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# Lifestyle risk factors for atherosclerosis in adults with type 1 diabetes

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## Abstract

The objective of this study was to compare the amount of self-reported physical activity, alcohol and tobacco use in a large sample of adults with type 1 diabetes and non-diabetic subjects. A second aim is to test the hypothesis that these lifestyle risk factors are associated cross-sectionally with coronary artery calcification. In 2000–2002, the Coronary Artery Calcification in Type 1 Diabetes (CACTI) study applied validated questionnaires for smoking, alcohol and physical activity to 582 type 1 diabetes subjects and 724 non-diabetic subjects. More type 1 diabetes subjects reported current smoking than non-diabetic subjects (12.3% versus 8.6%,  $p=0.027$ ). Overall, reported physical activity did not differ by diabetes status ( $p=0.79$ ). More type 1 diabetes subjects reported never having consumed alcohol (10% versus 4%,  $p<0.0001$ ) and those who drank consumed less alcohol ( $p=0.0015$ ) than non-diabetic subjects. Physical activity and smoking were significantly associated with the presence of coronary artery calcification (adjusted OR=0.9, 95% CI: 0.8–0.996,  $p=0.045$ , and OR=1.7, CI: 1.1–2.6,  $p=0.03$ , respectively). Type 1 diabetes was independently associated with increased odds of coronary artery calcification (OR=3.5, 95% CI: 2.5–5.0,  $p<0.0001$ ). Differences exist in lifestyle-related cardiovascular risk factors in men and women with type 1 diabetes compared with non-diabetic subjects in the CACTI study.

## Keywords

diabetes, cardiovascular disease, physical activity, smoking, alcohol

## Introduction

Scant data exist in persons with type 1 diabetes regarding lifestyle factors, such as physical activity,<sup>1</sup> alcohol consumption<sup>2</sup> and smoking.<sup>3</sup> Increasing physical activity and smoking cessation can improve the risk profile of cardiovascular disease (CVD).<sup>4</sup> Moderate alcohol consumption has been shown to have a beneficial effect on CVD risk,<sup>5–7</sup> but intake is recommended to be limited to one drink per day for adult women and two for adult men.<sup>4</sup>

CVD is the leading cause of morbidity and mortality in type 1 diabetes subjects<sup>8</sup> and the age-adjusted relative risk for CVD may be greater in type 1 diabetes than type 2 diabetes.<sup>9</sup> The current American Diabetes Association and the American Heart Association recommendations for primary prevention of CVD in people with diabetes include glycaemic control, blood pressure and lipid treatment to achieve goals, cessation of tobacco use, antiplatelet agent therapy and lifestyle management.<sup>4</sup> The recommendation for lifestyle management focuses on achieving or maintaining a healthy weight, medical nutrition therapy and physical activity.

Despite these recommendations little is known concerning lifestyle factors in adults with type 1 diabetes and the few published studies are limited by the small numbers of subjects.<sup>1</sup> The aim of this report is to describe cross-sectional lifestyle

factors in a large cohort of young adults with type 1 diabetes compared with non-diabetic subjects. A second aim is to test the hypothesis that these lifestyle factors are associated cross-sectionally with coronary artery calcification (CAC), a marker of subclinical coronary artery atherosclerosis.<sup>10</sup>

## Methods

The data presented in this report were collected as part of the baseline examination of 1,416 subjects in the Coronary Artery

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Acronyms: CAC: Coronary Artery Calcification; CACTI: Coronary Artery Calcification in Type 1 Diabetes Study; CVD: Cardiovascular Disease; IRAS: Insulin Resistance Atherosclerosis Study; CAD: Coronary Artery Disease; EBCT: Electron Beam Computed Tomography

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Calcification in Type 1 Diabetes (CACTI) study.<sup>11</sup> Of these, 1,306 subjects (92%) completed questionnaires (582 subjects with type 1 diabetes [46% male, age  $37 \pm 9$  yr] and 724 non-diabetic subjects [51% male,  $39 \pm 9$  years]) and were included in the analysis. The validated questionnaires for tobacco and alcohol use were originally developed by the Insulin Resistance Atherosclerosis Study (IRAS).<sup>12</sup> The validated physical activity or Modifiable Activity Questionnaire was designed for the Pima Indian study.<sup>13</sup> Smoking was categorised as never smoking (less than 100 cigarettes in a lifetime), current smoking or former smoking, all self-reported. Lifetime alcohol use was defined as 12 or more alcoholic beverages ever consumed. Physical activity (blocks and flights of stairs walked, sports and recreation/leisure) was estimated using kilocalories expended per week. Race/ethnicity was reported in the categories of non-Hispanic white, Black or African American, American Indian or Alaskan Native, Asian, Native Hawaiian or other Pacific Islander, other race, or no response. Income was reported as total family income, before taxes, for all family members living in the home, from all sources in the last year. The income categories (per year) were defined as, low (<\$10,000 to \$30,000), medium (>\$30,000 to \$75,000) and high (>\$75,000). Education was reported as 'less than college' or 'college or higher'. The non-diabetic subjects were generally spouses, friends and neighbours of the cases, and thus were expected to be more similar with respect to lifestyle factors than the general population. All subjects were asymptomatic from coronary artery disease (CAD) and had no history of coronary artery bypass graft, coronary angioplasty, myocardial infarction or unstable angina. All subjects with diabetes had been diagnosed <30 years of age or had a diagnosis of type 1 diabetes confirmed by an endocrinologist and had been treated with insulin within the first year of diagnosis. All non-diabetic subjects reported never having been diagnosed with diabetes of any type, including gestational diabetes.

Participants completed the baseline examination between March 2000 and April 2002. Current height, weight, waist circumference (measured at the smallest point between the 10th rib and the iliac crest over the bare skin) and hip circumference (measured at the maximum circumference of the buttocks) were recorded, and BMI (weight/height<sup>2</sup>) and waist-to-hip ratio (WHR) were calculated. Resting systolic blood pressure (SBP) and fifth-phase diastolic blood pressure (DBP) were measured three times while the subjects were seated, and the second and the third measurements were averaged. After an overnight fast, blood was collected and centrifuged, and separated plasma was stored at 4°C until assayed. Total cholesterol and triglyceride levels were measured using standard enzymatic methods. High-density lipoprotein (HDL) cholesterol was separated using dextran sulfate, and low-density lipoprotein (LDL) cholesterol was calculated using the Friedewald formula. High-performance liquid chromatography (HPLC; BioRad variant) was used to

measure HbA1c. An abdominal computed tomography scan at the L2–L3 levels was obtained on each subject. The L2–L3 disc space was located by counting the lumbar vertebra with L1 being the first non-rib-bearing vertebra. A single 6-mm thick image was obtained through the L2–L3 disc space during suspended respiration.

All subjects underwent two electron beam computed tomography (EBCT) scans within 5 minutes without contrast at baseline.<sup>14</sup> Images were obtained of the entire epicardial system using an Imatron C-150 Ultrafast CT scanner (Imatron, South San Francisco, CA), with a 100 ms exposure. The standard acquisition protocol was used as described previously.<sup>15</sup> Scanning started from near the lower margin of the bifurcation of the main pulmonary artery. Images were electrocardiographically triggered at 80% of the R–R interval, and 30 to 40 contiguous 3 mm slices were acquired. The volume scores were calculated using the volumetric method, which is based on isotropic interpolation as described previously.<sup>16</sup>

The study protocol was approved by the Colorado Combined Institutional Review Board. Informed consent was obtained from all subjects before enrolment.

Demographic data are reported as means and standard deviations. General linear and logistic regression models (SAS 9.0, SAS Institute Inc., Cary, NC) were used to calculate age-adjusted estimates and to determine whether lifestyle factors differed by sex and diabetes. Interaction terms for sex\*diabetes were included in the models to test whether differences between subjects with type 1 diabetes and non-diabetic subjects were similar for men and women. Logistic regression analysis was used to determine the association between demographic and lifestyle factors (race/ethnicity, education, income, smoking, physical activity, and alcohol consumption) and presence of CAC (CAC>0, yes/no) at baseline adjusting for age, education and income, then in multivariable analysis with all variables included in the model, adjusting for age, education and income. The following variables were found to be distributed non-normally and therefore were log-transformed: triglycerides, visceral fat, alcohol (drinks/month) and physical activity (kcal/week). All tests were two-sided and a p-value of  $p<0.05$  was considered significant.

## Results

The differences in lifestyle related risk factors for CVD among subjects with type 1 diabetes and non-diabetic subjects are shown in Table 1. More type 1 diabetes subjects reported being current smokers than non-diabetic subjects (12.3% versus 8.7%,  $p=0.03$ ). Sex-specific age-adjusted comparison demonstrated that a higher percentage of men with type 1 diabetes smoke than non-diabetic subjects (12.7% versus 7.9%,  $p=0.005$ ), although the difference was

not significant in women with type 1 diabetes compared with non-diabetic subjects (12.3% versus 9.2%,  $p=0.19$ ). Overall, reported physical activity was not different between subjects with type 1 diabetes and non-diabetic subjects (1,324 versus 1,346 kcal/week, respectively;  $p=0.79$ ). There was a significant interaction of sex and diabetes on physical activity ( $p=0.01$ ), reflecting the opposite relationships of type 1 diabetes and physical activity in men and women. The data trend toward higher reported physical activity in men with type 1 diabetes (adjusted for age) compared with non-diabetic men and women with type 1 diabetes reporting less physical activity than non-diabetic women, although the differences were not statistically significant ( $p=0.08$  and  $p=0.097$ , respectively).

Type 1 diabetes subjects were more likely to report no lifetime alcohol use (10% versus 4%,  $p<0.0001$ ), and those who drink reported consuming less alcoholic drinks per month ( $p=0.002$ ) than non-diabetic subjects, although when stratified by sex this was not statistically significant ( $p=0.053$  for men and  $p=0.08$  for women). Overall, women reported significantly less ( $p>0.0001$ ) consumption of alcoholic drinks per month than men.

Subjects with type 1 diabetes had significantly less visceral fat ( $p<0.0001$ ), lower average waist circumference ( $p=0.02$ ), lower cholesterol ( $p<0.0001$ ), lower LDL-c ( $p<0.0001$ ), higher HDL-c ( $p<0.0001$ ), lower triglycerides ( $p<0.0001$ ), higher average SBP ( $p<0.0001$ ), lower average DBP ( $p=0.003$ ) and less alcohol consumption ( $p=0.002$ ) than non-diabetes subjects (Table 1). Men with type 1 diabetes had significantly lower BMI ( $p=0.03$ ), less visceral fat ( $p<0.0001$ ), lower average waist circumference ( $p=0.002$ ) and waist-to-hip measurements ( $p<0.0001$ ), lower total cholesterol ( $p<0.0001$ ), LDL-c ( $p<0.0001$ ), triglycerides ( $p<0.0001$ ) and higher HDL-c ( $p<0.0001$ ) than non-diabetic subjects. However, men with type 1 diabetes had higher average SBP and DBP ( $p=0.0004$  and  $p=0.005$ , respectively) than non-diabetic men. Women with type 1 diabetes had lower BMI ( $p=0.01$ ), less visceral fat ( $p=0.03$ ), lower average waist circumference ( $p=0.01$ ), lower total cholesterol ( $p=0.001$ ), LDL-c ( $p=0.0001$ ), triglycerides ( $p=0.003$ ) and higher average SBP ( $p=0.001$ ) than non-diabetic women. Waist-to-hip, HDL-c and average DBP were not significantly different between the women with diabetes and the non-diabetic women (Table 1).

Significant differences in race/ethnicity, education and income were found between type 1 diabetes subjects and non-diabetic subjects (Table 1). Race/ethnicity data were analysed in the categories of 'non-Hispanic white' and 'other'. Non-diabetic subjects reported a higher percentage of 'other' race/ethnicity compared with type 1 diabetes subjects (16.0% versus 6.1% [ $p<0.0001$ ] for group, 12.8% versus 6.7% [ $p=0.008$ ] for men and 19.1% versus 5.6% for women [ $p<0.0001$ ], respectively). Type 1 diabetes subjects reported 'college or higher' less frequently than non-diabetic

subjects (53.2% versus 68.6% [ $p<0.0001$ ] for group, 55.9% versus 68.6% [ $p=0.001$ ] for men and 50.6% versus 68.6% [ $p<0.0001$ ] for women). Type 1 diabetes subjects reported their income category to be lower than non-diabetic subjects ( $p<0.001$  for group,  $p=0.001$  for men and  $p=0.003$  for women).

The association between education and lifetime alcohol use was not significant for either the type 1 diabetes subjects or the non-diabetic subjects; however there was an association between alcohol use and smoking in type 1 diabetes subjects ( $p<0.0001$ ) and non-diabetic subjects ( $p=0.002$ ). Smoking was also related to education level and type 1 diabetes subjects with less than a college education were more likely to be a current or former smoker ( $p<0.0001$ ) as similar with the non-diabetic subjects ( $p=0.0003$ ).

## Associations with CAC

As expected, age was independently associated with presence of CAC in the overall cohort and in all stratified models. In addition, in the entire cohort type 1 diabetes was independently associated with increased odds of CAC (adjusted OR=3.5, 95% CI: 2.5–5.0,  $p<0.0001$ ). Physical activity was significantly inversely associated with presence of CAC in all subjects (adjusted OR=0.9, 95% CI: 0.8–0.996,  $p=0.045$ ) and smoking (current versus never) was significantly associated with presence of CAC (adjusted OR=1.7, CI: 1.1–2.6,  $p=0.03$ ) for the entire cohort (Model 1, Table 2). BMI, average waist circumference and visceral fat (adjusted for age, income and education) were also significantly associated with presence of CAC in all subjects in univariable analysis ( $p<0.0001$ ,  $p<0.0001$ ,  $p<0.0001$ , respectively; Model 1, Table 2). However, in a multivariable model adjusting for all demographics and lifestyle factors (Model 2, Table 2) only BMI, average waist circumference and visceral fat were significantly associated with presence of CAC in all subjects ( $p<0.0001$ ).

In multivariable models stratified by diabetes status, BMI was independently associated with CAC (adjusted OR=1.8, 95% CI: 1.4–2.4,  $p<0.0001$  for diabetic subjects and adjusted OR=2.0, 95% CI: 1.6–2.6,  $p<0.0001$  for non-diabetic subjects), average waist circumference was independently associated with CAC (adjusted OR=2.0, 95% CI: 1.5–2.6,  $p<0.0001$  for diabetic subjects and adjusted OR=2.0, 95% CI: 1.5–2.6,  $p<0.0001$  for non-diabetic subjects), as was visceral fat (adjusted OR=1.5, 95% CI: 1.2–1.9,  $p=0.001$  for diabetic subjects and adjusted OR=1.6, 95% CI: 1.2–2.2,  $p=0.003$  for non-diabetic subjects). (Data not shown in Table 2.)

Stratified by sex and diabetes status, BMI, average waist circumference and visceral fat were independently associated with CAC in men and women with and with out type 1 diabetes (Table 2). In addition, alcohol intake was independently

**Table 1.** Lifestyle factors in type 1 diabetes (T1D) and non-diabetic (non-DM) subjects by group and sex

Variable	T1D and Non-DM group			Men			Women		
	T1D n=582	Non-DM n=724	p-value	T1D n=268	Non-DM n=369	p-value*	T1D n=314	Non-DM n=355	p-value*
Age, years**	37±9	39±9	<0.0001	37±9	40±9	0.0002	36±9	38±9	0.003
Race/ethnicity (%)									
Non-Hispanic white	93.9	84.0	<0.0001	93.3	87.2	0.01	94.4	80.9	<0.0001
Other (age-adjusted)	6.1	16.0		6.7	12.8		5.6	19.1	
Education (%)									
Less than College	46.8	31.4	<0.0001	44.2	31.4	0.001	49.4	31.4	<0.0001
College or higher (age-adjusted)	53.2	68.6		55.9	68.6		50.6	68.6	
Income (%)									
Low	12.7	8.5	<0.0001	14.5	6.0	0.001	11.2	11.1	0.003
Medium	47.4	39.3		40.4	38.4		53.1	40.1	
High (age-adjusted)	39.9	52.2		45.1	55.6		35.7	48.8	
BMI, kg/m <sup>2</sup> †	26.2±4.4	26.1±5.0	0.68	26.5±3.9	27.2±4.1	0.03	26.0±4.7	25.0±5.5	0.01
Visceral fat (cm <sup>2</sup> ) §	10.3±0.64	10.6±0.65	<0.0001	10.5±0.64	10.9±0.56	<0.0001	10.2±0.62	10.3±0.61	0.03
Average Waist (cm)	85.1±12.5	85.8±14.4	0.37	90.3±11.1	93.1±12.1	0.002	80.8±12.0	78.5±12.8	0.01
Waist to Hip	0.82±0.08	0.83±0.09	0.02	0.87±0.06	0.89±0.06	<0.0001	0.77±0.07	0.77±0.06	0.05
Cholesterol	175.4±34.1	190.8±38.7	<0.0001	174.4±35.4	197.0±42.4	<0.0001	176.2±33.1	184.6±33.6	0.001
LDL-c	100.6±29.2	114.4±33.1	<0.0001	104.0±30.0	122.9±34.5	<0.0001	97.8±28.2	106.0±29.3	0.0001
HDL-c	56.2±16.3	50.7±14.7	<0.0001	51.2±13.8	43.2±10.8	<0.0001	60.3±17.1	58.1±14.2	0.06
Triglycerides	93.1±56.4	130.1±100.1	<0.0001	95.9±61.2	156.7±120.4	<0.0001	90.6±52.0	103.6±64.5	0.003
Average systolic BP	117.2±14.0	114.2±0.5	<0.0001	121.2±13.5	117.8±10.9	0.0004	113.9±13.5	110.5±12.6	0.001
Average diastolic BP	77.6±8.7	78.9±12.3	0.003	80.2±8.6	82.0±7.7	0.005	75.4±8.1	75.9±8.0	0.41
Smoking (%) ‡	12.3	8.7	0.03	12.7	7.9	0.005	12.3	9.2	0.19
(age adjusted)									
Physical Activity§	1324±3.2	1346±3.0	0.79	1680±3.0	1442±2.9	0.08	1082±3.2	1254±3.1	0.097
Kcal/wk (age-adjusted)									
Alcohol drinks /month	13.8±1.0	18.4±1.1	0.002	20±1.6	24±1.4	0.05	9±1.5	13±1.4	0.08
T †† (age adjusted)									

\* p-values comparing type 1 diabetes subjects to non-diabetic subjects within sex

\*\* Observed means and standard deviations

† Least-squares means and standard errors, adjusted to the average age of the cohort

‡ Logistic regression adjusted proportions, adjusted to the age distribution of the cohort

§ Least-squares geometric mean and standard errors, adjusted to the age distribution of the cohort

**Table 2.** Relationship of lifestyle risk factors to coronary artery calcification (CAC) at baseline

Variable	Model 1				Model 2			
	Men OR (95% CI) p-value		Women OR (95% CI) p-value		Men OR (95% CI) p-value		Women OR (95% CI) p-value	
	T1D	Non-DM	T1D	Non-DM	T1D	Non-DM	T1D	Non-DM
BMI kg/m <sup>2</sup>	2.0 (1.7-2.4) p<0.0001	2.7 (2.1-3.6) p<0.0001	1.6 (1.3-2.1) p<0.0001	1.9 (1.5-2.5) p<0.0001	2.0 (1.5-2.8) p<0.0001	2.4 (1.8-3.2) p<0.0001	1.6 (1.2-2.0) p=0.0009	1.7 (1.4-2.3) p<0.0001
Average Waist Circumference (cm)	2.2 (1.8-2.6) p<0.0001	2.3 (1.7-3.0) p<0.0001	2.1 (1.6-2.9) p<0.0001	2.0 (1.5-2.8) p<0.0001	2.0 (1.4-2.9) p<0.0001	2.0 (1.5-2.7) p<0.0001	2.0 (1.4-2.7) p<0.0001	1.8 (1.3-2.5) p=0.0003
Visceral fat log visceral fat	1.8 (1.5-2.2) p<0.0001	2.1 (1.6-2.8) p<0.0001	1.6 (1.2-2.1) p=0.001	1.8 (1.3-2.5) p=0.0005	1.6 (1.2-2.2) p=0.002	1.7 (1.3-2.4) p=0.001	1.4 (1.1-1.9) p=0.02	1.5 (1.0-2.1) p=0.03
Physical Activity log kcal/week	0.9 (0.8-0.996) p=0.045	0.9 (0.7-1.1) p=0.26	0.9 (0.7-1.1) p=0.36	0.9 (0.7-1.2) p=0.35	0.9 (0.7-1.2) p=0.51	1.0 (0.8-1.2) p=0.71	1.0 (0.7-1.2) p=0.74	1.0 (0.7-1.3) p=0.75
Smoking (current versus never)	1.7 (1.1-2.6) p=0.03	1.4 (0.6-3.7) p=0.46	2.2 (1.0-4.8) p=0.06	2.1 (0.9-5.1) p=0.11	1.0 (0.4-2.4) p=0.96	1.3 (0.5-3.6) p=0.59	1.6 (0.7-3.7) p=0.30	2.1 (0.8-5.2) p=0.12
(former versus never)	1.1 (0.8-1.6) p=0.56	1.1 (0.6-1.9) p=0.76	1.3 (0.7-2.4) p=0.48	0.9 (0.4-2.0) p=0.85	1.1 (0.5-2.3) p=0.83	1.1 (0.6-2.0) p=0.75	1.2 (0.6-2.3) p=0.57	0.9 (0.4-2.1) p=0.78
Alcohol log drinks/month	0.9 (0.8-1.1) p=0.15	1.1 (0.9-1.4) p=0.51	0.8 (0.6-1.2) p=0.26	0.6 (0.4-0.8) p=0.003	1.0 (0.7-1.3) p=0.81	1.2 (0.9-1.5) p=0.98	0.8 (0.6-1.2) p=0.26	0.6 (0.4-0.9) p=0.02

T1D, type 1 diabetes; non-DM, non-diabetic

Model 1: Adjusted for age, education, and income

Model 2: All demographics and lifestyle (adjusted for age, education and income)

Odds ratios (OR) are per standard deviation change in each variable: BMI (kg/m<sup>2</sup>) SD=4.72; average waist (cm) SD=13.58; log visceral fat (cm<sup>3</sup>) SD=0.66; physical activity (log kcal/week) SD=1.11; alcohol (log drink per month) SD=1.27

associated with CAC in non-diabetic women (adjusted OR=0.6, 95% CI: 0.4-0.8,  $p=0.003$  [Model 1] and adjusted OR=0.6, 95% CI: 0.4-0.9,  $p=0.02$  [Model 2]; Table 2).

## Discussion

Compared with non-diabetic subjects in the CACTI study, adults with type 1 diabetes reported more current smoking and less alcohol intake. A significant sex difference existed in physical activity by diabetes status; the data trends towards higher reported physical activity in men with type 1 diabetes than non-diabetic control men, but in women with diabetes the data trends toward lower reported physical activity than non-diabetic control women. In addition to efforts to improve glycaemic control, blood pressure and lipids, adults with type 1 diabetes could benefit from more intensive interventions targeting smoking cessation and increased physical activity to improve their cardiovascular health.

It is well documented that physical activity and avoidance of smoking have beneficial health effects in people with diabetes.<sup>17,18</sup> These risk factors are known to be prevalent in adults with diabetes, similar to that of the general population<sup>18,19</sup> and little data exist on whether these risk factors are being properly addressed in people with diabetes and by the health care community.<sup>20</sup> Differences in reported physical activity have been previously reported in adolescents with type 1 diabetes in the Hvidore Study Group.<sup>21</sup> The differences in reported physical activity between men and women need to be followed up in future studies in order to investigate whether sex-specific differences exist in other populations and if exercise recommendations need to be sex specific.

The lifestyle risk factors for CAC are similar in adults with and without type 1 diabetes, as BMI and physical activity are both associated with the presence of CAC. The relationships between lifestyle risk factors for CAC need to be investigated further.

The relationship of alcohol to atherosclerosis is complex and while data show that alcohol consumption can be favourably related to CVD risk profile, the concern for potential abuse makes it difficult to advocate alcohol as a therapy for decreasing CVD risk. Furthermore, for people with type 1 diabetes alcohol can have complex effects on glycaemia (hyperglycaemia and delayed hypoglycaemia) and can impair judgment on appropriate diabetes care. Alcohol consumption was not associated with CAC in type 1 diabetes subjects in this data.

The limitations of these data include that some study subjects did not complete the questionnaires, but data analysis was performed on 92% of CACTI subjects, comparable to the IRAS study.<sup>22</sup> Second, this population might be healthier due to living with someone with diabetes and

possible increased knowledge of healthy lifestyle factors, although that would not explain the less-healthy lifestyle factors in subjects with diabetes as compared with the non-diabetic subjects. Additionally, by having non-diabetic subjects be made up of spouses (approximately a third), friends and neighbours, the lifestyle factors between these two groups would tend toward the null when in fact significant differences were present. The use of neighbours and friends can be viewed as a strength as they are expected to be more similar with respect to lifestyle factors (demographics, socioeconomic status) than the general population. Also, there were significant differences in race/ethnicity, education and income between type 1 diabetes subjects and non-diabetic subjects within sex. Type 1 diabetes affects disproportionately more non-Hispanic whites than racial/ethnic minorities; however, the study recruited minorities similar to the Colorado general population, not the Colorado type 1 diabetic population, per NIH guidelines. In addition, some of the subjects were recruited from the local university which could increase education and income status in the control group. Even though the CACTI cohort has an overall lower rate of smoking than other large type 1 diabetes cohorts<sup>23-25</sup> and the Colorado and US averages,<sup>26,27</sup> the subjects were selected to limit confounding lifestyle factors for CAD by including spouses, friends and neighbours, and yet the subjects with type 1 diabetes smoke more than the non-diabetic subjects.

Differences exist in lifestyle-related risk factors in men and women with type 1 diabetes compared with non-diabetic subjects in the CACTI study. Adults with type 1 diabetes could benefit from more intensive interventions targeting smoking cessation and increasing physical activity, especially in women. BMI, waist circumference and visceral fat are associated with the presence of CAC in these data. Further data on the relationship of lifestyle risk factors and atherosclerosis are needed to develop programs to target and improve these lifestyle risk factors.

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