Potato consumption as high glycemic index food, blood pressure, and body mass index among Iranian adolescent girls

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Original Article

Abstract

BACKGROUND: Potato as a high glycemic index food has different effects on healthy nutritional status. In the current study, we investigated the association between potato consumption and obesity and blood pressure among adolescent girls.

METHODS: This cross-sectional survey was conducted on 205 girls (11-13 years old) in 2013 who were selected by systematic cluster random sampling from schools of all regions of Isfahan, Iran. Dietary intakes were collected by 53-items food frequency questionnaire. Anthropometric measurements were done based on a standard protocol.

RESULTS: Adolescents that consumed all kinds of potato more than once per week had significantly higher prevalence of overweight and obesity (prevalence of overweight and obesity was 86.7 and 13.3%; $P < 0.0010$ in more than once per week and less than once per week groups, respectively) as well as prevalence of abdominal obesity in more than once per week consumption group was higher than less than once per week consumption group (78.2 vs. 21.8%; $P < 0.001$). Potato consumption (as independent variables) increased body mass index and waist circumference (as dependent variables) in crude and adjusted regression models ($P < 0.050$). Mean blood pressure was not significantly different among lower and higher potato consumers.

CONCLUSION: Our findings suggested a positive association between potato consumption and obesity. We did not find any association between potato consumption and blood pressure in adolescents.

Keywords: Potato, Obesity, Blood Pressure, Adolescence

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Introduction

Prevalence of obesity and overweight is increasing among adolescents and is associated with many chronic disorders. Adolescent obesity is a strong predictor of obesity in young adulthood.

According to recent studies, hypertension and obesity are related to certain lifestyle habits as well as sun healthy dietary habits.[1,2] Therefore, dietary modification is suggested as the first step for hypertension and obesity control in adolescence.[3,4] Refine grains consumption are associated with higher prevalence of metabolic syndrome and some of its components.[5] Unfortunately, refine grains consumption are more popular among Iranian, and this may be associated with enhanced chronic diseases.[6]

Recently, it is revealed that the glycemic index (GI) and glycemic load (GL) have been associated with some chronic disease. Epidemiologic evidence and meta-analysis supported a positive association between GI, GL, and risk of chronic disease.[7] High carbohydrate foods such as potato, rice, and bread might induce high glycemic response and increase postprandial hyperglycemia and hyperinsulinemia.[8]

Low GI foods promote satiety and enhance weight control, but high GI foods with high carbohydrate such as white flour, rice, bread, and potato promote weight gain.[8]

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Most of the studies investigated dietary plan.[9,10] And a few studies have focused on specific food on problem health in an adolescent. According to the results of the recent study, potato consumption was associated with some risk factors of cardiovascular disease (CVD) such as fasting blood sugar level, high-density lipoprotein level, and diabetes mellitus in adult.[11] Evidence showed the intake of potato chips and potatoes was more strongly associated with weight gain among men and women.[9] In general, finding about potato is controversial, and studies concern that potato consumption especially in large amount because of the high amount of rapidly digestible starch is related to some cancers and risk of Type 2 diabetes.[12] Today, dietary habit especially in an adolescent move to consumption of French fries and chips potato that consist of hydrogenate oil and trans fatty acid.[13] One study showed that French fries positively associated with Type 2 diabetes in women.[12]

Most of the studies on blood pressure or obesity have focused on the relation between these problems and nutrient intake, but intake of specific foods is rarely considered in this regard. Most of the prior data are from Western countries, and few studies have been conducted in Middle East region and Iran. There is no investigation about the association between potato consumption and risk factors of progression of CVD such as blood pressure and obesity in adolescent and findings about the effect of low or high GI and GL diet on risk of diseases are controversial. Since potato is low cost and is one of the major sources of carbohydrate intake in Iranian diet; we investigated the association between potato consumption, blood pressure, abdominal obesity, and body mass index (BMI) among Iranian adolescent.

Materials and Methods

In this cross-sectional study, 205 Isfahanian female students aged 11-13 years old are selected by the use of systematic sampling in May 2013. In this study, we randomly selected some regions from among all the regions of Isfahan, Iran. We selected 12 clusters. We tried to include different regions with different socioeconomic status in the present study. Then some schools were randomly chosen from selective regions. The list of students' records was obtained from each school, and the students were randomly selected according to a computer-based random sequencing program. All students were eligible to enter this study unless they were on a specific diet. Finally, 205 adolescents completed the study. Written informed consent was taken from each student and one of her parents.

The 53-items food frequency questionnaire (FFQ) was used for assessment of usual daily intake. We randomly selected 92 subjects and evaluated the reliability of FFQ and compared nutrient consumption on two occasions. FFQ contain three kinds of potato items including boiled potato, French fries, and chips potato. Validity and reliability of this FFQ were good.[14] Students and one of their parents were trained to fill the FFQ. All data were converted to the daily amount and gram per day.

Height was measured in a standing position by the meter to the nearest 1 cm without shoes that shoulders and heels were in a normal position. Weight was measured by Seca scales (Germany) without shoes and with minimal clothing by standard scale to the nearest 0.1 kg. Waist circumference (WC) was measured in the middle of the lowest gear and the top of the iliac crest (narrowest girth) by un-stretchable tape without any pressure in standing position to the nearest of 0.1 cm. BMI was calculated as weight (kg) divided by height (m) squared. Overweight and obesity were defined based on World Health Organization guidelines as BMI = 85-95th percentile and > 95th, respectively.

Systolic blood pressures (SBP) and diastolic blood pressures (DBP) were taken using a standardized mercury sphygmomanometer (Beurer BM70 Blood) on the right arm, after a 15 min rest in a sitting position. Before measuring the blood pressure, the participant was asked about drinking tea or coffee, physical activity (PA), smoking, and full bladder. The SBP was defined as the appearance of the first sound (Korotkoff phase 1), and DBP was defined as the disappearance of the sound (Korotkoff phase 5)

Personal information such as age, sex, disease history, and medication use were obtained by questionnaires. For the calculation of PA, each participant wrote kind of their activities and their duration 3 days a week (2 working days and 1 holiday). Mean of PA was calculated according to below equation:

$$PA_{means} = \sum \frac{(Time_{activity} \times MET)}{72}$$

Where, PA_{means} is the mean of PA, $Time_{activity}$ is the total time (h) of each activity within 3 days (72 h), and MET is the metabolic equivalent extracted from reference table.[15]

All statistical analyses were performed with SPSS for Windows (version 16, SPSS Inc., Chicago, IL,

USA). Means continuous variables (age, height, PA, SBP, DBP were compared with independent Student's t-test and chi-square test was applied for qualitative variables (BMI, WC). Energy-adjusted distribution of nutrient intake in each frequency of potato consumption items were analyzed with ANCOVA. The relationships between dependent variables and potato consumption were examined using multiple linear regression and logistic regression analysis in crude model and after controlling for confounders such as energy intake, meat, fruit, vegetable, dairy, grain, bread, oils, rice, and PA. $P < 0.0500$ was considered statistically significant.

Results

Demographic characteristic of an adolescent in three kinds of potato items consumption is shown in table 1. Older adolescents consumed more potato in all kinds of potato items than young adolescents ($P < 0.0500$). Subjects that consumed all kinds of potato more than once per week had significantly higher prevalence of overweight and obesity as well as abdominal obesity. SBP and DBP were not significantly different among lower and higher potato consumers.

Table 2 shows the energy-adjusted (except for energy intake) distribution of nutrients intake by the frequency of potato consumption per week. Adolescents who consumed potato more than once per week had more energy intake and consumed more amount of fat, saturated fatty acid and sodium. Adolescents with higher consumption of potato intake had lower amounts of fiber, vitamin D, vitamin C, potassium, calcium, iron, magnesium, and zinc intake.

Multiple linear regression analysis showed that higher consumption of potato associated with increase the amount of BMI and WC. The significant relationships remained after adjusting for energy intake and food groups. There were no significant associations between potato consumption and SBP and DBP ($P > 0.0500$) (Table 3).

Table 4 shows total potato consumption more than once per week increase the risk of overweight and general or central obesity in crude and adjusted model significantly. Potato consumption did not have any significant effect on blood pressure in crude and adjusted model.

Discussion

In the present study, we found a significant positive relationship between potato consumption and general obesity and abdominal obesity in adolescent girls. It seems that a higher amount of potato consumption is related to increase prevalence of obesity. Adolescent who consumed a higher amount of potato had a lower amount of vitamins and minerals intake and higher amount of fat and energy intake. It may be one reason of increasing prevalence of obesity among potato consumers. This is the first study to investigate the association between potato consumption and obesity and blood pressure in the adolescent population.

Poor nutritional habits may be formed during the teenage years, and most nutritional habits in adults result from nutritional behaviors gained during adolescence. Nowadays, adolescents tend to consume chips potato and French fries more than before and investigation the effect of unhealthy food choices on health status is essential.[16,17]

Current evidence showed that high GI foods such as potato were associated with obesity. However, findings are controversial. Ludwig[8] reported that high GI foods enhanced blood glucose and subsequently increased insulin secretion. Therefore, blood glucose dropped again and subsequently leads to hunger, eat more, and finally obesity. The Nurses' Health Study investigated specific dietary and lifestyle behaviors. They found that high daily intake of some food items such as potato chips, potatoes (including boiled or mashed potatoes and French fries), French fries and boiled, baked, or mashed potatoes lead to 1.69 lb, 1.28 lb, 3.35 lb, and 0.57 lb weight gain after 4 years follow-up, respectively. They reported potato products (which are low in sugars and high in starches) had the strongest relationship with weight gain.[9] Furthermore, crossover study showed that body weight and energy intake in low GI diet groups were less than high GI diet groups during 5 weeks.[18]

Leathwood and Pollet[19] compared bean puree as low GI starch with potato as high GI starch. They showed that bean puree lead to lower plasma glucose, lower insulin levels, and finally slower return to hunger. More studies showed hyperinsulinemia after high GI foods intake promoted storage of fat, stimulate the intake of food and weight gain.[20,21] These findings were also reported among children.[22] Others suggested low GL diet might be effective in treating adolescent obesity.[23,24] Obese teenage boys that consumed high GI breakfast and lunch had a higher score in hunger test, and their energy intake were 53% greater than a teenager with lower GI meal. Thus high GI food enhanced hunger and finally eats more.[25]

Table 1. Demographic characteristics of subjects that consumed all kinds of potato, boiled potato, French fries, and chips potato

Variables	Total potato			Boiled potato			French fries			Chips potato		
	Less than once per week (n = 100)	More than once per week (n = 105)	P*	Less than once per week (n = 114)	More than once per week (n = 91)	P	Less than once per week (n = 117)	More than once per week (n = 88)	P	Less than once per week (n = 110)	More than once per week (n = 95)	P
Age (year)	12.1 ± 1.0	12.5 ± 0.8	0.0020	12.1 ± 0.9	12.5 ± 0.9	0.0080	12.0 ± 1.0	12.6 ± 0.8	< 0.0010	12.0 ± 1.0	12.6 ± 0.8	< 0.0010
Height (cm)	150.2 ± 7.7	153.7 ± 7.6	0.0010	150.4 ± 7.7	154.0 ± 7.5	0.0010	150.7 ± 7.7	153.9 ± 7.6	0.0020	150.3 ± 7.7	154.0 ± 7.5	0.0010
PA (METh/day)	13.8 ± 4.6	13.3 ± 5.2	0.4700	13.6 ± 4.7	13.4 ± 5.1	0.7500	13.8 ± 4.9	13.2 ± 4.9	0.3900	13.7 ± 4.9	13.4 ± 5.0	0.6000
SBP	115.3 ± 12.8	117.4 ± 16.2	0.3100	115.6 ± 12.5	117.3 ± 16.9	0.4000	115.2 ± 13.2	117.9 ± 16.2	0.2000	115.2 ± 13.0	117.7 ± 16.2	0.2300
DBP	71.9 ± 11.0	73.5 ± 11.2	0.3100	72.4 ± 10.9	73.1 ± 11.4	0.6300	71.5 ± 11.0	74.3 ± 11.1	0.0700	71.6 ± 11.2	74.0 ± 10.9	0.1200
BMI > 85th (%)	13.3	86.7	< 0.0010	11.9	88.1	< 0.0010	4.5	95.5	< 0.0010	4.5	95.5	< 0.0010
WC >75th (%)	21.8	78.2	< 0.0010	32.1	67.9	< 0.0010	32.1	67.9	< 0.0010	28.2	71.8	< 0.0010

* P values resulted from t-test analysis for quantitative variables and χ^2 for qualitative variables; PA: Physical activity; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; BMI: Body mass index; WC: Waist circumference

Table 2. Energy-adjusted distribution of nutrient intake by frequency of potato consumption per week

Variables	Total potato			Boiled potato			French fries			Chips potato		
	Less than once per week (n = 100)	More than once per week (n = 105)	P*	Less than once per week (n = 114)	More than once per week (n = 91)	P*	Less than once per week (n = 117)	More than once per week (n = 88)	P*	Less than once per week (n = 110)	More than once per week (n = 95)	P*
Energy intake (kcal)**	2069.2 ± 807.4	2713.3 ± 1041.9	0.0001	2175.0 ± 886.1	2680.0 ± 1038.4	0.0001	2112.4 ± 799.7	2780.4 ± 1083.3	0.0001	2048.2 ± 719.1	2805.4 ± 1096.9	0.0001
Protein (g)	76.0 ± 18.2	72.9 ± 18.2	0.2200	74.9 ± 18.1	73.9 ± 18.1	0.7100	75.4 ± 18.2	73.1 ± 18.3	0.3700	75.4 ± 18.4	73.3 ± 18.6	0.4300
Fat (g)	77.8 ± 24.6	86.8 ± 24.5	0.0100	80.4 ± 24.5	85.0 ± 24.6	0.1900	77.6 ± 24.3	88.8 ± 24.5	0.002	77.6 ± 2.3	88.1 ± 2.5	0.004
SFA (g)	22.6 ± 7.7	25.4 ± 7.7	0.0100	23.6 ± 7.7	24.7 ± 7.7	0.3000	22.6 ± 7.6	25.9 ± 7.5	0.004	22.7 ± 7.8	25.7 ± 7.8	0.009
Fiber (g)	13.5 ± 0.4	12.2 ± 0.4	0.0200	13.2 ± 3.9	12.4 ± 3.9	0.1100	13.3 ± 3.9	12.2 ± 3.9	0.0300	13.5 ± 3.9	12.2 ± 3.9	0.0300
Cholesterol (mg)	179.3 ± 89.2	161.8 ± 89.0	0.1700	178.8 ± 87.8	159.8 ± 88.2	0.1300	181.6 ± 88.4	155.4 ± 89.2	0.0400	184.9 ± 89.1	153.5 ± 89.6	0.0100
Sodium (mg)	2412.0 ± 529.7	2474.0 ± 528.6	0.4100	2426.0 ± 522.5	2466.0 ± 524.5	0.5800	2398.0 ± 526.3	2505.0 ± 530.8	0.1600	2403.0 ± 533.5	2491.0 ± 536.6	0.2600
Vitamin D (µg)	2.7 ± 2.3	2.4 ± 2.3	0.3700	2.6 ± 2.3	2.5 ± 2.3	0.7600	2.8 ± 2.3	2.2 ± 2.3	0.0900	2.7 ± 2.3	2.3 ± 2.3	0.2400
Vitamin C (mg)	60.7 ± 6.3	45.0 ± 7.4	0.0300	59.3 ± 9.6	44.4 ± 8.7	0.0300	59.3 ± 9.1	43.9 ± 8.2	0.0300	59.1 ± 7.4	45.3 ± 6.7	0.0600
Folate (µg)	230.7 ± 53.2	227.5 ± 53.0	0.6700	230.8 ± 52.4	226.8 ± 52.6	0.5900	226.9 ± 52.9	231.9 ± 53.4	0.5100	226.9 ± 53.6	231.6 ± 53.9	0.5400
Potassium (mg)	3455.0 ± 943.5	3136.0 ± 941.5	0.0100	3402.0 ± 934.5	3153.0 ± 938.0	0.0600	3412.0 ± 943.6	3131.0 ± 951.6	0.0400	3414.0 ± 956.1	3149.0 ± 961.6	0.0600
Calcium (mg)	1563.0 ± 621.0	1413.0 ± 619.7	0.0900	1526.0 ± 614.8	1436.0 ± 617.0	0.3000	1547.0 ± 619.56	1405.0 ± 624.85	0.1100	1540.0 ± 628.3	1424.0 ± 631.9	0.2000
Iron (mg)	9.5 ± 2.0	9.1 ± 2.0	0.1600	9.5 ± 2.0	9.0 ± 2.0	0.2000	9.5 ± 2.0	8.9 ± 2.0	0.0700	9.6 ± 2.0	8.9 ± 2.1	0.0600
Magnesium (mg)	283.7 ± 68.2	266.9 ± 68.1	0.0800	280.4 ± 67.5	268.4 ± 67.8	0.2100	282.0 ± 68.1	265.9 ± 68.6	0.1000	281.6 ± 69.04	267.6 ± 69.4	0.1600
Zinc (mg)	9.4 ± 2.7	8.4 ± 2.7	0.2800	9.2 ± 2.7	9.1 ± 2.7	0.7300	9.3 ± 2.7	8.9 ± 2.8	0.3900	9.3 ± 2.8	9.0 ± 2.8	0.5100

Values are mean ± SD unless indicated (P < 0.05 was considered as significant); * P values of energy intake are resulted from t-test analysis for crude analysis and ANCOVA test was used for energy-adjusted analysis for all variables except energy intake. ** Energy was not adjusted for any variable; SFA: Saturated fatty acid; SD: Standard deviation

Table 3. Multiple linear regression analysis on the association among three kinds of potato items consumption and obesity and blood pressure

Items	BMI		WC		DBP		SBP	
	B	P	B	P	B	P	B	P
Total potato								
Crude	0.07	< 0.0010	0.16	< 0.0010	0.03	0.2300	0.05	0.0900
Model 1*	0.06	< 0.0010	0.14	< 0.0010	0.02	0.5100	0.03	0.3100
Model 2	0.03	< 0.0010	0.10	< 0.0010	0.01	0.4200	0.03	0.2300
Boiled potato								
Crude	0.08	< 0.0010	0.17	< 0.0010	0.035	0.1500	0.061	0.0600
Model 1	0.06	< 0.0010	0.15	< 0.0010	0.026	0.3600	0.046	0.1900
Model 2	0.05	< 0.0010	0.15	< 0.0010	0.017	0.2700	0.036	0.1800
French fries and chips potato								
Crude	0.09	< 0.0010	0.18	< 0.0010	-0.02	0.7200	-0.01	0.8800
Model 1	0.06	< 0.0010	0.13	0.0070	-0.04	0.4900	-0.05	0.5800
Model 2	0.07	< 0.0010	0.17	0.0010	-0.03	0.3800	-0.02	0.4900

* B-coefficient; values are adjusted for energy intake in Model 1 and further adjusted for meat, fruit, vegetable, dairy, grains, bread, rice, and physical activity; BMI: Body mass index; WC: Waist circumference; DBP: Diastolic blood pressure; SBP: Systolic blood pressure

Table 4. Multivariate adjusted odds ratio for being obese or central obese or having high blood pressure by frequency of total potato consumption per week

Items	Total potato consumption		P
	Less than once per week	More than once per week	
Overweight and obesity			
Crude	1.00	3.15 (1.34-5.57)**	0.0040
Model 1*	1.00	3.04 (1.19-5.38)	0.0300
Model 2	1.00	2.91 (1.02-5.17)	0.0300
Central adiposity			
Crude	1.00	3.46 (1.45-5.81)	0.0030
Model 1	1.00	3.22 (1.27-5.57)	< 0.0300
Model 2	1.00	3.01 (1.10-5.34)	< 0.0400
High blood pressure			
Crude	1.00	2.93 (0.83-5.05)	0.3800
Model 1	1.00	2.68 (0.76-4.81)	0.5500
Model 2	1.00	2.81 (0.89-4.93)	0.7500

* Values are adjusted for energy intake in Model 1 and further adjusted for meat, fruit, vegetable, dairy, grains, oils, bread, rice, and physical activity in Model 2; ** OR (Confidence interval 95%); OR: Odds ratio

However, some studies did not show any preference between low GI and high GI diets on appetite and body weight[26] and others showed a protective effect of potato on weight gain. One long-term interventional study (4 months) in 24 subjects with impaired glucose tolerance showed that low GI diet (0.19 kg) had smaller weight loss than high GI diet (0.49 kg).[27] Our previous study showed a negative association between higher potato consumption and weight and BMI in adult.[11] Leeman et al.[28] suggested potato as a protective agent to weight gain and could control appetite.

According to these inconsistent findings, several studies still prefer low GI to high GI foods. High GI foods alter fuel partitioning in order to the storage of body fat. In contrast, low-GI foods may enhance weight control, increase satiety, reduce postprandial insulin secretion, and keeping insulin sensitivity. Intervention studies in humans and long-term studies in animal models have also shown that high GI starches enhance weight gain, visceral adiposity, and higher concentrations of lipogenic enzymes compare with low GI starches.[29]

We did not find any significant association between potato consumption and blood pressure. Sloth et al.[26] did not observe any significant differences between low and high GI diet groups in resting heart rate or SBP or DBP changes, which was similar to our findings. In contrast, a crossover trial on hypertensive participants did not show any significant effect of potato consumption on fasting plasma glucose, blood lipids, and weight gain, however, diastolic and SBP decreased significantly.[30] Low GI diets such as dietary approaches to stop

hypertension (DASH) diet contain more fiber and nutrients, and this could be a possible reason for their beneficial effects on metabolic parameters.[26]

There are a few interventional studies to assess the effects of dietary GI on CVD risk factors and available findings are controversial.[12] However, some studies showed that high GI foods such as potato induced lipid profile disorders and increased risk factors of diabetes and CVD.[31,32] Halton et al.[12] suggested a modest positive association between the potato consumption and the risk of Type 2 diabetes in women 34-57 years of old. This association enhanced when whole grains were replaced with potatoes.

Hyperglycemia and hyperinsulinemia which usually occur after consumption of high GI foods lead to the generation of reactive oxygen species, oxidative stress, tissue damage, and endothelial dysfunction. These changes may be associated with hypertension.[33,34]

These results were affected by some limitations. Due to the cross-sectional nature of the present study, causal relationship could not be concluded. Moreover, we used an FFQ consists of 53 food items for dietary assessment. Although the validity and reliability of this FFQ had been assessed, the variation of food choices might be more than 53 food items. Small sample size is another limitation. However, the sample was drawn through well-conducted random sampling, and the study finding showed statistically significant associations. However, data from large sample size studies are more credible.

Conclusion

Findings showed potato consumption as high GI food might increase the risk of general or abdominal obesity. However did not have any significant effect on blood pressure among Iranian adolescents.

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Conflict of Interests

Authors have no conflict of interests.

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