Original Article

Effect of Potato consumption as a high glycemic index food on pre-diabetes adult patients

Bijan Iraj[1], Motahar Heidari-Beni[2], Maryam Bakhtiari-Broujeni[3], Alireza Ebneshahidi[4], Massoud Amini[5], Reza Ghiasvand[6], Gholamreza Askari[7]

ABSTRACT

Objective: The novel dietary factors glycemic index (GI) and glycemic load (GL) have been associated with some chronic diseases. Studies have showed that high carbohydrate foods such as potato, rice and bread induce high glycemic response [high glycemic index (GI)] and increase postprandial hyperglycemia and hyperinsulinemia. Since potato is low cost and is one of the major sources of carbohydrate intake in Iranian, we investigate the effect of potato consumption on pre-diabetes risk factors such as lipid profiles, obesity and blood pressure in Iranian adults.

Methodology: Six hundred thirty nine (639) participants 35 to 55 year of age were included in the present study. Dietary intake was assessed with three days record and record's contents were changed to grams. Weight of each boiled potato was considered 70 gram. Biochemical assessments, Systolic and diastolic blood pressures and anthropometric indices were determined according to the standard protocol.

Results: Almost 25% of participant were male and 75% were female. After dividing the participants into four categories (quartiles) according to the amount of potato consumption, TG was significantly different across quartiles with and without adjustment. Distributions of other variables were not significantly different across quartiles. Multiple regression analysis showed positive associations between potato consumption and TG level (p=0.01). No other significant associations were observed between other parameters and potato consumption.

Conclusions: Potato consumption as a high GI and GL food can positively effect on TG level and didn't have any effect on other risk factors of diabetes.

KEY WORDS: Potato, Diabetes risk factor, Pre-diabetes, Adult.

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1. Bijan Iraj,
   Assistant Professor of Internal Medicine and Endocrinology,
2. Motahar Heidari-Beni ,
   Food Security Research Center,
3. Maryam Bakhtiari-Broujeni,
4. Alireza Ebneshahidi,
5. Massoud Amini,
   Professor of Internal Medicine and Endocrinology,
6. Reza Ghiasvand,
   Assistant Prof. of Clinical Nutrition, Food Security Research Center,
7. Gholamreza Askari,
   Assistant Prof. of Clinical Nutrition, Food Security Research Center,

1, 3-5: Isfahan Endocrine and Metabolism Research Center.
1-7: Isfahan University of Medical Sciences, Isfahan, Iran.

Correspondence:

Gholamreza Askari, MD, PhD,
E mail: askari@mui.ac.ir

INTRODUCTION

Diabetes mellitus is a major health problem that affect on quality of life. Approximately 80% of diabetes patient will develop macrovascular disease.[1,2] Cardiovascular complications are the more frequent problem among diabetes patient especially in type 2.[3] When hypertension and abnormal lipid profiles accurs with diabetes mellitus in the same patient it destroy cardiovascular system. The risk of stroke or any cardiovascular diseases increase when the hypertensive patients and patient with abnormal lipid profiles have diabetes mellitus.[4] Obesity is another public health problem in recent decades. More studies have documented that obesity contributes to such chronic diseases as cardiovascular and diabetes mellitus.[5]

According to a recent study life style and diet plan has an effect on obesity, blood pressure and lipid profiles that all of them have adverse effect on progression and complication of diabetes.[6] Recently, the novel dietary factors glycemic index (GI) and glycemic load (GL) have been associated with some chronic disease.[7,8] Studies showed that high carbohydrate foods such as potato, rice and bread induce high glycemic response [high glycemic index (GI)] increase postprandial hyperglycemia, hyperinsulinemia. In insulin resistant patient consumption of high GI foods induce postprandial hyperglycemia and hyperinsulinemia and destroy B cell and develop diabetes type 2.[9-11] It is possible that an excess of circulating insulin, the result of greater peripheral resistance, produces a vasoconstriction in vessels and caused the hypertension[12] but results are controversial. Some studies suggested that potato is enriched potassium food and increased potassium intake may play a role in the prevention and treatment of hypertension.[13] Low GI foods promote satiety and enhance weight control but high GI foods with high carbohydrate such as white flour, rice, bread and potato promotes weight gain.[11] Some studies didn't support beneficial of low GI foods comparison to high GI foods and suggested no difference in body weight decrease between low and high GI foods.[14]

Most of the studies investigated diet plan and a few studies have focused on specific food on risk factors of pre-diabetes patient. There are no studies about the association between potato consumption as a high GI food and risk factors of progression of diabetes such as blood pressure, obesity and lipid profiles in pre-diabetes patient. Since potato is low cost and is one of the major sources of carbohydrate intake in Iranian, we investigated the effect of potato consumption on pre-diabetes risk factors such as lipid profiles, obesity and blood pressure in Iranian adults.

METHODOLOGY

Participant: This cross-sectional study was done in the framework of the Isfahan Diabetes Prevention Study (IDPS). IDPS is a cohort study that was done in Isfahan Endocrine and Metabolism Research Center (IEMRC) that was conducted from 2003 until now with 3454 men and female 35 to 55 years. Our aim in IDPS was type 2 diabetes prevention by changing in life style or by medical intervention among at high risk people. One thousand three hundred fifteen (1315) subjects were pre-diabetes and 1050 of them had food record. Six hundred thirty nine (639) participants reported that they consume potato. According to ADA criteria[15] 155 subjects were impaired fasting glucose (IFG), those with 100-125 mg/dl of fasting blood glucose. Two hundred one subjects had Impaired Glucose Tolerance (IGT), those with 140-199 mg/dl of blood glucose 120 minute after intake 75gr oral glucose. Two hundred eighty three subjects were combined pre-diabetes (IFG +IGT). Those who used medicine that effect on glucose tolerance test and lipid profiles were excluded.

The Isfahan Endocrine and Metabolism Research Center (IEMRC) Medical Ethics Committee approved this study and each participant filled in the Consent Form.

Biochemical assessment: Blood samples were taken from 7:30 to 9:30 AM, after 12 h 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 75gr 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:[16]

LDL-C=Total cholesterol –HDL-C-TG/5

HbA1c were assessed with DS5 analyzer using low pressure cat ion exchange chromatography in conjunction with gradient elution to separate human hemoglobin subtypes and variants from hemolyse whole blood.[17,18]

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.

Assessment of blood pressure: Systolic and diastolic blood pressures were taken using a standardized mercury sphygmomanometer on the right arm, after a 15 minute rest in a sitting position. Before measuring the blood pressure, the participant was asked about drinking tea or coffee, physical activity, smoking and full bladder. The systolic blood pressure was defined as the appearance of the first sound (Korotkoff phase 1) and diastolic blood pressure was defined as the disappearance of the sound (Korotkoff phase 5).

Assessment of anthropometric indices: Weight was measured by Seca scales (Germany) to the nearest 100 g with minimal clothing and without shoes. Height was measured in a standing position, without shoes while the shoulders were in a normal position to the nearest 0.5 cm. Waist circumference (WC) was measured using un-stretchable tape in a standing position without applying any pressure to the body's surface, and was recorded to the nearest 0.1 cm. WC was measured in the middle of the lowest gear and the top of the iliac crest (the most narrow waist circumference) Body mass index was estimated as weight (kg) divided by height (m) squared. WC was considered as abdominal obesity index and BMI was considered as general obesity index.

Assessment of dietary intake: Dietary intake was assessed by use othree 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 were trained how to record the data. Then record's contents were changed to grams. Weight of each boiled potato was considered 70 gram.[19]

Statistic analysis: All statistical analyses were performed with SPSS version 13. Quantitative data were reported as mean±standard deviation (SD). We divided the participants into four categories (quartile) according to the amount of potato consumption. One-way analysis of variance (ANOVA) was used to identify significant difference across quartiles categories of potato consumption. Analysis for covariate (ANCOVA) was used to adjust for potentially confounding variables, which included age, sex and energy intake and compare the means of variables in each quartiles. The relationships between dependent variables with potato consumption were examined using multiple linear regression analysis, after controlling for potential confounders (adjusted with age, sex, energy intake). $P<0.05$ was considered statistically significant.

RESULTS

About 25% of participant were men and 75% were women, Clinical and biochemical variables of participants showed in Table-I.

We divided the participants into four categories (quartiles) according to the amount of potato consumption. TG was significantly different across quartiles and patient who consumed more potatoes tended to have a higher TG. Distributions of other variables were not dependent on potato consumption and were not significantly different across quartiles. After adjusting with some covariate (age, sex, energy intake) only TG was significantly different across quartiles and There were not any significant relationship between amount of potato consumption and other variables across quartiles.

We applied multiple regression analysis for determination the relationship between potato consumption and other variables (Table-III) and after controlling for total energy, sex and age we found positive associations between potato consumption and TG level ($p=0.01$). No other significant associations were observed between other parameters and potato consumption.

DISCUSSION

In this study, we found a significant association between amounts of potato consumption and TG

Table-I: Clinical and biochemical variables of participants.

Variables	*Mean(SD)*
Age	44.25±6.82
Weight	74.86±11.82
Height	159.08±7.99
Waist circumference	90.78±9.42
Hip circumference	108.4±9.26
BMI	29.59±4.25
FBS	105.7±10.84
BS120*	143.51±38.39
HbA1C	5.22±0.82
TC	202.35±40.4
TG	174.95±10.5
HDL	45.63±12.33
LDL	109.03±24.73
Systolic blood pressure	11.7±1.67
Diastolic blood pressure	7.6±1.22
Potato consumption	97.72±12.3
Energy intake	1655.38±55.65

* Blood suger120 minutes after glucose taking.

Table-II: Distribution of variables across quartiles of amount of potato consumption

Variables	*Quartile 1*	*Quartile 2*	*Quartile 3*	*Quartile 4*	*P**	*P***
Age	44.55±5.9	44.88±6.5	43.78±6.9	42.8±6.2	0.03	-
Waist circumference	90.08±9.04	91.48±8.3	89.6±8.9	90.25±9.1	0.58	0.55
BMI	29.5±4.2	30±3.3	29.7±4.4	29.6±4.2	0.83	0.72
Systolic blood pressure	11.7±1.4	11.6±1.7	11.8±1.8	11.7±1.6	0.83	0.56
Diastolic blood pressure	7.5±1.1	7.5±1.2	7.7±1.3	7.6±1.2	0.63	0.51
FBS	103.72±10.7	105.31±11.7	103.73±11.2	102.42±11.1	0.31	0.51
Bs120	149.82±28.1	149.16±32.6	152.28±26.5	155.32±27.5	0.20	0.13
HbA1C	5.28±0.94	5.38±0.79	5.25±0.87	5.1±0.76	0.14	0.17
TC	201.83±38.8	207.37±46.1	205.16±38.6	199.63±42.1	0.47	0.51
TG	168.3±78.9	170.57±92.1	177.61±100.9	222.77±207.5	0.007	0.01
HDL	45.08±12.25	44.1±11.1	46.12±12.8	45.9±11.5	0.63	0.69
LDL	105.6±24.9	115.1±4.1	105.5±32.2	115.6±21.7	0.78	0.97

* p-values resulted from ANOVA test and show difference between Quartile of potato consumption.
** p-values resulted from ANCOVA test with age, sex and energy intake as covariate and show difference between Quartile of potato consumption

level. Increasing the amount of potato consumption lead to increased TG levels in prediabetes patients. We didn't find any significant association between amounts of potato consumption and other variables. Potato has been considered as a high GI food and some studies showed that high GI food increase plasma insulin and TG concentrations.[20] Observational studies demonstrated TG level tend to rise and HDL level decrease with GI and GL high foods. In interventional studies effect of high or low GI foods on plasma lipid concentrations has been less consistent.[21,22] Studies showed low GI foods improve the lipid profiles and decrease TG levels and increase HDL levels.[23] Low GI diet reduces the amount of insulin-stimulating HMG-CoA reductase (3-hydroxy-3-methyl-glutaryl-CoA reductase) activity and improves plasma lipid profiles.[24]

Our study didn't show any significant association between potato consumption and blood glucose parameters. Some studies confirmed the adverse effect of high GI foods such as potato on fasting blood sugar and postprandial glucose[25,26] and other have failed to show these findings.[27] On the other hand, no significant association between GI and GL with diabetes and coronary heart disease risk factors was seen in older men in the Zutphen study.[28] Some studies have suggested that adverse effect of high GI food is on person with high body weight and with insulin resistant.[29]

In this study we didn't find any association between potato consumption and body weight. Effect of high GI foods such as potato on obesity and weight gain is inconsistent. Finding showed that high GI foods lead to more insulin secretion than low GI foods and decrease glucose blood level and finally return to hunger rapidly, so high GI foods may promote weight gain.[11] Most short term studies showed low GI foods reduce hunger and increase satiety and effect on weight control. However this finding is controversial and no long term clinical trial was done to investigate the effect of low and high GI foods on body weight.[22,30] In epidemiological study relationship between GI and body weight are inconsistent.[31] Harvard group indicated that potato consumption in all methods to prepare it (French fries or chips, baked, boiled and mashed potatoes) leading to weight gain. They claim that the starch in cooked potatoes is quickly broken down to glucose and elevate blood glucose

Table-III: Multiple regression analysis on the association between potato consumption and other parameters.

Model	*R2*	*B ±SE*	*P*
Model 1:BMI	0.26	0.001±0.002	0.94
Model 2:WC	0.1	1.2±0.003	0.98
Model 2: Systolic blood pressure	0.08	0.001±0.001	0.20
Model 3: Diastolic blood pressure	0.03	0.001±0.001	0.49
Model 4:FBS	0.03	0.002±0.004	0.59
Model 5:BS120	0.036	0.015±0.01	0.13
Model 6: HbA1C	0.01	0.001±0.001	0.18
Model 7:TC	0.05	0.003±0.1	0.82
Model 8:TG	0.04	0.32±0.03	0.04
Model 9: HDL	0.04	0.001±0.004	0.84
Model 10: LDL	0.2	0.013±0.051	0.8

*Data are B-coefficient ± Standard Error. Values are corrected for various confounders such as total energy, sex and age. Independent variable is potato consumption.

and insulin secretion and ultimately increased hunger.[32] Many researchers have suggested that total caloric intake is the most important factor in determining weight gain not type of calories or food source. One study showed that boiled potato has the highest satiety index and cause feeling of satiety more than other foods and decrease hunger. These finding about satiety index of potato is opposite to Harvard findings.

Potato is a good source of vitamin C, potassium and abundant polyphenol. These compounds have health benefits including anti-hypertensive effects. However we didn't find any significant relationship between amounts of potato consumption and blood pressure. Findings of a crossover trial that was done on hypertensive subjects showed no significant effect of potato consumption on fasting plasma glucose, blood lipids and weight gain but diastolic and systolic blood pressure significantly decreased.[33] Some studies have suggested that High GI food such as potato absorb from intestine rapidly and caused the elevate blood glucose and insulin[24] and finally disturbs function of endothelium.[34] Hyperglycemia increase Reactive oxygen species (ROS) and decrease antioxidant concentration, changes are associated with increase blood pressure. However larger observational studies failed to show any association between GI and insulin resistance and effect of GI on blood pressure.[35]

CONCLUSION

Most of the studies that looked at the association between GI and GL of foods on risk factors of disease were done on healthy patient, and foods with different GI and GL have very different effects on healthy subjects and patients. Despite the controversy findings a low-GI diet can improve glycemic control in patients with diabetes. Further investigation is needed to support the effect of low and high GI foods to prevention and treatment of diabetes and control of complications of these disorders.

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Authors Contributon:

Bijan Iraj: Proposal writing.
Motahar Heidari-Beni and Maryam Bakhtiari-Broujeni: Data Collection.
Alireza Ebneshahidi: Statistical analysis.
Massoud Amini and Reza Ghiasvand: Manuscript writing.
Gholamreza Askari: Managing the research project.