The association between score of plant-based diet and non-alcoholic fatty liver disease in adults

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Abstract

Background: Plant-based diet as resource of antioxidants and anti-inflammatory phytochemicals, that was considered to protect against onset and development of NAFLD.

Aim: To investigate the association between plant-based diet and NAFLD in adults.

Methods: The present case control study was conducted on 240 individuals (120 with NAFLD and 120 control) aged 20–69 years. Provided recommendations by the American College of Gastroenterology and the American Gastroenterological Association were used for NAFLD diagnosis. Dietary intake was assessed using 178-food item food frequency questionnaire. Also, plant-based diet score was evaluated based on 18 food groups classified into animal foods, healthy and unhealthy plant foods. A multiple logistic regression model was used to examine the relationship between fatty liver disease and tertiles of PDI.

Results: The results of this study showed that we did not observe any association between tertiles of plant-based diet index (PDI) and NAFLD in crude model (OR: 1.29, 95%CI:0.66 – 2.52, P:0.44) and after adjustment for confounders including age, energy intake, physical activity, body mass index (OR:0.76, 95%CI: 0.31 – 1.86, P:0.52). Also, there were not any association of tertiles of healthy PDI (hPDI) (OR:1.14, 95%CI: 0.50 – 2.60, P:0.74) and unhealthy PDI (uhPDI) (OR:0.89, 95%CI:0.36–2.18, P: 0.79) with NAFLD after full adjustment for potential confounders.

Conclusion: There was not any association of PDI, hPDI, and uPDI with NAFLD in adults. More research needs to examine whether this specific diet may impact and improve NAFLD.

Introduction

Non-alcoholic fatty liver disease (NAFLD) is a chronic hepatic steatosis occurring subsequent to the fat accumulation. Risk factors such as obesity, metabolic syndrome, type 2 diabetes, dyslipidemia, and importantly unhealthy dietary patterns can be developed disease (1–4). It may progress to cirrhosis and ultimately cause mortality if it was not treated (5). According to the recent research, overall prevalence of NAFLD was 32.3% consisting of 22.7% obese and 9.6% non-obese (6).

Notably, NAFLD is a metabolic condition having different rates of manifestation and progression. It can begin from simple steatosis, advanced on non-alcoholic steatohepatitis (NASH) which is the severe illness accompanied by inflammatory and injured hepatocyte, ended to fibrosis and cirrhosis where most liver-related mortality take place (7). It has been assumed that hepatic triglyceride accumulation (steatosis) as a result of fatty acid metabolism disorder is primarily cause of NAFLD (8). Normal metabolism of lipid in the liver is carried out by hepatocyte uptake and denovo synthesis of free fatty acids (FFAs). When this mechanism is disrupted, elevated triglycerides accumulate within hepatocytes leading to steatosis. In addition, raising hepatocyte death rate can be owing to the oxidative/metabolic stress happening after altered lipid homeostasis (9). Hence, the imbalanced homeostasis is vital in

NAFLD pathogenesis which should be diagnosed in early stages to prevent the progression from steatosis to cirrhosis (7).

There are some approaches and interventions for the treatment of NAFLD, particularly modification of food habits and dietary patterns (10–12). Because NAFLD usually stems from the accumulation of lipids related to excess dietary fat or carbohydrates intake (10). Dietary patterns and nutrients are the contributors not only to the progression, but also to treatment of NAFLD (11). In more details, it has been demonstrated that diets high in calorie, trans/saturated fat and cholesterol, carbohydrates, and fructose-sweetened beverages induced fat accumulation in the liver (12). In contrast, when patients with NAFLD are treated by means of healthy dietary patterns including balanced diet in calorie, saturated fats, carbohydrate, and fructose, as well as the nutrients intake such as choline, polyphenolic catechins, caffeine, and vitamin E, they can be prevented from late stages of this disease (12). Furthermore, fruits and vegetables which are rich in antioxidants and anti-inflammatory phytochemicals can protect against onset and development of NAFLD (13). However, it is noteworthy to mention that these protective and effective foods need to be consumed in a mix of healthy dietary patterns such as plant-based diet to impact on NAFLD more efficiently (14). Some evidence came to the conclusion that Mediterranean and Vegetarian diets play the crucial role in liver-related diseases, although some others did not indicate the efficient influence of vegetarian diet on fatty liver (15–17). In addition, a research observed that plant-based diet could reduce the risk of NAFLD (18).Hence, due to the insufficiency of findings about the impact of plant-based diet on NAFLD, to elucidate this relationship, we aimed to investigate the association between plant-based diet with NAFLD in adults.

Methods And Materials

Study population

The present case-control study was conducted among 240 individuals aged 20–69 years. 120 control (without NAFLD) and 120 patients with NAFLD were selected according to laboratory tests and abdominal ultrasound using the convenience sampling method from the Academic Liver Disease Clinic in Iran, Yazd, from October 2017 to March 2019. Also, 120 participants without NAFLD were recruited from the same clinic in the same period after matching for age and gender. The eligibility criteria were not intake alcoholic beverages, and having a body mass index (BMI) of greater than 25 kg/m^2. Individuals were excluded if using drugs inducing hepatotoxicity (tamoxifen, steroids, amiodarone); having cardiovascular diseases (coronary artery disease, congestive heart disease), diabetes type 1, chronic B or C hepatitis virus infections, cancer, Wilson's disease, hemochromatosis, biliary diseases or cirrhosis, and other liver diseases; and being on a special diet. The study protocol was approved by the Ethics Committee in Yazd Shahid Sadoughi University of Medical Sciences (IR.SSU.SPH.REC.1396.38) and the written informed consents were obtained from all participants.

Clinical measurements

All participants underwent an abdominal ultrasound by the same radiologist using the same device. The liver steatosis was estimated by evaluating the image brightness of the echo pattern. Abdominal ultrasound is not able to detect hepatic fat deposition in the case that it is less than 33% of the total liver weight (19). In this regard, patients with a total liver weight of lower than 33% were categorized as controls. Recommendations provided by the American College of Gastroenterology and the American Gastroenterological Association were used for NAFLD diagnosis .(20)

Assessment of dietary intake

The participants' last year dietary intake was assessed using a validated semi-quantitative Food Frequency Questionnaire (FFQ) (21). The original semi-quantitative FFQ contains 168 food items; however, other 10 food items were added regarding the specific foods consumption in Yazd, which made a total of 178 items (22). Trained interviewers completed questionnaires after asking the participants to report the amount and frequency of each food item consumption daily, weekly, and monthly in the past year. Also, they were asked about their usual consumption rate of each food item. The photographs of household portions were applied to confirm the accurate food intake. Daily macro-nutrients, micro-nutrients, and energy intakes of each participant were calculated in grams/day using Nutritionist IV software based on the US Department of Agriculture's National Nutrient Databank.

Calculation of Plant-based diet

Whole PDI, healthy PDI, and unhealthy PDI were created based on previous studies (23, 24). First, 18 food groups were generated and classified into animal foods, healthy and unhealthy plant foods in line with nutrient and culinary standard features. Healthy plant food groups included fruits, vegetables, whole grains, legumes, vegetable oils, nuts, tea and coffee, while less healthy plant food groups included sugar-sweetened beverages, refined grains, fruit juices, potatoes, sweets and desserts, and dairy products, eggs, animal fats, fish and seafood, poultry and red meat, and miscellaneous animal-based foods were located in animal food groups. These 18 food groups were ranked into tertiles and give scores between 1 and 10. The highest tertiles of PDI had the score of 10 for each plant food groups and the participants were in below the lowest tertiles received a score of 1 for each plant food groups. In contrast, a score of 1 was given to each animal food groups upper the highest tertiles of consumption and a score of 10 for consumption under the bottom tertiles. To calculate hPDI, scores of 10 and 1 were given to subjects with the highest and lowest consumption of healthy plant foods, respectively and for uPDI, a score between 10 and 1 was given to the highest through the lowest consumption of unhealthy plant foods. Finally, all 18 food group scores were summed (range 18–180) to obtain the indices score indicating that a higher intake of all three indices manifested lower animal food intake.

Assessment of other variable

Demographic information including age, gender, education, occupation, medical history, smoking as well as medications and dietary supplements were obtained. In line with anthropometric measurements, weight, fat and muscle mass were measured in light clothes with no shoes by a digital scale (Omron Digital Scale, Model BF511) with 5 g precision by a trained nutritionist. Height was measured using a

tape to the nearest 0.5 cm in standing position without shoes. Then, BMI was calculated as weight in kilograms divided by square of height (m^2). Moreover, waist circumference (WC) and hip circumference (HC) measurements were performed between the last ribs and the iliac crest by a non-elastic tape without any pressure on the body. The International Physical Activity Questionnaire was used to assess physical activity (25).

Statistical analysis

All data were analyzed by SPSS version 23. Analysis of variance and chi-square test were run to compare continuous and categorical variables between tertiles of PDI, uPDI and hPDI respectively. A multiple logistic regression model was applied based on the ORs and the 95% confidence intervals to examine the relationship between fatty liver disease and tertiles of PDI,uPDI and hPDI in crude and adjusted models.

Results

Table 1 indicates the characteristics of the study participants across tertiles of PDI. Sex, physical activity, drug use and **supplement consumption** were no significant differed between tertile of PDI. Demographic and dietary intake of participants across the tertiles of PDI scores are presented in **Table 2**. Participants with higher score of PDI has higher intake of energy (P<0.001), carbohydrate (P<0.001), vitamin B_6 (P<0.001), vitamin B_9 (P<0.001), calcium (P=0.001), and zinc (P:0.003). Also, adults in the third tertiles were younger (P=0.7) and more obese (P=0.23).

Table 3 indicates Multivariable-adjusted odds ratio of the associations between PDI, hPDI, uhPDI and NAFLD. In crude model (OR: 1.29, 95%CI:0.66 – 2.52, P:0.44) and adjusted model for age, energy intake, physical activity and BMI (OR:0.76, 95%CI: 0.31 – 1.86, P:0.52), we did not observe any association between tertiles of PDI and NAFLD. Also, there were not any association of hPDI tertiles in crude (OR: 1.00, 95%CI: 0.53– 1.89, P:0.99) and full adjustment (OR:1.14, 95%CI: 0.50 – 2.60, P:0.74) models as well as association of uhPDI in crude model (OR: 0.53, 95%CI: 0.27– 1.04, P:0.06) and after adjustment for potential confounders (OR: 0.89, 95%CI:0.36– 2.18, P:0.79) with NAFLD.

Discussion

In the current study, we found no relationship of PDI, hPDI, and uhPDI with NAFLD in adults. Moreover, individuals with high adhering to PDI consumed higher amount of vitamin B_6, B_9, calcium, and zinc.

There are limited evidence examining the association between PDI and NAFLD in adults. Similar to our findings, a study carried out by Choi et al investigated that vegetarian diet, an antioxidant rich source, was not associated with odds of NAFLD in Buddhist priests (15). In contrast, Chiu et al observed that people having vegetarian diet were protected from fatty liver than non-vegetarians (26). In contrast to our results, a research conducted on elderly population examined three priori dietary patterns including Mediterranean Diet Score (MDS), the Dutch Dietary Guidelines (DDG), and the World Health Organization (WHO). Finally it was investigated that WHO diet as plant-based, high-fiber, and low-fat diet was linked to

regression of NAFLD (27). Moreover, another study in which liver function was examined using alanine aminotransferase (ALT), aspartate aminotransferase (AST) and fatty liver index (FLI) reported that adults adhering to hPDI had lower risk of NAFLD and more optimal liver function (18). Overall, there are contradictory results related to PDI and vegetarian diet; however, it seems to have more likely a protective role in odds of NAFLD.

A review came to the conclusion that PDI can alleviate fatty liver disease (28). There are different mechanisms related to the impact of this specific diet on NAFLD. Since this crucial liver disease accompanied by inflammation and oxidative stress, the influence of some food as anti-inflammatory and antioxidant sources could help (28, 29). It is noteworthy to point out that fruits such as grapes having resveratrol as antioxidant source can inhibit oxidative stress and upregulating signaling pathway in HepG2 cells (30). Vegetables such as tomato inhibits autophagy in the NAFLD cell model by upregulating the peroxisome proliferator-activated receptor alpha (PPAR-α) signaling pathway (31). A hypothesis is that the prevalence of NAFLD in our population was not great enough to show this inter-relationship. Another hypothesis is related to the difference between raw and cooked vegetables stated that cooked vegetables cannot influence on NAFLD than raw ones which we did not consider this contrast in the current study (32). Furthermore, PDI had minimum level in our participant needing to be achieved for health benefits. Considering the use of sample-based scores, the diets of the population may be less healthy (or less plant-rich) than those of professional recommendations.

Our study had some strength needing to mention. We considered individuals with and without NAFLD. Also, we analyzed three type of PDI as PDI, hPDI, and uhPDI. However, this research has some limitations. First, it was case control study that did not allow us to interpret the causal relationships. Second, we did not consider the prevalence of NAFLD in the participants that it might reduce the power to detect the association.

In conclusion, there was not any association of PDI, hPDI, and uhPDI with NAFLD in adults. More research needs to examine whether this specific diet could impact and improve NAFLD in cohort study.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Ethics' Committee in Yazd Shahid Sadoughi University of Medical Sciences (IR.SSU.SPH.REC.1396.38). All methods were performed in accordance with the relevant guidelines and regulations. The written informed consent form was signed by all participants and their parents before the data collection.

Consent for publication

Not applicable.

Availability of data and materials

The data are not publicly available due to their containing information that could compromise the privacy of research participants. The data and materials of the current study is available from the corresponding author, Mahdieh Hosseinzadeh , on reasonable request.

Competing interests

There is no conflict of interest.

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Authors' contributions

MM conceived the idea. ZD and AF prepared the proposal. MH, TN obtained ethical approvals, applied for funding, provided data collection. HA, AF wrote the manuscript. ZD revised the manuscript. FM, SR were collected data. Authors read and approved the final manuscript.

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Tables

Tables 1 to 3 are available in the Supplementary Files section

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