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Nut consumption, serum fatty acid profile and estimated coronary heart disease risk in type 2 diabetes

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Abstract *Background and aims:* Nut consumption has been associated with decreased risk of coronary heart disease (CHD) and type 2 diabetes which has been largely attributed to their healthy fatty acid profile, yet this has not been ascertained. Therefore, we investigated the effect of nut consumption on serum fatty acid concentrations and how these relate to changes in markers of glycemic control and calculated CHD risk score in type 2 diabetes.
Methods and results: 117 subjects with type 2 diabetes consumed one of three iso-energetic (mean 475 kcal/d) supplements for 12 weeks: 1. full-dose nuts (50–100 g/d); 2. half-dose nuts with half-dose muffins; and 3. full-dose muffins. In this secondary analysis, fatty acid concentrations in the phospholipid, triacylglycerol, free fatty acid, and cholesteryl ester fractions from fasting blood samples obtained at baseline and week 12 were analyzed using thin layer and gas chromatography. Full-dose nut supplementation significantly increased serum oleic acid (OA) and MUFAs compared to the control in the phospholipid fraction (OA: $P = 0.036$; MUFAs: $P = 0.024$). Inverse associations were found with changes in CHD risk versus changes in OA and MUFAs in the triacylglycerol ($r = -0.256$, $P = 0.011$; $r = -0.228$, $P = 0.024$, respectively) and phospholipid ($r = -0.278$, $P = 0.006$; $r = -0.260$, $P = 0.010$, respectively) fractions. In the cholesteryl ester fraction, change in MUFAs was inversely associated with markers of glycemic control (HbA1c: $r = -0.250$, $P = 0.013$; fasting blood glucose: $r = -0.395$, $P < 0.0001$).
Conclusion: Nut consumption increased OA and MUFA content of the serum phospholipid fraction, which was inversely associated with CHD risk factors and 10-year CHD risk.
Clinical Trial Reg. No.: NCT00410722, clinicaltrials.gov.

Acronyms: MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid; FFA, free fatty acid; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; OA, oleic acid; CHD, coronary heart disease; HbA1c, hemoglobin A1c; FAME, fatty acid methyl esters; NCEP, National Cholesterol Education Program.

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Introduction

The Mediterranean diet has been associated with reduced risk of coronary heart disease (CHD) and type 2 diabetes [1–4]. Nuts, which are a component of the Mediterranean diet, have been associated with decreased risk for the development of CHD [5–8] and diabetes [9,10] in cohort studies, and improvement in CHD risk factors and markers of glycemic control in clinical trials [11–13]. The health promoting effects of the Mediterranean diet and nut consumption has largely been attributable to their healthy fatty acid profile [14].

The serum fatty acid profile has been associated with CHD and diabetes, and while studies have investigated the potential role of fatty acids in the prevention of diabetes [15], to our knowledge no studies have assessed this association in those already with diabetes.

In a previously published clinical study, we reported that consumption of tree nuts and peanuts improved glycemic control and LDL-C levels in subjects with type 2 diabetes [12]. The aim of the present secondary analysis was to evaluate the effect of nut consumption on the serum fatty acid profile in individuals with type 2 diabetes, and to assess whether these related to changes in CHD risk factors, calculated Framingham 10-year CHD risk score (referred to as 10-year CHD risk), and markers of glycemic control. To our knowledge this is the first study to look at the serum fatty acid composition with nut consumption in individuals with type 2 diabetes.

Methods

The study methods have previously been described in detail [12].

Study protocol

This is a secondary analysis of a twelve week randomized controlled parallel trial with three isocaloric treatment diets consisting of; 1) full-dose nut diet (50–100 g mixed nuts per day), 2) half-dose nut diet (25–50 g mixed nuts per day), or 3) control diet (an isocaloric muffin supplement), incorporated into their current diabetes, NCEP Step 2-based diet [16].

After overnight fasts (12–14 h), body weight, blood samples, and blood pressure were obtained at the start of the study and weeks 2, 4, 8, 10, and 12. Seven-day weighed diet records were obtained prior to baseline and at each visit.

The Ethics Committee of the University of Toronto and St. Michael's Hospital approved the study, and all subjects gave informed consent. Clinical trial registration number: NCT00410722.

Study population

Healthy men and postmenopausal women with type 2 diabetes were recruited by newspaper and TTC advertisements and from patients attending the Risk Factor Modification Centre of St. Michael's Hospital. As previously reported [12], 38 of 40 (95%) completed the full-dose nut (i.e. provided a blood sample in the final month), compared with 32 of 38 (84%) of those taking the half-dose nut and 30 of 39 (77%) on muffins. Three discontinued for reasons directly related to the study (food allergies, $n = 2$; two consecutive HbA1c levels >8.5%, $n = 1$). The majority ($n = 11$) withdrew for unrelated reasons.

Diets

Subjects were instructed to continue following their current diabetes diet based on NCEP Step 2 recommendations (i.e. <7% energy from saturated fat and <200 mg/d dietary cholesterol) [12], and to exclude nuts, soy, and dietary supplements (vitamins, minerals, herbal remedies) for at least a week prior to starting the study. For each of the three treatment groups, the supplement was replaced starchy foods (breads, bagels, non-study muffins, and breakfast cereals), to allow supplements to be incorporated into the background diet without increasing total energy intake. The diets, described above, provided approximately 25% of daily energy needs where intake level was based on participants' estimated daily energy requirement, as previously described [12].

The supplement of mixed nuts included; unsalted and mostly raw tree nuts (almonds, hazelnuts, pistachios, macadamia nuts, pecans, walnuts, and cashews) and peanuts. The macronutrient composition of the muffin was formulated to provide a comparable amount of saturated fatty acids (SFA), polyunsaturated fatty acids (PUFA), and fiber to the mixed nut supplement. Monounsaturated fatty acids (MUFA) from the mixed nuts balanced the carbohydrate from the muffins.

During the study, subjects were asked to not consume any additional nuts or nut products or alter consumption of dietary fiber or vegetable protein foods. Compliance was assessed from 7-day diet records, a supplement checklist on which subjects recorded supplements consumed, and return of uneaten supplements and their packaging, which were weighed and recorded.

Analyses

Serum was analyzed according to the Lipid Research Clinics protocol [17] for total cholesterol, triglyceride, and HDL cholesterol after dextran sulfate-magnesium chloride precipitation, and LDL cholesterol was calculated, as previously described [12]. Blood glucose was measured in the hospital routine analytical laboratory by a glucose oxidase method. HbA1c was analyzed within 2 days of collection on whole blood collected in EDTA Vacutainer tubes and measured by a designated high-performance liquid chromatography (HPLC) method (Tosoh G7 Automated HPLC Analyzer, Tosoh Bioscience, Grove City, OH) (CV 1.7%).

To assess fatty acid fractions, total lipids were extracted from serum according to the Folch method [18]. Thin layer chromatography (TLC) plates were activated by heating at 100 °C for 1 h. Total lipids were then loaded on a TLC plate