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In adult patients with type 1 diabetes healthy lifestyle associates with a better cardiometabolic profile

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Abstract *Background/aims:* Little is known about lifestyle habits of adults with type 1 diabetes (T1D) and their association with cardiometabolic risk (CMR) factors. The aims of the present study were to determine the prevalence of adults with T1D who adopted a healthy lifestyle and to explore the association between a healthy lifestyle and the cardiometabolic profile.
Methods and results: This is a cross-sectional analysis of 115 adults with T1D. Participants wore a motion sensor and completed a 3-day food record. The following CMR factors were assessed: body mass index, waist circumference, body composition (iDXA), glycated hemoglobin, lipids and blood pressure. Insulin resistance was estimated (estimated glucose disposal rate). Participants were classified according to the number of healthy lifestyle habits adopted (ranging from 0 to 3): regular physical activity (physical activity level $\geq$1.7), good diet quality (Canadian Healthy Eating Index score >80) and none-smoking status. The proportion of participants who adopted 3, 2, 1 or 0 lifestyle habits were 11%, 30%, 37%, and 23%, respectively. As the number of healthy lifestyle habits adopted increased, participants had significantly lower body mass index, waist circumference, body fat, total cholesterol, non-HDL-cholesterol, triglycerides and systolic blood pressure ($p < 0.05$). In addition, a trend for lower estimated insulin resistance was observed ($p = 0.06$). For each increase of one healthy lifestyle habit, body mass index decreased by 1.9 kg/m^2, waist circumference by 4.0 cm for men and 4.8 cm for women and trunk fat by 3.6% for men and 4.1% for women.
Conclusions: These results suggest the importance of a healthy lifestyle among adults with T1D in order to control CMR factors.

Introduction

Type 1 diabetes (T1D) is a chronic disease associated with an increased risk of cardiovascular disease (CVD) [1]. Despite major improvements in diabetes management such as the use of intensive insulin therapy aiming for long-term/sustained good glucose control, CVD remains the leading cause of morbidity and mortality among this population [2]. In addition, recent cohort studies have

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shown an increasing prevalence of excess weight gain, obesity and other cardiometabolic risk (CMR) factors such as dyslipidemia, hypertension and insulin resistance among patients with T1D [3,4]. During the 18-year follow-up of T1D patients in the Pittsburgh Epidemiology of Diabetes Complications Study cohort, the prevalence of overweight patients almost doubled and the obesity rate increased by 7-fold [3]. Other studies have shown a prevalence of up to 45% of the metabolic syndrome among this population increasing the risk of both micro- and macrovascular complications as well as mortality [5,6]. Reducing the prevalence of CMR factors is thus of major importance for this high risk population to prevent CVD.

Among the general population, the promotion of a healthy lifestyle including a balanced diet, regular physical activity, smoking cessation and weight management is essential to prevent or improve CMR profile [7]. Among T1D patients, numerous studies have focussed on lifestyle approaches aiming to improve glycemic control, but only a few studies have explored the association between lifestyle habits and CMR factors [8]. It has been reported that the adoption of an atherogenic diet [9,10], a sedentary lifestyle [11] or active smoking [12,13] are associated with worse CMR profiles in T1D patients. However, to the best of our knowledge, there have been no reports assessing the prevalence of T1D patients who adopt an overall healthy lifestyle including regular physical activity, a good diet quality and none-smoking habits, and the relationship with the CMR profile. Therefore, the aims of the present study were to determine the prevalence of adults with T1D who adopted a healthy lifestyle and to explore the association between a healthy lifestyle and their cardiometabolic profile.

Methods

Study design and subjects

This cross-sectional observational study included 124 participants recruited between September 2011 and August 2013 at the Institut de Recherches Cliniques de Montréal (IRCM) and at the Montreal University Hospital Centre (CHUM). Inclusion criteria included: age ≥18 years, T1D duration ≥6 months, treatment with continuous subcutaneous insulin infusion with rapid insulin analog (Aspart, Lispro or Glulisine) or a multiple daily injections regimen with rapid and basal (Glargine or Detemir) insulin analogs. Pregnant women were excluded as well as patients who reported severe hypoglycemia (requiring assistance) during the previous 3 months or ≥3 episodes in the previous year. Ethical approval was obtained from the CHUM and the IRCM ethic review boards and all participants gave written consent to participate. Recruitment strategies included; information on Quebec Diabetes Association's Webpage, random invitation through routine appointments with nurses or physician and invitation letters to participate which were sent to >100 participants of previous studies conducted in our institution.

Data collection

Participants were tested at the IRCM during two visits approximately one week apart. At visit 1, body weight and height were measured in light clothing and shoeless. Body mass index (BMI) was calculated (kg/m^2). Waist and hip circumference were measured (mean of 3 measures) in a standing position to the nearest 0.1 cm using a non-stretchable tape over the unclothed abdomen at the top of the iliac crest and over the underwear at the largest circumference around buttocks, respectively [14]. After a 5-min rest period in the sitting position, resting blood pressure and heart rate were measured three times using an automatic sphygmomanometer and the mean values were calculated. A fasting blood sample was drawn to measure glycated hemoglobin (A1c) and lipids (total-cholesterol, HDL-cholesterol, triglycerides). Finally, a portable motion sensor (SenseWear Armband™; Health-Wear Bodymedia, Pittsburgh, PA, USA) was placed to measure physical activity. During the 72 h after the clinic visit, patients were asked to wear the device and complete a detailed food record and an insulin dosage logbook while maintaining their daily routine.

At the second visit, they brought back the device to be downloaded and a registered dietitian reviewed the food record with the participant. Fat mass percentage was measured by dual energy X-ray absorptiometry (iDXA) using an LUNAR Prodigy system version 6.10.019 (General Electric Lunar Corporation, Madison, WI, USA). Patients completed a self-administered questionnaire to obtain data on smoking habits (allowing categorization of the participants as current, former or never-smokers), insulin treatment, ethnicity, marital status, education level and household income. An endocrinologist recorded the medical history and medication list either at visit 1 or visit 2, depending on his availability.

LDL-cholesterol levels were calculated according to the Friedwald formula [15] and non-HDL-cholesterol levels from the difference between serum total cholesterol and HDL-cholesterol. Insulin resistance was estimated using the validated formula of "estimated glucose disposal rate" (eGDR = 24.31 − 12.22*(Waist-to-hip ratio) − 3.39*(Hypertension) − 0.57*(A1c)) where hypertension status being a blood pressure >140/90 mmHg or use of anti-hypertensive medications [16]. Lower eGDR values correlate with greater degrees of insulin resistance. Mean daily insulin dose was calculated from the 3-day insulin dosage logbook.

Classification of a healthy lifestyle habits

The SenseWear Armband data were analyzed using the Innerview Research Software version 6.1 (Health-Wear Bodymedia). This provided an estimation of resting, total and physical activity energy expenditure (measured in metabolic equivalents of task (METs)) and of the physical activity level (PAL). The PAL is calculated by dividing total energy expenditure by the estimated resting energy