ± 1.1% to 9.8 ± 1.1%, $P = 0.04$
Roberts et al., 2002 (9)	n=24 T1D Adolescents HbA1c > 9 (12) HbA1c < 9 (12)	All: 12 weeks supervised exercise, then 12 weeks unsupervised	VO <sub>2max</sub> A1c	<b>VO<sub>2max</sub>:</b> Increased during supervised, back to baseline during unsupervised exercise. <b>A1c:</b> No change in either group after supervised training

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Author, Year	Subjects	Groups, Intervention	Outcome(S)	Main Results
Ramalho et al., 2006 (10)	n=13 7 group A 6 group B	Resistance (group A) vs. Moderate aerobic exercise (group B) walk/run 40' 3 x each week 12 weeks	A1c Fasting glucose Insulin dose Lipids BMI Waist circumference	<b>A1c:</b> No change either group <b>Fasting glucose:</b> No change either group <b>Insulin dose:</b> Decreased in both <b>Lipids:</b> No change in either group <b>BMI:</b> No change in either group <b>Waist circumference:</b> Improved in aerobic group, not resistance
Harmer et al., 2007 (11)	n=8, T1D	7 weeks, 3 x each week Intermittent High intensity cycle training — ramped up number of bouts	HbA1c Glucose during exercise	<b>HbA1c:</b> No change: $8.6 \pm 0.8\%$ to $8.1 \pm 0.6\%$ ( $P = 0.09$ ) <b>Glucose during exercise:</b> Sustained rise during exercise and early recovery attenuated with training (But possible type II error. May be significant change.)

BMI, body mass index; DBP, diastolic blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein; NS, not significant; SBP, systolic blood pressure; TGs, triglycerides; T1D, type 1 diabetes

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