Original Article

A Case-Control Study on Potato Consumption and Risk of Stroke in Central Iran

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Abstract

Background: Potato, a high- glycemic index (GI) food, is one of the most widely used starchy foods worldwide. Previous studies on the association of dietary intakes with stroke have mostly focused on the dietary GI and there is no information regarding the association between potato consumption and risk of stroke. This case-control study was conducted to evaluate the association between potato consumption and risk of stroke in an Iranian adult population.

Methods: In this case-control study, 195 patients with stroke, hospitalized in the Neurology Ward of Alzahra University Hospital and 195 controls from other wards of the hospital with convenience non-random sampling method were enrolled. To assess participants' dietary intakes, a validated food frequency questionnaire was used. Information on socioeconomic and demographic variables, physical activity pattern, and smoking were collected by the use of questionnaires. Logistic regression method in different models was applied to explore the associations between potato intake and stroke. First quartile of potato intake was used as a reference in all models. Mantel-Haenszel extension chi-square test was used to assess the overall trend across quartiles of potato consumption.

Results: Individuals with stroke were more likely to be male (60% vs. 46%, $P < 0.05$) and older (68.0 ± 1.0 vs. 61.5 ± 0.8 y, $P < 0.001$) as compared with controls. They had lower body mass index (BMI) (25.2 ± 0.3 vs. 28.5 ± 1.0 kg/m^2, $P < 0.05$), and were less likely to be obese (11.3% vs. 29.2%, $P < 0.001$) compared with controls. The mean potato consumption was 31.1 ± 3.4 and 23.4 ± 1.3 g/d for cases and controls, respectively. Participants with the highest potato consumption were younger and more likely to be physically active. High potato consumption was associated with higher intakes of energy, fruits, vegetables, pulses, and grains. After adjustment for age, sex, and total energy intake, we found that individuals with the highest potato consumption were more likely to have stroke as compared with those with the lowest consumption (OR: 1.9; 95%CI: 1.0 – 3.6). The correlation between physical activity and potato consumption was 0.03, $P = 0.54$ and that of smoking and potato intake was -0.004, $P = 0.94$. Even after additional control for smoking and physical activity, the association remained significant (OR: 1.9; 95% CI: 1.0 – 3.6). Further adjustment for dietary intakes made the associations non significant (OR: 1.1; 95%CI: 0.5 – 2.5). However, when BMI was taken into account in the final model, we found that individuals in the third quartile of potato consumption were significantly more likely to have stroke (OR: 2.2; 95%CI: 1.0 – 4.7).

Conclusion: We found evidence indicating that there is a marginally significant independent association between potato consumption and risk of stroke. Further prospective studies are required to confirm this finding.

Keywords: Diet, food frequency questionnaire, glycemic index, potato, stroke

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Introduction

World Health Organization (WHO) has revealed that the probability risk of stroke is more than formerly considered and it become the second cause of death around the world.[1] Recent data suggest that the incidence of stroke has decreased in many wealthy countries, but in poor- or middle- income countries, the incidence has increased in last decades.[2] Over 80% of stroke deaths in the world occur in developing countries.[3] In Iran, it has been shown that the incidence is considerably greater than that in most Western countries, with the high prevalence among younger ages[4] As stroke is largely preventable, data on risk factors within a certain country are an essential step in reducing its incidence and resulting disease burden.

Dietary intakes have long been at the center of investigations focusing on stroke incidence.[5] Carbohydrate intake as a macronutrient has an important role in postprandial glycemia and insulin secretion[6] and so might be associated with the incidence of several acute and chronic diseases including stroke.[7] Nowadays, it seems that the quality of carbohydrate intake in addition to its quantity might be an influencing factor in the incidence of chronic diseases.[8] To assess the quality of carbohydrate intake, the concept of glycemic index (GI) and glycemic load (GL) has been proposed. Several cross-sectional and prospective studies have assessed dietary GI and GL in relation to the prevalence and incidence of chronic diseases. It has been shown that those with high dietary GI or GL are at increased risk of type 2 diabetes,[9] vascular disease,[10] and systemic inflammation[11] as compared with those with lower dietary GI and GL. Elevated levels of blood lipid profile[12]

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as well as blood pressure[13] have also been linked to dietary GI and GL. As hypertension and hyperlipidemia are well-known risk factors for stroke,[14] one would expect a positive association between dietary GI and GL and risk of stroke. Although the direct association between dietary GI and stroke has rarely been investigated, several studies have looked at the association between low GI foods and incidence of stroke.[15] For instance, inverse associations have been reported between whole grain consumption and risk of stroke in epidemiologic studies.[16,17]

Potato, a high- GI food, is one of the most widely used starchy foods in Iranian diet.[18] In the Food Guide Pyramid, it has been included in the vegetable group as a food to be encouraged. However, several studies have indicated its detrimental effects on human health. In a prospective study, a positive significant association has been found between the consumption of potatoes and the risk of type 2 diabetes in women.[19] In contrast, a protective association has been reported among Chinese population.[20] It has also been highlighted that potatoes could not play a role in the beneficial relation of vegetables with cancer incidence. Despite these documents, American Heart Association has considered potatoes as a healthy food.[19] Potato is a high -GI food which contains low amounts of dietary fiber. To the best of our knowledge, there is no information regarding the association between potato consumption and risk of stroke. This study aimed to assess the relationship between potato consumption and risk of stroke among a group of Iranian population.

Subjects and Methods

Participants

In this case-control study, which was conducted in Alzahra University Hospital (A center for admission of stroke patients) in 2008, 195 nonconsecutive stroke cases (the ones who gave consent to join the study) and 195 controls were selected with convenience nonrandom sampling method. Subjects hospitalized in Neurology Ward of the hospital were chosen as cases and patients hospitalized in other wards (orthopedic or surgical) with no history of cerebrovascular accident (CVA) or neurologic disorders considered as a control group. For each patient a written informed consent was taken. The Local Ethics Review Committee approved the study protocol.

Assessment of Dietary Intakes

Usual dietary intakes of the participants were assessed by means of a validated 168-item semi-quantitative food frequency questionnaire (FFQ)[21] that was administered by trained dietitians. Patients were requested to report portion sizes and consumption frequency [as daily (e.g. bread), weekly (e.g. rice, meat), and monthly (e.g. fish)] during the last year for each food item. As brain damage or impaired memory is the most common sequel of stroke and recalls of dietary intakes from these patients would be biased, we asked their family members to help complete the FFQ. The reported frequency as well as the portion size was double checked with the person responsible for cooking at home. The food items included in the FFQ were those that have high consumption among Iranian population.[21] The reported frequency for each food item was then converted to a daily intake. Portion sizes of consumed foods were converted to grams using household measures. Total energy intake was calculated by summing up energy intakes from all foods. Potato consumption was defined as the sum of boiled potato, potato chips, and French fries.

Assessment of Stroke

For all patients, the incidence of acute stroke (consisted of both ischemic and hemorrhagic stroke) was confirmed by a specialist with magnetic resonance imaging (MRI) or brain computed tomography (CT). Individuals that had head trauma, primary intracranial hemorrhage, or subarachnoid or subdural hemorrhage were not included as cases in the study. One episode of focal neurologic deficit with acute onset due to a vascular cause and lasting more than 24 hours was defined as ischemic stroke.

Assessment of Other Variables

Data on socio-demographic status (like sex, age, and occupation), medical history, physical activity, and smoking habits were obtained by questionnaires. Height and weight were measured respectively in bare foot and light clothing. BMI was computed as weight (kg) divided by square of height (m^2). Measurement of waist circumference was done at the costal margin as the least circumference and hip circumference at the highest circumference. After 10 minutes rest, blood pressure was measured in sitting position.

Statistical Methods

We used Statistical Package for Social Science (SPSS Inc., Chicago IL. Version 16.0) for our analysis. To compare means of continuous variables among cases and controls, independent samples Student's t- test was used. Chi-square test was applied to compare categorical variables between cases and controls. For categorizing participants, quartile cut-points of potato intake were used. Analysis of variance, chi-square, and analysis of covariance were used to compare general characteristics and dietary intakes of participants across quartiles of potato consumption. Age- and energy-adjusted dietary intakes were calculated by the use of General Linear Model. Logistic regression method in different models was applied to explore the associations between potato intake and stroke. The first adjustment was made for age, sex, and total energy intake. Further adjustments were made for main vascular risk factors like hypertension, diabetes, dyslipidemia, physical activity, and smoking in the second model. Dietary intakes were additionally controlled in the third model. Finally, we added BMI to the model. First quartile of potato intake was used as a reference in all models. Mantel-Haenszel extension chi-square test was used to assess the overall trend across quartiles of potato consumption. The correlation between physical activity and potato consumption was examined through Pearson correlation. The correlation between smoking and potato intake was looked for through Spearman correlation.

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Results

Individuals with stroke had lower BMI (25.2 ± 0.3 vs. 28.5 ± 1.0 kg/m^2, $P < 0.05$) and weight (69.5 ± 1.0 vs. 72.4 ± 1.1 kg, $P < 0.05$) and were less likely to be obese (11.3% vs. 29.2%, $P < 0.001$) as compared with controls. Potato consumption was significantly higher in cases than in controls (31.1 ± 3.4 vs. 23.4 ± 1.3, $P < 0.05$). Individuals with stroke had higher consumption of high-fat dairy (132.2 ± 15.0 vs. 73.6 ± 8.9, $P < 0.001$) and lower consumption of low-fat dairy (270.3 ± 14.9 vs. 339.9 ± 20.1, $P < 0.05$) compared with the control group. Among stroke cases, dietary intake of pulses (34.6 ± 2.3 vs. 25.0 ± 1.8, $P < 0.001$) and fruits (358.6 ± 29.6 vs. 280.5 ± 17.2, $P < 0.05$) was higher and dietary intake of non-hydrogenated vegetable oils was lower (10.4 ± 0.8 vs. 19.2 ± 1.3 $P < 0.001$) as compared with the control group. For other dietary variables, no significant differences were found.

Characteristics of the study population across categories of potato consumption are shown in Table 1. Participants with the highest potato consumption were younger than those with the lowest ($P < 0.05$). The mean weight, BMI, and prevalence of obesity were not significantly different across quartile categories of potato consumption. Participants in the top quartile of potato consumption were more likely to be physically active ($P < 0.05$). No significant differences were found in terms of the distribution of current smokers across quartiles of potato consumption.

Dietary intakes of the study participants across categories of potato consumption are presented in Table 2. High potato consumption was associated with higher intakes of energy, fruits, vegetables, pulses, and grains. No significant differences were found in terms of other dietary intakes across quartile categories of potato intake.

Crude and multivariate-adjusted odds ratios (ORs) for the associations between potato consumption and stroke are provided in Table 3. In crude models, no significant associations were found between potato consumption and stroke. After adjustment for age, sex, and total energy intake in the first model, we found that individuals with the highest potato consumption were more likely to have stroke as compared with those with the lowest consumption (OR: 1.9; 95%CI: 1.0 – 3.6; $P < 0.05$). The associations remained significant even after additional control for hypertension, diabetes, dyslipidemia, physical activity, and smoking. When the dietary intakes (vegetables, fruits, sugar-sweetened beverages, grains, meat, hydrogenated and non hydrogenated vegetable oils, pulses, low- and high-fat dairy) were taken into account, the associations disappeared. After further control for BMI in the final model, we found that individuals in the third quartile of potato consumption were significantly more likely to have stroke as compared to those with the lowest intake (OR: 2.2; 95%CI: 1.0 – 4.7).

The correlation between physical activity (continuous in METs-h/wk) and potato consumption was 0.03, $P = 0.54$ (Spearman correlation). The correlation between smoking and potato intake was -0.004, $P = 0.94$ (Spearman correlation).

Discussion

In this case-control study on hospitalized patients in Iran, we found a marginally significant independent association between potato consumption and risk of stroke after adjustment for potential confounders. To the best of our knowledge, this is the first study reporting the association between potato intake and stroke. Potato has been recognized as one of the most commonly used foods around the world and is presented in different forms. It is usually eaten boiled or as French fries.[22] Due to its nutritional content of carbohydrates, protein, vitamins, minerals, and antioxidants, potato has an important role in human health, satiety, appetite control, and weight gain.[23] Furthermore, potato has been considered as a high -GI food which may adversely affect human health and could be associated with obesity, diabetes, and CVD. However the GI of potato depends on different cooking methods, cultivation regions, different variety, and maturity fol-

Table 1. General characteristics of the study participants across quartiles of potato consumption[1]

	Quartiles of potato consumption				P
	Q1 (n = 97)	Q2 (n = 98)	Q3 (n = 97)	Q4 (n = 98)	
Age (y)	66.0 ± 1.4	67.2 ± 1.2	62.4 ± 1.2	63.2 ± 1.2	< 0.05
Weight (kg)	69.9 ± 1.5	71.5 ± 1.4	72.1 ± 1.3	70.3 ± 1.7	0.69
BMI (kg/m^2)	26.9 ± 0.5	26.8 ± 0.5	26.6 ± 0.4	27.4 ± 1.0	0.96
Male (%)	42.7	54.3	52.6	62.6	0.06
Physical activity (MET-min/day)	1895.5 ± 431.0	3910.3 ± 109.4	6283.0 ± 970.8	5165.2 ± 129.7	< 0.05
Obesity[2] (%)	23.6	23.8	20.6	13.1	0.20
Smoking (%)	5.6	12.4	12.4	8.1	0.30

[1]Data are means ± standard error unless indicated; [2]BMI ≥ 30.

Table 2. Dietary intake of the study participants across quartiles of total potato consumption[1]

	Quartiles of potato consumption				P
	Q1 (n = 97)	Q2 (n = 98)	Q3 (n = 97)	Q4 (n = 98)	
Total energy (kcal)	1966.9 ± 118.8	1843.6 ± 69.8	2238.3 ± 89.6	2336.6 ± 95.0	< 0.001
Low-fat dairy (g)	310.9 ± 23.3	318.3 ± 22.6	324.8 ± 25.2	267.5 ± 28.9	0.37
High-fat dairy (g)	89.7 ± 16.5	86.2 ± 15.4	102.7 ± 19.5	132.5 ± 18.7	0.23
Fruit (g)	306.4 ± 38.5	239.9 ± 15.6	315.1 ± 22.6	419.5 ± 49.8	< 0.05
Pulses (g)	20.3 ± 2.1	19.8 ± 1.1	26.4 ± 2.2	52.4 ± 4.3	< 0.001
HVO (g)	17.4 ± 3.0	20.4 ± 2.8	26.9 ± 4.4	20.1 ± 3.4	0.26
Non-HVO (g)	16.3 ± 2.3	14.7 ± 1.3	14.7 ± 1.3	13.6 ± 1.2	0.69
Meat (g)	80.2 ± 34.5	56.5 ± 7.2	59.7 ± 4.9	83.6 ± 8.8	0.57
Vegetable (g)	271.6 ± 22.4	189.2 ± 10.9	285.3 ± 19.4	324.9 ± 24.4	< 0.001
Grain (g)	253.7 ± 16.5	291.8 ± 18.5	361.1 ± 20.0	323.3 ± 16.1	< 0.001
Sugar sweetened beverages (g)	45.3 ± 7.9	50.8 ± 10.2	45.5 ± 8.4	48.7 ± 8.2	0.96
Boiled potato (g)	2.7 ± 0.3	12.9 ± 0.2	21.7 ± 0.6	50.2 ± 5.9	< 0.001
Fried potato (g)	2.6 ± 0.3	3.3 ± 0.3	4.3 ± 0.4	9.8 ± 1.0	< 0.001
Total potato (g)	5.3 ± 0.4	16.2 ± 0.2	26.0 ± 0.3	60.0 ± 6.1	< 0.001

[1] Data are means ± standard error; HVO: Hydrogenated vegetable oils.

Table 3. Multivariate-adjusted odds ratio for stroke across quartiles of potato consumption

Stroke	Quartiles of potato consumption				P_{trend}
	Q1 (n = 97)	Q2 (n = 98)	Q3 (n = 97)	Q4 (n = 98)	
Crude	1.00	1.5 (0.8–2.7)	1.2 (0.7–2.2)	1.6 (0.9–2.9)	0.27
Model 1[1]	1.00	1.5 (0.8–2.8)	1.6 (0.8–3.0)	1.9 (1.0–3.6)	0.04
Model 2[2]	1.00	1.4 (0.8–2.6)	1.4 (0.8–2.7)	1.9 (1.0–3.6)	0.05
Model 3[3]	1.00	1.8 (0.9–3.5)	1.8 (0.8–3.6)	1.1 (0.5–2.5)	0.19
Model 4[4]	1.00	2.2 (1.0–4.5)	2.2 (1.0–4.7)	1.3 (0.6–3.0)	0.09

[1]Adjusted for age, sex, and energy; [2]Further adjusted for hypertension, diabetes, dyslipidemia, physical activity, and smoking; [3]Additionally adjusted dietary intakes of vegetables, fruits, SSB, grains, meat, HVO, non-HVO, pulses, and low-fat and high-fat dairy; [4]Further adjusted for BMI.

lowing planting.[22] In a recent study in Britain, potato GI has been reported at the range of 56 to 94.[24] The amylose content of boiled potato retrogrades at cooling to produce resistant starch. When potato is served shortly after cooking, a GI of 89 was found.[25] When cooking followed by a cooling for 12 – 24 hours, a GI of 56 was reported.[22]

In this study, we found a significant association between potato consumption and risk of stroke after adjustment for age, sex, energy intake, physical activity, and smoking. It has been suggested that dietary factors influencing postprandial glycemia might probably affect stroke risk. High GI and high amount of carbohydrates make potato as a potential candidate food for increasing risk of stroke. Some studies have shown that the effect of a cup of potato on blood glucose is similar to that of a can of Coca Cola.[26] Diets with high amount of rapidly digested carbohydrates, such as potato, can lead to obesity, diabetes, and heart disease.[19,27,28] A population-based cohort study showed a significant association between GI and risk of stroke.[29] Moreover, in a prospective study, relative risk of stroke was higher among those with the highest carbohydrate intake.[7] It has been reported that formation and aggregation of glycation products as well as damage in microvasculature walls induced by a high-GI diet could be a probable mechanism by which dietary GI might affect risk of stroke.[30,31] Additionally, high carbohydrate diets may possibly contribute to the risk of stroke by decreasing HDL concentrations,[32] increasing blood pressure,[33] and exacerbating insulin resistance.[34]

Adjustment for dietary intakes made the association between potato intake and stroke non significant. It is not unexpected because besides carbohydrates and a high- GI feature, potato contains other nutrients which might neutralize its effect on stroke. Although earlier studies have shown a significant association between high- GI diets and risk of chronic diseases,[9,35] some studies have indicated that potato consumption might reduce the risk of diabetes.[20] Moreover, experimental studies have introduced high-potato diet as a beneficial contributor to lipid metabolism and antioxidant status.[36,37] Such beneficial effects of potato intake on glucose tolerance have also been reported from a 20-year cohort study in humans.[38] Various antioxidants in potato might prevent the incidence of atherosclerosis, cancers, cardiovascular diseases, diabetes, and arthritis.[39] Resistance starch, fiber, and protein in potato can also help explaining our findings. Such contents of potato have been reported as responsible factors for improving lipid metabolism.[40] High amounts of phosphorus in potato have also been reported as a possible contributor to lipid metabolism. It is believed that digestion and absorption of gelatinized high-phosphorus starch are very slow.[41] Potato as an excellent potassium source may possibly protect against hypertension.[42] Although potatoes have several ingredients to influence the association with stroke positively or negatively, other dietary components are more effective.

Several limitations must be considered. The first limitation is the case-control design of the study that does not allow inferring causal relations between potato consumption and stroke. The second limitation is the use of FFQ as the dietary assessment method. As mentioned in previous studies, the use of FFQ would result in misclassification of participants and this is usual with all nutritional epidemiologic studies. In addition, since stroke patients may have difficulty in remembering foods, we preferred to ask from relatives. The third limitation is not matching between case and control groups. Although we tried to match cases and controls for age and gender at first, but unfortunately due to lack of adequate sample for control group, we failed to do matching. Furthermore, we did not gather any information about the cooking methods of potato and the duration between preparation and consumption. Moreover, it must be kept in mind that patients in the surgical ward (control patients) were older than those in the case group.

We found an evidence indicating that there is a marginally significant independent association between potato consumption and risk of stroke. Additional studies are required to confirm this finding.

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