INTRODUCTION
Diabetes mellitus as a group of metabolic diseases is characterized by hyperglycemia resulting from insulin resistance and beta cell dysfunction. The prevalence of diabetes has increased over the past and was estimated to increase further by 50% in the world by the year 2030. Blindness, kidney failure, limb amputation and cardiovascular disease are major complications of diabetes. Sedentary lifestyle, obesity and changing diet toward processed foods, have been related to the rise in diabetes prevalence. Abnormal lipid profile in diabetic patients is major risk factor for cardiovascular disease. Studies have showed that diet with low saturated fatty acids contents decrease low density lipoprotein cholesterol (LDL-C) levels and cardiovascular events. It also showed that replacing saturated
and trans fatty acids with unsaturated fatty acids, including nuts in diet, may help to prevent from diabetes. Nuts have some components like fiber and magnesium that decrease insulin resistance. Walnut has a higher content of polyunsaturated fatty acid (PUFA) and alpha-linolenic acid. PUFA reduced LDL-cholesterol and total cholesterol. Some studies have showed that walnut decrease total cholesterol and LDL-C and increase high-d have recommended that walnut consumption protect against cardiovascular disease. Most of studies were done on type 2 diabetes mellitus (T2DM) patients. Literature search showed that there was no study that evaluated the effect of walnut consumption on pre-diabetes patients who were the first-degree relatives of T2DM patients. In this study, we evaluated the role of walnut consumption on lipid profiles in pre diabetes patients who were the first-degree relatives of T2DM patients.

**METHODOLOGY**

**Participants:** This was a cross-sectional study. The participants were the first-degree relatives of T2DM people in Isfahan Diabetes Prevention Study (IDPS). Our aim in IDPS was to prevent from T2DM by changing life style or by medication intervention among at high-risk group. We selected participants from a cohort study that was conducted from 2003 until now with 3454 member in Isfahan Endocrine and Metabolism Research Center (IEMRC). One thousand fifty member had food record. Diabetic patient (n=46) and patient with normal glucose tolerance test (n=364) excluded from study. From 640 pre diabetics 229 subjects did not report walnut consumption in their records. Finally, 411 men and female 35 to 55 year of age were included to this study. Those who use medicine that effect on glucose tolerance test and lipid profiles were excluded. Pre diabetes patients according to ADA criteria (23) included impaired fasting glucose (IFG), those with fasting blood glucose 100-125 mg/dl (n=48) and Impaired Glucose Tolerance (IGT), blood glucose 120 minute after intake 75gr oral glucose, 140-199 mg/dl, (n=53) and combined pre diabetics, IFG +IGT (n=310) were include. The Isfahan Endocrine and Metabolism Research Center (IEMRC) Medical Ethics Committee approved this study and each participant written informed consent.

**Assessment of dietary intake:** Dietary intake was assessed by use of three days record and trained dietitian adjusted it. These records had eleven columns that included cereals group, legumes, dairy, meat, fat, nuts, and fruit, vegetable, sweet, sugar, and drinks. Dietitians educated groups how to prepare records. Then record’s contents were changed to grams. Weight of each walnut was considered 4 grams.

**Biochemical assessment:** Blood samples were taken from 7:30 to 9:30 AM, after 12 hour overnight fasting to determine serum lipids and whole blood glucose levels. Blood glucose, serum triglyceride (TG), total cholesterol and high-density lipoprotein cholesterol (HDL-C) levels were determined by using an enzymatic method. Oral Glucose Tolerance Test (OGTT) was done after 10-12 hours of overnight fasting, a 75 gr oral glucose was administered and plasma glucose concentrations were measured at fasting and 120 minutes after glucose taking (BS120). The analysis of sample was performed with an auto analyzer (BT 3000, Rome, Italy) using commercial kits (Chem Enzyme, Tehran Iran). Serum total cholesterol and triglycerides levels were measured by enzymatic reagents (Chem. Enzyme, Tehran Iran) adapted to Selecta auto analyzer. HDL-C levels were measured by using available commercial kits (Pars Azmun, Tehran Iran). Low density lipoprotein cholesterol levels (LDL-C) were calculated from the values of serum triglyceride (TG), total cholesterol and HDL cholesterol according to the Fried Wald formula in triglyceride <400 mg/dl: \[ \text{LDL-C} = \text{Total cholesterol} - \text{HDL-C} - (\text{TG}/5) \] HbA1c were assessed with D5S analyzer uses low pressure cat ion exchange chromatography in conjunction with gradient elution to separate human hemoglobin subtypes and variants from haemolysed whole blood.

Inter assay coefficients of variations were 1.25 for triglycerides, 1.2 for cholesterol and 1.25 for glucose. The corresponding intra-assay coefficients of variations were 1.97, 1.6 and 2.2, respectively.

**Statistical analysis:** SPSS (version 13) was used for statistical analysis. Continuous variables presented as mean ± standard deviation. Partial correlations between continuous variables evaluated by Pearson’s partial r coefficient, after adjusting for age, sex and BMI. The relationships between lipid profiles and glycemic control parameters.
RESULTS

About 18% of participants were men and 82% were women. Clinical and characteristics of the study participants are shown in Table-I.

Table-II shows the partial correlation coefficients between walnut consumption and lipid profiles and glycemic control parameters. When we stratified the analysis by gender, no gender differences were observed in the magnitude of the correlations of Walnut consumption and lipid profiles and glycemic control parameters. Thus, the analysis was performed after adjusting with age, sex and BMI. Walnut consumption was positively correlated with HDL-C levels but not with glycemic control parameters and other lipid profile components.

Relationships between lipid profiles and glycemic control parameters with walnut consumption may be confounded by several characteristics, especially dietary habits and obesity. Thus, we applied multiple regression analysis (Table-III) and after controlling for total energy and total fat intake, body mass index, sex and age we found positive associations between walnut consumption and HDL-C level \( (p=0.01) \). No other significant associations were observed between other blood lipids, glycemic control parameters and walnut consumption.

DISCUSSION

In this study, walnut consumption affected on HDL-C levels and it could increase HDL-C levels but it did not have any effect on glycemic control parameters and other lipid profile components. A number of clinical trials have examined the
The effect of walnut consumption on lipid profiles

ACKNOWLEDGMENTS

We would like to acknowledge “Maryam Zare, Maryam Samsamshariat, Najmaheh Mehrvari Far, Zahra Alhaj, Fereshteh Khorami, Shiva Zahed, Elnaz Tabatabaei, Elaheh Zade and Maryam Tabesh” as dietitians for their help in collecting records and also like to acknowledge Majid Abyar for help on the computer.

REFERENCES


In conclusion, our study supports a positive association between walnut consumption and HDL-C in prediabetes patients who were at first-degree relative of type two diabetic patients. Lipid profiles disturbance are one of the complication of this and risk factor for cardiovascular disease, so walnut consumption may improve lipid profiles in prediabetes patients.