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Dietary patterns are associated with various vascular health markers and complications in type 1 diabetes

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ABSTRACT

Aims: Diet plays an important role in the management of type 1 diabetes. However, the association between dietary intake and health has not been extensively studied in this population. We studied the cross-sectional association between dietary factors, and selected vascular health markers and complications in type 1 diabetes.
Methods: Data from 874 individuals with type 1 diabetes participating in the FinnDiane Study were included. Dietary intake was assessed using a self-reported questionnaire and a diet score, expressing the extent to which individuals adhered to the dietary recommendations, was calculated. Diet questionnaire was also used to reveal dietary patterns using factor analysis.
Results: Seven factors with high degree of inter-correlation were formed; healthy, traditional, vegetable, sweets, modern, low-fat cheese, and fish and eggs. In multivariate models, higher diet score and healthy factor score were associated with better glycaemic control. Higher diet score was associated with higher, while sweets, and fish and eggs patterns were associated with lower systolic blood pressure. Healthy, sweets, and fish and eggs factors were additionally associated with lower diastolic blood pressure.
Conclusions: Closer adherence to the dietary recommendations, and a diet high in fresh vegetables, fruits and berries, cooked vegetables, fish dishes, and yoghurt may be beneficial for the glycaemic control in type 1 diabetes. Moreover, a diet pattern with fish and eggs may have beneficial effects for blood pressure.

1. Introduction

Nutrition plays an integral role in the management of many chronic diseases, including type 1 diabetes. Among individuals with diabetes dietary recommendations aim, in particular, at reducing the risks of various long term complications. This is achieved by adapting dietary practices that, amongst others, support good glycaemic control, weight management, and appropriate intake of macro- and micronutrients. Dietary recommendations, targeted at individuals with diabetes, encourage the consumption of fruits and vegetables, whole grain products, lean meats, fish, low fat liquid milk products, and vegetable oils, while the intakes of sugar, salt, and alcohol should be limited (Finnish Diabetes Association, 2008).

We have previously shown in the FinnDiane Study population that adherence to the dietary recommendations among individuals with type 1 diabetes is, in many aspects, suboptimal (Ahola, Mikkilä, Mäkimattila, et al., 2012). In particular, the intakes of carbohydrates and fiber are frequently lower than recommended, while the recommendations for salt, total fat, and saturated fat are often exceeded. Similar trends are seen in other studies of participants with type 1 diabetes (Leroux et al., 2014). While a number of studies have shown some health benefits of adhering to the dietary guidelines, most of them have been conducted in populations other than type 1 diabetes. For example, among middle-aged individuals with type 2 diabetes, closer adherence to dietary recommendations was associated with reduced risk of chronic kidney disease and death during a 5.5 year follow-up period (Dunkler et al., 2015), and in a population-based survey in the general population, better adherence to dietary guidelines was associated with lower fasting blood glucose

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concentrations, lower systolic blood pressure, and lower triglyceride concentration (Lee et al., 2013).

Some studies, conducted among individuals with type 1 diabetes, have assessed the role of selected dietary macro- and micronutrients on various health markers. In one such study, the percentage of energy from fats, saturated fats, and monounsaturated fats were all positively correlated with total and LDL cholesterol concentration, HbA_{1c}, BMI, waist circumference, and diastolic blood pressure, and negatively with estimated glucose disposal rate (eGDR) (Snell-Bergeon et al., 2009). In the same study, increased carbohydrate intake was negatively correlated with total, LDL, and HDL cholesterol concentration, HbA_{1c}, BMI, waist circumference, and diastolic blood pressure, but positively with eGDR. In another study, higher carbohydrate intake was associated with lower BMI and waist circumference, while higher saturated fat intake and lower intake of cereal fiber predicted higher waist-to-hip ratio (Toeller et al., 2001). Finally, lower intake of dietary fiber, polyunsaturated fatty acids, and vegetable protein, and higher intake of cholesterol were associated with endothelial dysfunction and low-grade inflammation (van Bussel et al., 2013).

Rather than focusing on individual macro- or micronutrients, however, there has been an increasing interest in the health consequences of various dietary patterns. It has been argued that a reductionist approach that focuses on isolated nutrients may oversimplify the complexity related to dietary intake at large (Sievenpiper & Dworatzek, 2013). In general, there are two distinct approaches related to dietary patterns. In a hypothesis-orientated approach, dietary patterns are constructed based on available scientific evidence about the health effects of given dietary variables. In an exploratory approach, on the other hand, statistical methods are applied to the collected data in order to identify patterns, or clusters of dietary variables, that are inter-correlated.

The Dietary Approaches to Stop Hypertension (DASH) dietary pattern, an example of the hypothesis-orientated approach, that emphasizes the intake of fruits, vegetables, low-fat dairy, whole grains, fish, nuts (US Department of Health and Human Services, National Institutes of Health, National Heart, Lung, and Blood Institute, 1998) was, among the youth with type 1 diabetes, inversely associated with the LDL-HDL cholesterol ratio, and HbA_{1c} (Liese et al., 2011). On the other hand, adherence to a carbohydrate-conscious Mediterranean diet pattern, compared to a low-fat diet, was associated with improved glycaemic control in newly diagnosed individuals with type 2 diabetes (Esposito et al., 2009). Improvements in the cardiovascular risk factor profile, with adherence to the Mediterranean diet, were also reported in moderately obese subjects with or without type 2 diabetes (Shai et al., 2008).

Our aim was therefore to study the association between adherence to the dietary recommendations and diet patterns, derived from exploratory analyses, and selected vascular health markers in adults with type 1 diabetes. We also studied the association between dietary intake and complications. These cross-sectional analyses serve as a baseline for future prospective analyses in this population.

2. Subjects, materials and methods

2.1. Study subjects

A total of 874 participants in the Finnish Diabetic Nephropathy (FinnDiane) Study were included in these cross-sectional analyses. Included were all individuals with type 1 diabetes who had filled in the diet questionnaire within 2 years of the study visit, and whose renal status and insulin dose were known. The Ethics Committee of the Hospital District of Helsinki and Uusimaa approved the study protocol. Signed informed consent was obtained from all participants prior to study inclusion.

2.2. Anthropometric measurements, blood pressure, blood samples, and smoking

Participants' height and weight were measured in light clothing, and body mass index (kg/m^2) was calculated. Waist-to-hip ratio was calculated from the respective measurements. Following a 10-minute rest, blood pressure was measured in the sitting position. A second blood pressure measurement was conducted after a further 2 minute rest. The means of these two measurements were used in the analyses. Blood samples were collected and HbA_{1c} was determined locally using standardised assays. Serum lipid and lipoprotein concentrations were measured as previously described (Thorn et al., 2005). Data on smoking and insulin dose were self-reported.

2.3. Urinary albumin excretion rate and complications

Urinary albumin excretion rate (AER) in at least two out of three timed 24-hour or overnight urine collections was used to assess participants' renal status. Participants were classified according to the AER: normal albumin excretion rate (AER <20 μg/min or <30 mg/24 h), microalbuminuria (AER ≥20 and <200 μg/min or ≥30 and <300 mg/24 h), macroalbuminuria (AER ≥200 μg/min or ≥300 mg/24 h), and end-stage renal disease (ESRD) (in dialysis or with kidney transplant). Advanced chronic kidney disease (CKD) was defined as macroalbuminuria or ESRD. Data on retinopathy and cardiovascular events were obtained from the medical records. Retinal laser-treatment was used as indication of severe retinopathy. Acute myocardial infarction, coronary bypass, stroke, amputation, and peripheral vascular disease were grouped as “major cardiovascular events”.

2.4. Diet

The diet questionnaire, that was used to collect the data on dietary intake, was previously described in detail (Ahola, Mikkilä, Mäkimattila, et al., 2012). In short, the self-reported questionnaire was designed to capture information on the participants' habitual dietary intake, and included questions regarding the consumption pattern of food items such as coffee, milk products, breads, spreads, cooking fats, and salt. As part of the form, a 19-item food frequency questionnaire (FFQ) was also included. In the FFQ, the consumption frequencies of the most common food items in Finland were queried. On a seven point response scale, ranging from “multiple times per day” to “once a month or less frequently”, participants reported their intakes of fish dishes, meat dishes, poultry, sausages and cold cuts, eggs, legumes, fresh vegetables, cooked vegetables, potatoes, pasta and rice, fruits and berries, high-fat cheese, low-fat cheese, yoghurt, ice cream, soft drinks, pastries, candy, and fried and grilled foods. Based on the replies on the diet questionnaire, a diet score was calculated for each participant, as previously described (Ahola, Mikkilä, Saraheimo, et al., 2012). The principals for calculating the score are also presented in the supplementary Table 2. Scores, ranging between 0 and 22 points, express the extent to which participants comply with the dietary recommendations. The higher the score, the better the adherence. The diet score is used as a continuous variable in the analyses. The FFQ part of the questionnaire was analysed by exploratory factor analysis, as described in the statistical analyses, and the obtained factor scores were used in further analyses.

2.5. Leisure time physical activity

Participants' leisure time physical activity (LTPA) was evaluated with a questionnaire (Wadén et al., 2005) in which participants retrospectively reported mean frequency, single session duration, and intensity of 21 common forms of physical activity for the past 12 months. The amount of weekly physical activity, displayed as metabolic equivalent of task hour (METh), was calculated by multiplying the reported duration of the activity by the activity- and intensity-specific metabolic equivalent.