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Serial Issue: 45 *Volume 11, Suppl 1, 2015* *Print ISSN: 1735-3955*
Online ISSN: 2251-6638

Original Article(s)

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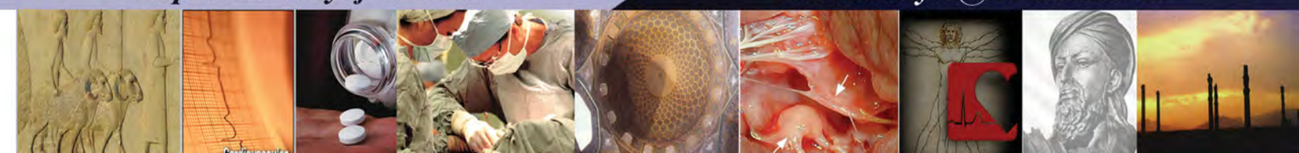
http://www.aryajournal.ir Email: arya @ crc.mui.ac.ir



ARYA Atherosclerosis

Official Journal of the Isfahan Cardiovascular Research Institute, Isfahan University of Medical Sciences

Publisher: Isfahan University of Medical Sciences,
Email: publications@mui.ac.ir

Copy Edit, Layout Edit, Design and Print: Farzanegan Radandish Co.
Tel: +98-311-2241953
+98-311-2241876
Email: f.radandish@gmail.com

Circulation: 500
Distribution: International
Language: English
Interval: Bimonthly
Print ISSN: 1735-3955, **Online ISSN:** 2251-6638

Address: ARYA Journal Office, Isfahan Cardiovascular Research Institute, Seddigheh Tahereh Research Complex, Khorram Ave. Isfahan, Iran
PO. Box: 81465-1148 Tel: +98-311-3377883 Fax: +98-311-3373435
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3. Gaston M. The psychological care of patients following a myocardial infarction [Online]. 2003; Available from: URL: http://www.nursingtimes.net/the-psychologicalcare-of-patients-following-a-myocardialinfarction/199464.article/

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Major dietary patterns in Iranian adolescents: Isfahan Healthy Heart Program, Iran

Omolbanin Kafeshani[(1)], Nizal Sarrafzadegan[(2)], Fatemeh Nouri[(3)], Noushin Mohammadifard[(2)]

Original Article

Abstract

BACKGROUND: Limited information exists from the dietary pattern of children and adolescents particularly in developing countries. We aimed to detect major dietary patterns and their association with socio-demographic characteristics of Iranian adolescents.

METHODS: Healthy Heart Promotion from Childhood as one of the "Isfahan Healthy Heart Program", Iran, projects was conducted in adolescents aged 11-18 years in Isfahan, Najafabad, and Arak districts, Iran, selected randomly by multistage sampling. This survey was conducted on 1992 adolescents in 2007. Dietary intake was assessed using a 50-item food frequency questionnaire in both communities.

RESULTS: Four major dietary patterns labeled "prudent diet," fast food diet," "animal fat diet," and "Mediterranean diet" were identified. We found a significant inverse relationship between prudent and animal fat dietary patterns with age, prudent and Mediterranean dietary patterns with being boy. However, a positive relationship between fast food dietary pattern and age; fast food and animal fat dietary patterns with being boy were detected (all $P < 0.05$). While urbanization and TV watching correlated positively with the fast food diet, an inverse relationship between urbanization and animal fat and Mediterranean dietary patterns were found (all $P < 0.01$). The animal fat and fast food dietary patterns inversely associated with nutrition knowledge; however, Mediterranean diet had a positive relationship with it (all $P < 0.05$). Membership in sport team was positively related to all dietary pattern and regular physical activity associated only with prudent diet (all $P < 0.05$).

CONCLUSION: The study suggests that socio-demographic characteristics and physical activity are related to dietary patterns in Iranian adolescents.

Keywords: Diet, Adolescent, Socio Demographic Factors

Date of submission: 15 Aug 2014, ***Date of acceptance:*** 22 Oct 2014

Introduction

The nutritional requirements significantly associated with rapid physical and cognitive development as well as maturation in adolescents.[1-3] Moreover, adolescence represents an important lifetime for the development of dietary behaviors which usually persist into adulthood.[4] The diet quality of Iranian adolescents has declined by increasing the intake of fast food, soft drinks, and salty snacks along with decreasing fruit and vegetable consumption.[5] Thus, these alterations have significantly increased the cardiometabolic risk factors in adolescents.[6] Most dietary assessments have focused on intake of nutrients, individual foods or food groups.[7] Although these studies are valuable, separating the food or nutrients effects on disease progress is complicated.[8] Therefore, using dietary pattern method, which considers a more comprehensive overview of the diet could provide more interpretable findings than studying single nutrients or foods.[9,10] Methods for studying dietary patterns, such as factor/cluster analysis, have become more widely used in nutrition epidemiology to summarize dietary data and assess the cumulative effect of combined foods on health outcomes.[3,9,11]

Most dietary patterns studies conducted among adults, however very limited information exists from dietary pattern of children and adolescents

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particularly in developing countries, therefore; this study is a unique study to identify dietary patterns among a representative sample of Iranian adolescents by using factor analysis. In addition, we aimed to evaluate the association of major dietary patterns and socio-demographic characteristics.

Materials and Methods

Data from the Healthy Heart Promotion from Childhood, one of Isfahan Healthy Heart Program, Iran, project, collected in 2007 from three districts in the central part of Iran, was used to carry out this study. Written informed consent was obtained from the parents or legal guardians of students. The study was approved by the Research Council of the Isfahan Cardiovascular Research Center. Sampling was carried out by multistage random cluster sampling method from 56 middle and high schools of different urban and rural areas. Sampling details were presented elsewhere.[12] In this cross-sectional survey, a total of 2000 students in middle and high schools (1000 girls, 1000 boys) aged 11-18 years were selected from Isfahan, Najafabad, and Arak, Iran, districts. Due to incomplete reports and missing data from questionnaires, almost 93.89% of the participants who successfully fulfilled the questionnaires were enrolled into the study. A total of 1992 students of middle and high schools were studied.

Trained nurses carried out data collection in the schools.[12] The questionnaires covered various health issues including socioeconomic, demographic characteristics, settlement, TV watching time, smoking, membership in sports team, and regular physical activity.[13] Nutrition knowledge determined through 29 questions about the impact of all food groups on health status. The study design has been described elsewhere.[12,13] All measurements were conducted according to a standard protocol by using calibrated instruments. Height and weight were measured to ± 0.1 cm and ± 0.1 kg, respectively, with students being barefoot and lightly dressed. Body mass index was calculated as weight (kg) divided by height squared (m^2).

The common foods consumed in Iran were assessed by a validated 50-item-food frequency questionnaire (FFQ).[5] These items were classified into 35 food categories. The FFQ was adopted from the Non communicable Disease Intervention program questionnaire.[14] Four experts in nutrition and pediatrics assessed the content validity of the FFQ. Moreover, the criterion validity was evaluated compared with three 24 h recall questionnaire. Although these data have not been published yet, the criterion validity was acceptable.

Food patterns were identified using factor analysis (principal component) of 50 food items conveyed as consumption frequency per week. The factors were rotated by an orthogonal transformation using SPSS for Windows (version 15, SPSS Inc., Chicago, IL, USA) to minimize the number of variables that have high loadings on each factor. This method reaches simpler structure with greater interpretability.

Four major dietary patterns with eigenvalues > 1.29 were extracted based on the screen plot and interpretability of the factors. The factors were rotated by an orthogonal (varimax) rotation to minimize the number of variables. Dietary patterns explained by applying factor loadings > 0.4.

Factor scores were calculated for a respective dietary pattern in individual participant by multiplying factor loadings with corresponding of standardized value for each food and summing across the food items. Thus, participants were categorized on the basis of factor score of each dietary pattern. The factor scores point out how well they follow a particular dietary pattern. A high factor score for a particular pattern meant a high adherence to those foods while a low factor score showed a low intake of that dietary pattern.

Factor loadings represent correlation coefficients between each food group and dietary pattern. Food groups with positive loading represent contribute to a dietary pattern and food groups with negative loadings are inversely associated with a dietary pattern. The proportion of variance explained by each factor was calculated by dividing the sum of the squares of the respective factor loadings by the number of food groups.

We utilized analysis of variance and chi-square tests to compare the differences of qualitative and qualitative variables among quartiles. Multiple linear regressions were used to identify the association between dietary patterns and sociodemographic characteristics such as sex, school grade, physical activity, and TV watching. $P < 0.050$ was considered significant.

Results

The study participants were 1992 adolescents consist of 1014 boys and 978 girls from whom 1039 were recruited from guidance schools and 953 from high schools. Using factor analysis, 4 major dietary patterns labeled “prudent diet,” fast food diet,” “animal fat diet,” and “Mediterranean diet” were derived from 50 food items in the study’s

participants. These four dietary patterns accounted for 30.65% of the total between-person variance.

Loading factors of food items in these dietary patterns were presented in table 1. The prudent diet was illustrated by a high intake of dried fruits, legumes, raw vegetables, walnut, fruits, fresh fruit juice, pickles, nuts, cooked vegetables, and potato. The fast food diet was described by frequent consumption of junk foods, carbonated beverages, sausages, hamburger, sweet and biscuits, and chocolate. The animal fat diet characterized by the low amount of low-fat dairy products as well as high intake of whole fat dairy products, animal fat, and organ meat. Mediterranean diet was typified by low intake of hydrogenated vegetable oil and high intake of non-hydrogenated vegetable oil, fish, raw vegetable and olive oil.

Table 2 indicates the basic characteristics of the participant according to the quartiles of the major dietary patterns score. People in the highest quartile of prudent diet were younger and had more nutrition knowledge and were more physically. We also found the prudent dietary pattern was less frequent in high school student (all $P < 0.050$). Compared to the lowest quartile of fast food diet, adolescents in the highest quartile more watched TV and being boy and had less nutrition knowledge (all $P < 0.050$).

Table 1. Factor loading matrix for major dietary patterns in Iranian adolescents: Isfahan Healthy Heart Program

Food groups	Prudent diet	Fast food diet	Animal fat diet	Mediterranean diet
Dried fruit	0.558	-	0.233	-
Legumes	0.553	-	-	-
Raw vegetables	0.542	-	-0.303	0.419
Walnut	0.517	-	-	-
Fruits	0.509	-	-	-
Fresh fruit juices	0.464	-	-	0.303
Pickles	0.454	0.302	-	-
Nuts	0.447	-	-	-
Cooked vegetables	0.412	-	-	-
Potato	0.410	0.332	0.210	-
Jam	0.389	0.225	-	-
Red meat	0.368	-	-	-
Egg	0.319	-	0.223	-
Rice	0.278	-	-	-
Cheese	0.272	-	-	-
Junk food	-	0.651	-	-
Carbonate beverage	-	0.591	0.250	-
Sausages	-	0.511	-	-
Sweet and biscuit	-	0.429	-	-
Chocolate	-	0.413	-	-
Seeds	-	0.396	-	-
Canned food	-	0.362	-	-
Mayonnaise	0.333	0.339	-	-
Low-fat dairy products	-	-	-0.691	-
Whole fat dairy products	-	-	0.680	-
Animal fat	0.246	-	0.484	-
Organ meats	0.286	-	0.437	-
Hydrogenated oil	-	-	0.338	-0.591
Pizza	-	0.374	-	0.391
Hamburger	-	0.442	-	0.332
Liquid oil	-	-	-	0.440
Fish	0.252	-	-	0.435
Olive oil	-	-	-	0.403
Bread	-	-	-	-0.335
Chicken	0.223	0.228	-	0.241
Variance (%)	10.690	7.740	6.320	5.900
Total variance (%)			30.65	

The individuals in the highest quartile of animal fat diet had less nutrition knowledge, settled in urban and being high school student as well as residing in urban compared to the lowest quartile. In addition, being boy and middle school student were more in the highest quartile of animal fat diet compared to the lowest quartile (all $P < 0.010$). In comparison to the participants in the lowest quartile of the Mediterranean diet, someone in the highest quartile had more nutrition knowledge, settled in urban areas, was a member of a sport team, and was less likely to be a boy (all $P < 0.050$).

Table 3 illustrates the adjusted relationship of dietary pattern with demographic and behavioral characteristics. Prudent diet and animal fat had an inverse association with age ($\beta = -0.03$, $P = 0.030$ and $\beta = -0.02$, $P = 0.010$, respectively), whereas fast food diet related straightly with age ($\beta = 0.03$, $P = 0.020$). While the relationship of being a boy with prudent and Mediterranean diets were significantly reversed, it's relationship with fast food, and animal fat dietary patterns were positive (all $P < 0.050$). Urbanization correlated positively with the fast food diet, inversely related with animal fat and Mediterranean dietary patterns (all $P < 0.010$). The all dietary pattern had a significant positive correlation with membership in sports team (all $P < 0.050$), whereas only prudent diet showed a significant positive association with regular physical activity ($P < 0.001$). The fast food diet had a significant positive relationship with TV watching and inverse correlation with nutrition knowledge (all $P< 0.050$). The animal fat diet inversely associated with nutrition knowledge; however, Mediterranean diet had a positive relationship with it ($P < 0.001$).

Discussion

This study sought to recognize dietary patterns among a population-based sample of Iranian adolescents and whether they were related to socio-demographic and behavioral characteristics. The current analysis of adolescents has identified four major dietary patterns "prudent," "fast-food," "animal fat" and "Mediterranean" dietary pattern. The prudent diet was consistent with the findings of another cross-sectional study in Iranian adults; however the other dietary pattern had differences.[6]

A few studies have used factor analysis to examine the dietary patterns of adolescents, however, the identified dietary patterns showed some similarities with previous studies among adolescents. "Prudent diet" was similar to the "healthy diet" that was recognized by Ambrosini et al.[15] and illustrated by high intakes of whole grain, fruit, vegetable, legumes, and fish. Moreover it was consistent with the "healthy diet" that was greatly loaded by whole grains, yellow or red vegetable, leafy green vegetables, tomato, cruciferous vegetable, other vegetables, fresh fruit, legumes and fish which was recognized by Ambrosini et al.[16] and the "healthy diet" categorized by Kiefte-de Jong et al.[17] characterizing by fruit, vegetables and fish. "fast food diet" was similar to the "junk food diet" that was illustrated by high intakes of fried foods, sweets and soft drinks identified by de Moraes et al.,[18] "unhealthy food diet" was characterized by high intakes of snacks, sweets, biscuits, and desserts in Fitzgerald et al.'s study,[19] the "Western diet" consisted of high intakes of takeaway foods, soft drinks, confectionery, French fries, refined grains, full-fat dairy products and processed meats recognized by Ambrosini et al.[15] as well as the "Snaky diet" was characterized by more frequent consumption of bakery products (buns, cakes and biscuits), sweets, salted snacks and soft drinks that was named by Kiefte-de Jong et al.[17] Mediterranean diet was typified by low intake of hydrogenated vegetable oil and high intake of non-hydrogenated vegetable oil, fish and olive oil. Moreover, the findings of the current study in 3 derived dietary patterns of fast food, animal fat, and Mediterranean dietary pattern were consistent with the results of Mohammadifard et al.'s study among the Iranian adults population.[20] Therefore, this similarity indicated the dietary pattern of parents might be affected in their children.

The present population-based study highlights potential roles of socio-demographic and behavioral characteristics in influencing dietary patterns. In this study, we found that prudent and animal fat diets had an inverse association with age whereas fast food diet related straightly with age. It was consistent with McNaughton et al.'s study that showed inverse association between fruit, salad, cereals, and fish intakes with age,[3] however it was inconsistent with Kiefte-de Jong et al.'s study that was showed inverse association between snaky pattern and age.[17] Furthermore, the scores of prudent and Mediterranean dietary patterns inversely associated with being boy while fast food and animal fat dietary patterns had a positive relationship with it. This finding was alike of Kiefte-de Jong et al.'s study[17] that was showed girls were more likely to follow the healthy dietary pattern.

In addition, higher nutrition knowledge score in the highest quartile of prudent diet compared to the lowest quartile showed having more nutrition

Table 2. Baseline characteristics of study population according to quartiles of dietary pattern

Characteristics	Prudent diet			Fast food diet			Animal fat diet			Mediterranean diet		
	Q_1	Q_4	P	Q_1	Q_4	P	Q_1	Q_4	P	Q_1	Q_4	P
Age (year)	14.6 ± 1.8	14.3 ± 1.8	0.040	14.3 ± 1.9	14.6 ± 1.7	0.080	14.4 ± 1.8	14.4 ± 1.8	0.200	14.5 ± 1.8	14.4 ± 1.9	0.080
Body mass index (kg/m^2)	19.9 ± 3.6	20.0 ± 3.8	0.500	20.0 ± 3.9	19.9 ± 3.5	0.90	20.6 ± 4.0	19.4 ± 3.4	0.100	19.5 ± 3.4	20.7 ± 4.2	0.100
TV watching (h/day)	3.2 ± 1.7	3.2 ± 1.6	0.700	3.0 ± 1.6	3.4 ± 1.6	0.020	3.2 ± 1.6	3.2 ± 1.6	0.600	3.3 ± 1.6	31 ± 1.7	0.100
Nutrition knowledge	45.5 ± 18.4	48.4 ± 19.3	0.005	56.2 ± 17.2	50.7 ± 21.2	< 0.001	48.2 ± 21.6	37.6 ± 22.4	< 0.001	57.0 ± 25.8	74.5 ± 24.1	< 0.001
Being boy (%)	50.4	49.3	0.500	48.1	55.5	0.007	38.2	64.4	< 0.001	58.7	47.2	< 0.001
Education degree												
Middle school (%)	26.0	25.7	0.900	26.9	23.2	0.100	21.5	27.8	0.008	24.5	25.7	0.800
High school (%)	33.8	24.2	0.040	22.8	25.8	0.070	28.8	21.9	0.001	25.5	24.2	0.800
Urbanization	77.2	73.9	0.300	76.8	79.9	0.100	95.2	43.3	< 0.001	63.9	88.8	< 0.001
Regular physical activity (%)	21.1	27.9	< 0.001	23.7	24.5	0.070	24.3	27.7	0.100	24.8	25.4	0.800
Membership in sports team (%)	19.3	29.9	0.001	22.6	27.2	0.300	22.8	25.2	0.200	23.0	28.8	0.030

Q1: Quartile 1; Q4: Quartile 4

Table 3. Linear regression of major dietary pattern with demographic and behavioral characteristics

Dietary pattern	R^2	Age		Being boy		Urbanization		Regular physical activity		Membership in sport team		TV watching		Nutrition Knowledge	
		β	P	β	P	β	P	β	P	β	P	β	P	β	P
Prudent diet	0.08	-0.03	0.030	-0.22	< 0.001	-0.10	0.070	0.25	< 0.001	0.15	0.006	-0.003	0.600	-0.17	0.200
Fast food diet	0.07	0.03	0.020	0.10	0.030	0.46	0.003	-0.04	0.500	0.11	0.040	0.400	0.006	-0.28	0.010
Animal fat diet	0.04	-0.02	0.010	0.40	< 0.001	-1.11	< 0.001	-0.03	0.400	0.14	0.002	-0.006	0.600	-0.35	< 0.001
Mediterranean diet	0.09	-0.02	0.070	-0.20	< 0.001	-0.36	< 0.001	0.07	0.100	0.19	< 0.001	-0.020	0.100	0.65	< 0.001

β: Linear regression coefficient

knowledge more likely to choose healthy dietary patterns and Mediterranean dietary pattern positively related to nutrition knowledge while unhealthy dietary patterns including animal fat and fast food diets had inverse association with nutrition knowledge. This finding was the similar to Tsartsali et al.'s study[21] that was revealed nutrient intake was a close coherence to the degree of nutritional knowledge. Urbanization correlated positively with the fast food diet and inversely with other dietary patterns that were consistent with McNaughton et al.'s study[3] in which vegetable dietary pattern positively associated with rural residency. Middle school students more likely to consume animal fat diet, however high school students had less intake of animal fat dietary pattern as well as prudent diet was alike Puska's study[22] that determined a clear trend toward lower intakes of fat, especially saturated fat, and increased consumption of vegetables and fruit from childhood to adolescence that These changes are supposed to have happened as a result of a main investing in nutrition education and our finding is contrasting with Mikkila et al.'s study that showed with passage from childhood to adolescence Intakes of fat and saturated fat had decreased, while the consumption of vegetables and fruit had increased.[23] The prudent and Mediterranean dietary patterns had a significant positive correlation with membership in sports team. In was in agreement with de Moraes et al.[18] finding that was demonstrated healthy dietary pattern was positively associated with physical activity level. In addition, some studies have shown physically active girls were more likely to have healthy eating patterns.[24,25] It might be due to who have healthy lifestyle such as regular physical activity more likely to consume healthy food. Our study illustrated that fast food dietary pattern positively associated with TV watching. It was similar to Ambrosini et al.'s study that was indicated Western and snack dietary patterns positively and healthy dietary pattern inversely correlated with TV watching.[15] Furthermore, other studies found TV watching associated with higher consumption of soft drinks[17] and fried foods.[26]

Study limitations and strengths

The study sample size was large which enables us to have an adequate power for some analyses. Moreover, the study population was from three districts of Iran with heterogeneous socioeconomic status. Therefore, we believe that the study has covered a wide range of dietary intakes.

Our study has some limitations. Factor analysis, as being a statistical technique, requires some arbitrary decisions and subjective interpretation of factors. Although a validated FFQ has been used for dietary data collection, we acknowledge the limitations of FFQ regarding individual measurement error; however, the FFQ remains one of the very most practical dietary methods for epidemiological studies. Our FFQ contained 50 common food items. It was shorter than some other FFQs used to obtain information about dietary patterns.[27] Moreover, our FFQ was qualitative and did not quantify food and total energy intake. However, some investigators believe that data on portion sizes do not add much to the dietary data.[28] Furthermore, among socio-demographic characteristics, some other factors such as family income, parents' education level, number of children have not been detected that can effect on the dietary pattern.

Conclusion

Our study of dietary patterns suggests that adolescent dietary intake is dependent on factors related to the sex, age, urbanization, TV watching, sports, and nutrition knowledge. Unhealthy dietary habits in adolescents are associated with more TV watching, and being boy as well as less nutrition knowledge, and urbanization. The identification of dietary patterns in this study will be useful for future longitudinal analyses of diet and various statuses.

Acknowledgments

This program was supported by a grant (No. 31309304) from the Iranian Budget and Planning Organization, as well as the Deputy for Health of the Iranian Ministry of Health and Medical Education and Iranian Heart Foundation as well as Isfahan Cardiovascular Research Centre and Isfahan Provincial Health Center, both affiliated to Isfahan University of Medical Sciences.

Conflict of Interests

Authors have no conflict of interests.

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How to cite this article: Kafeshani O, Sarrafzadegan N, Nouri F, Mohammadifard N. **Major dietary patterns in Iranian adolescents: Isfahan Healthy Heart Program, Iran.** ARYA Atheroscler 2015; 11 (Suppl 1): 61-8.

Association between dietary salt intake and reservation of renal function in patients with mild hypertension

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Original Article

Abstract

BACKGROUND: It is now hypothesized whether restricted salt intake can be a potential precursor to renal dysfunction in mild hypertension state. We aimed to study the association between salt intake and renal function in patients with mild hypertension.

METHODS: One hundred consecutive hypertensive Iranian patients (with systolic blood pressure 140-160 mmHg and/or diastolic 90-100 mmHg) who were referred to the hypertension research center, Isfahan, Iran, between 2011 and 2014 for screening of hypertension were assessed. Renal function was assessed by measuring serum creatinine (Cr) and creatinine clearance (CrCl). Daily salt intake was assessed on the basis of 24 h urinary sodium excretion.

RESULTS: There was no association between the amounts of sodium intake and serum Cr concentration (r = 0.138, P = 0.174), however, an association was revealed between sodium intake and value of CrCl (r = 0.303, P = 0.003). Multivariable linear regression model showed that sodium intake could effectively predict renal function assessed by CrCl (Beta = 0.070, P = 0.016).

CONCLUSION: There is an association between sodium intake and reservation of renal function in mild hypertension state and thus by restriction of dietary salt intake, reserving renal function, and preventing appearance and progression of renal insufficiency in higher degrees of hypertension can be facilitated.

Keywords: Dietary, Salt Intake, Renal Function, Mild Hypertension

Date of submission: 23 Aug 2014, ***Date of acceptance:*** 22 Oct 2014

Introduction

Hypertension has been still remained as the most frequent cause of cardiovascular, renal, and cerebrovascular impairment.[1] Although the overall prevalence of hypertension is now dramatically increased due to sedentary lifestyle and improper dietary regimens, because this risk factor is proposed as an asymptomatic event in about one-third of affected individuals,[1] it may be remained undiagnosed in these patients.[2] Moreover, because of the chronic nature of hypertension in most cases, its appropriate control can be naturally difficult and laborious and thus its controlling may be unsatisfactory.[3] It seems that the difficulty in hypertension treatment and control can be in order to its genetic and environmental sources. In this context, low-salt diet plays more important central role compared with drug treatment.[4] Dietary sodium restriction is a widely used method to treat hypertension in the absence of or in association with antihypertensive drugs.[5-7] This therapeutic regimen can be more effective in those with mild or moderate essential hypertension, because recent studies have suggested appropriate response to dietary salt restriction even without following a long-term treatment with anti-hypertensive drugs while considering non-pharmacological regiments in those with severe hypertension is unthinkable 8. However, the response of mild hypertension response to sodium intake restriction has been different in various populations probably due to some baseline genetic and nutritional behavioral

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factors.[8] Some studies found that reducing salt intake from 9,700 mg a day to 6,500 mg decreased blood pressure significantly in blacks, Asians, and whites who had untreated mild hypertension.[9] Besides, the effect of low-sat dietary regimen on renal function in patients with mild hypertension has been already questioned. Although long-term salt load promotes a decline in renal function in hypertensive patients and thus salt restriction is encouraged to prevent renal damage, but it is now hypothesized whether restricted salt intake can be potential precursor to renal dysfunction in mild hypertension state and thus inhibit its progression towards malignant hypertension. Herein, we aimed to study the association between salt intake and renal function in patients with mild hypertension.

Materials and Methods

In a cross-sectional population-based study, 100 consecutive hypertensive Iranian patients were selected using multi-stage cluster random sampling method. After informing the participants, one person aged 18 was selected from each household who were referred to the hypertension research center, Isfahan, Iran, between 2011 and 2014 for screening of hypertension in 2014 were included in the study. Inclusion criteria were age greater than 18 years, while exclusion criteria included history of diabetes insipid us, special dietary regimen or fasting at the day and time of sampling, history of using diuretics, history of renal insufficiency, menstruation or pregnancy, and excessive sweating during the day of urine collection. Baseline information regarding demographics, educational level, medical history, and medications were recorded. Height, weight, waist, and hip circumference were measured on the day of the visit to the clinic. Body mass index (BMI) was calculated as weight divided by height squared (kg/m^2). Blood pressure was measured twice in the left arm by an examining physician using a mercury column sphygmomanometer (Korotkoff phases I and V) after the subject had been at rest in the seated position for 5 min. Mild hypertension status was defined as systolic blood pressure 140-160 mmHg and/or diastolic 90-100 mmHg according to the World Health Organization-International Society of Hypertension Guidelines.[10] Participants fasted from the evening before the interview and collected on the day of interview a first voided urine sample into a sterile container for albumin estimation. Blood was also drawn after an 8-12 h overnight fasting period in the morning after completion of the 24 h urine collection. Plasma biochemical indices including sodium and potassium concentrations, as well as blood urea nitrogen and serum creatinine (Cr) levels, were measured by standard laboratory procedures. Renal function was assessed by measuring serum Cr and creatinine clearance (CrCl) calculated by the Cockcroft-Gault formula. This equation is often used as a method of estimating the glomerular filtration rate (GFR) from knowledge of serum Cr, age and weight as the following formula:

Creatinine clearance = [(140 - age in years) × (wt in kg)]/(serum creatinine in mg/dl × 72) that for women multiply the result of calculation by 0.85. Renal impairment was defined as a CrCl lower than 30 ml/min.

Daily salt intake was assessed on the basis of 24 h urinary sodium excretion since urinary sodium excretion largely equals sodium intake, when people are in steady state.[11] The subjects were divided into three categories according to the level of 24 h urinary sodium excretion: low-salt-intake group (n = 34, urine sodium ≤ 132 mmol/24 h), medium-salt-intake group (n = 24, urine sodium: 133-186 mmol/24 h), and high-salt-intake group (n = 42, urine sodium ≥ 187 Bmmol/24).

Kolmogorov–Smirnov test was used to check the normality of data. Results were presented as mean ± standard deviation for quantitative variables and were summarized by absolute frequencies and percentages for categorical variables. Continuous variables were compared using one-way analysis of variance and/or non-parametric Kruskal–Wallis test whenever the data did not appear to have normal distribution or when the assumption of equal variances was violated across the three groups of TR. Correlation between quantitative variables was assessed using the Spearman correlation coefficient test. Multiple linear regression analysis with the presence of confounders including those baseline variables which were univariately correlated to renal functional state (with considering P < 0.050 or less) was used to assess the value of sodium intake to predict renal function in study population. For the statistical analysis, the statistical software SPSS for windows (version 19.0, SPSS Inc., Chicago, IL, USA) was used. P = 0.050, or less were considered statistically significant.

Results

The average of the participants was 46.41 ± 12.39 years and 47% of them were men. Cigarette smoking was observed in 9% and obesity as BMI higher than 30 kg/m^2 was revealed in 33%.

As described in table1, none of the study patients had serum Cr higher than 1.07 as well as CrCl lower than 35. Considering different categories of sodium intake, the mean serum Cr level in low sodium intake group was 1.00 ± 0.19 mg/dl, in intermediate sodium intake group was 1.02 ± 0.19 mg/Dl, and in high sodium intake group was 1.03 ± 0.21 with no significant difference (P = 0.876); while, the level of CrCl was significantly increased in line with the increase of sodium intake (CrCl was 89.35 ± 26.73 ml/min in low sodium intake group, 99.38 ± 25.96 ml/min in intermediate sodium intake group, and 112.04 ± 33.02 ml/min in high sodium intake group, P = 0.006) (Table 2). The Spearman correlation test showed no association between the amounts of sodium intake and serum Cr concentration (r = 0.138, P = 0.174), however, an association was revealed between sodium intake and value of CrCl r = 0.303, P = 0.003) (Figure 1).

Table 1. Baseline characteristics in study population

Characteristics	Mean ± SD	Median	Minimum	Maximum
Age (year)	46.41 ± 12.39	47.00	21.00	76.00
Weight (kg)	76.71 ± 14.55	74.00	46.50	103.00
Height (cm)	164.44 ± 10.33	164.25	143.00	188.00
Body mass index (kg/m^2)	28.26 ± 4.22	27.79	20.36	45.64
Waist circumference (cm)	91.12 ± 10.94	89.00	69.00	136.00
Hip circumference (cm)	96.83 ± 8.15	95.50	78.50	134.00
Systolic blood pressure (mmHg)	125.18 ± 9.10	125.00	90.00	145.00
Diastolic blood pressure (mmHg)	82.90 ± 6.52	82.50	60.00	98.00
Serum BUN	15.40 ± 3.34	15.00	9.00	24.00
Serum Cr (mg/dl)	1.02 ± 0.20	1.00	0.60	1.07
CrCl (ml/min)	101.55 ± 30.82	96.76	35.27	207.21
Serum Na (mg/dl)	139.55 ± 3.16	140.00	139.00	145.00
Urinary sodium (mg/dl)	185.34 ± 80.69	178.00	38.00	402.00
Urinary potassium (mg/dl)	66.85 ± 31.24	62.00	25.00	276.00
Urinary Cr (mg/dl/100)	14.19 ± 5.10	13.07	3.25	31.99
Urinary protein (mg/dl)	50.46 ± 41.87	39.00	5.00	237.00

SD: Standard deviation; BUN: Blood urea nitrogen; Cr: Creatinine; CrCl: Creatinine clearance

Table 2. Comparing serum creatinine (Cr) and creatinine clearance (CrCl) according to the level of sodium intake

Variables	Low sodium intake	Intermediate sodium intake	High sodium intake	P
Serum Cr (mg/dl)	1.00 ± 0.19	1.02 ± 0.19	1.03 ± 0.21	0.876*
CrCl	89.35 ± 26.73	99.38 ± 25.96	112.04 ± 33.02	0.006**

* ANOVA test; ** Kruskal–Wallis test; Cr: Creatinine; CrCl: Creatinine clearance; ANOVA: Analysis of variance

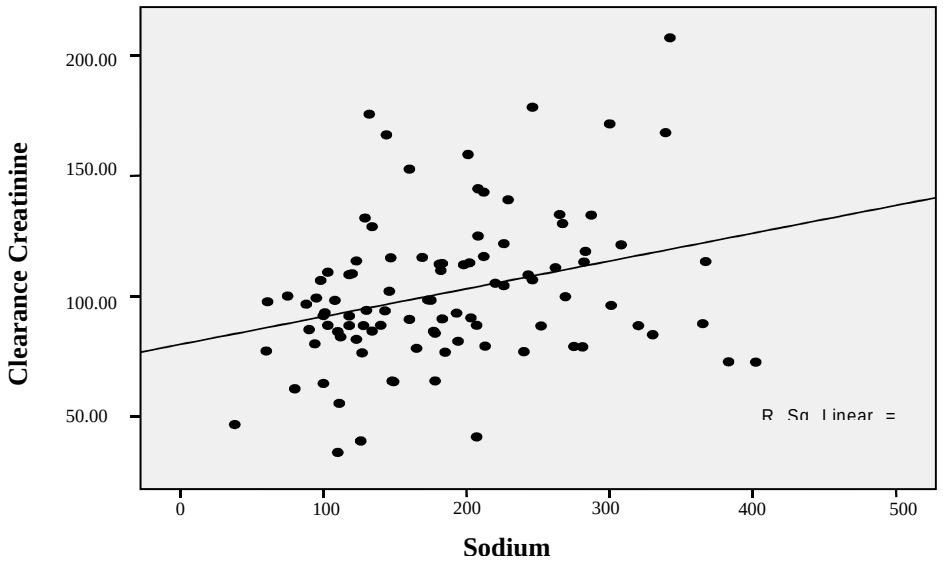

Figure 1. Association between sodium intake and creatinine clearance

Table 3. Multiple linear regression model to predict renal function (assessed by CrCl) by measurement of sodium intake

Characteristics	Univariate P	Beta	SD	Multivariate P
Sodium intake	0.002	0.070	0.029	0.016
Male gender	< 0.001	22.987	4.873	< 0.001
Age	< 0.001	-1.674	0.178	< 0.001
Waist circumference	< 0.001	-1.524	0.205	< 0.001
Cigarette smoking	0.045	-3.888	3.677	0.293
Serum Na	0.047	0.422	0.686	0.546
Systolic blood pressure (mmHg)	0.021	0.056	0.248	0.821
Diastolic blood pressure (mmHg)	0.008	-0.402	0.370	0.279

R^2: 0.650; CrCl: Creatinine clearance; SD: Standard deviation

Multiple linear regression model with the presence of confounders including gender, age, smoking, and waist circumference showed that sodium intake could effectively predict renal function assessed by CrCl (Beta = 0.070, P = 0.016). In this model, female gender, advanced age, and higher waist circumference were main determinants of low CrCl and thus renal insufficiency (Table 3).

Discussion

Numerous studies showed beneficial effects of low-salt dietary regimens on lowering and regulating blood pressure in those with mild essential hypertension. As the first aim and to the best of our knowledge, we attempted to reveal the effect of salt intake restriction on serving a renal function in patients with mild essential hypertension. In this regard, we showed a positive association between the amount of salt intake measured by assessment of urinary sodium excretion and renal functional status assessed by CrCl. On the other hand, by limiting dietary sodium intake, renal function can be reserved in those with mild hypertension. Previous studies mostly focused on this association regardless of the degrees of hypertension.[12-14] According to the confirmed effects of salt intake restriction on controlling blood pressure in those with mild hypertension and also in order to close causative relationship between high blood pressure and renal dysfunction, reserving renal function by restricting dietary sodium intake can be predictable in these patients. It is interesting to say that the pointed association can be independent of the range of blood pressure 12. As noted by Ohta et al.,[12] the association between the average salt excretion and baseline GFR was independent of blood pressure change or an increased number of antihypertensive drugs. Although bordering salt intake in hypertensive subjects can stabilize renal function in various blood pressure degrees, by preserving renal function in the early stages of hypertension, prevention of the outbreak of more serious renal adverse events following severer stages of hypertension.

For assessment of renal function state in this study, we considered two parameters of serum Cr level and CrCl, however association between sodium intake and renal function was only revealed with considering CrCl, not with serum Cr. On the other hand, among these two diagnostic parameters, CrCl can be only valid tool for assessment of renal function in mild hypertensive patients. It seems that the role of definitional components of CrCl including patient's age, gender, and body weight for predicting renal function status is fundamental. To confirm this subject, our multivariable analysis showed the central role of these indicators for prediction of renal dysfunction in mild hypertensive patients. On the other, some other predictors such as baseline proteinuria, lower serum high-density lipoprotein cholesterol,[13] black race, urea nitrogen, and phosphorus[1,4] as well as history of diabetes or urinary tract problems[15] expressed to be associated with renal insufficiency in hypertensive patients that should be considered in combination with estimation of CrCl to assess renal function in mild hypertensive subjects.

The potential limitations of the present study were the cross-sectional nature of the data, including inadequate follow-up time and hence a small sample, inability to determine effects of nutritional components and ingredients on renal function, and ignoring those with renal dysfunction as targeted population.

In conclusion, there is an association between sodium intake and reservation of renal function in mild hypertension state and thus by restriction of dietary salt intake, reserving renal function and preventing appearance and progression of renal insufficiency in higher degrees of hypertension can be facilitated. Among available criteria for

assessment of renal function in these patients, CrCl especially combined with other factors influencing renal function in hypertensive patients can be considered as the most valid tool.

Acknowledgments

This project was funded by the Isfahan Cardiovascular Research Institute.

Conflict of Interests

Authors have no conflict of interests.

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How to cite this article: Khaledifar A, Gharipour M, Bahonar A, Sarrafzadegan N, Khosravi A. **Association between dietary salt intake and reservation of renal function in patients with mild hypertension.** ARYA Atheroscler 2015; 11 (Suppl 1): 69-73.

The effect of probiotic soy milk and soy milk on anthropometric measures and blood pressure in patients with type II diabetes mellitus: A randomized double-blind clinical trial

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Original Article

Abstract

BACKGROUND: The objective of this clinical trial was to assess the effects of probiotic soy milk and soy milk on anthropometric measures and blood pressure (BP) in type 2 diabetic (T2D) patients.

METHODS: A total of 40 patients with T2D, 35-68 years old, were assigned to two groups in this randomized, double-blind, controlled clinical trial. The patients in the intervention group consumed 200 ml/day of probiotic soy milk containing Lactobacillus planetarium A7 and those in control group consumed 200 ml/day of soy milk for 8 weeks. Anthropometric and BP measurements were performed according to standard protocols. For detecting within-group differences paired-sample *t*-tests was used and analysis of covariance was used for determining any differences between two groups. (The trial has been registered in the Iranian Registry of Clinical Trials, identifier: IRCT: IRCT201405265062N8).

RESULTS: In this study, we failed to find any significant changes between probiotic soy milk and soy milk in term of body mass index (26.65 ± 0.68 vs. 26.33 ± 0.74, P = 0.300) and waist to hip ratio (1.49 ± 0.08 vs. 1.54 ± 0.1, P = 0.170). Although soy milk did not have any effect on BP, probiotic soymilk significantly decreased systolic (14.7 ± 0.48 vs. 13.05 ± 0.16, P = 0.001) and diastolic BP (10 ± 0.7 vs. 9.1 ± 1, P = 0.031).

CONCLUSION: In our study, probiotic soy milk in comparing with soy milk did not have any beneficial effects on anthropometric measures in these patients. We need more clinical trial for confirming the effect of probiotic foods on anthropometric measure in diabetic patients. However, probiotic soy milk decreased systolic and diastolic BP significantly.

Keywords: Probiotics, Obesity, Diabetes Mellitus, Soy Milk, Blood Pressure

Date of submission: 15 Aug 2014, ***Date of acceptance:*** 22 Nov 2014

Introduction

The proportion of individuals with obesity and type 2 diabetes (T2D) has increased rapidly in worldwide.[1] Moderate weight reduction in obese patients with T2D causes a decrease in insulin resistance, glycemic parameters, and diabetic complications.[2] Thus, anti-obesity agents may be useful as treatment for obese patients with diabetes.

Recent research has documented a significant impact of gut microbiota on body weight.[3] Intestinal microbiota has been suggested to impact energy balance in animals and humans[4] by contributing to energy metabolism from components of the diet and playing a role in energy storing and expending.[4,5] Probiotics are of interest because it is shown that can alter the composition of the gut bacterial community and differentiate food intake and appetite.[6,7] Dietary non-digestible carbohydrates can be fermented by probiotics and resulting in the production of short-chain fatty acids (SCFAs) such as acetate, propionate and butyrate. SCFAs play a role in energy metabolism and adipose tissue expansion.[7]

In human and animal studies co-administration of probiotics with other interventions like herbal

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drugs or weight reduction diet could reduce anthropometric measures,[8-11] and to our knowledge no reports are available indicating the effects of probiotic supplements alone especially this strain of probiotics. Furthermore, previous studies have mostly been done in animal models and limited data of the effects on humans are available.

Obesity and insulin resistance increase blood pressure (BP) in diabetic patients. Previous human studies have found some beneficial effects of Lactobacillus species in reducing BP in patients with hypertension.[12] Scientists believe that probiotics can reduce BP by decrease in pro-inflammatory cytokines and intestinal permeability so resulting in splanchnic vasodilation and deceasing BP in patients with hypertension.[13] To our knowledge, there is not any study about the effect of Lactobacillus planetarium A7 on BP among diabetic patients. New evidence proposed probiotics can ferment soy phytoestrogen and increase the amount of SCFA produced by probiotics, therefore; soy foods are able to strengthen the useful effect of these bacteria.[14,15] Hence in this study, we fortified soy milk with L. planetarium A7 and assessed the effect of daily consumption of probiotic soy milk on anthropometrics measure and BP in patients with T2D.

Materials and Methods

This randomized double-blinded parallel-group controlled clinical trial was carried out in Isfahan, Iran. Subjects were recruited from Endocrine and Metabolism Research Center, Isfahan University of Medical Sciences, Isfahan, Iran, during their annual health assessment. Our subjects were T2D patients with fasting blood glucose ≥ 126 mg/dl, blood sugar (2 h postprandial sugar) ≥ 200, aged from 25 to 65 years, and having diabetes for more than 1-year. Subjects were excluded if they have a history of inflammatory bowel disease, infection, liver disease, rheumatoid arthritis, smoking, alcoholism, recent antibiotic therapy, and daily intake of multivitamin and mineral. Each participant was assigned an order number and was randomly assigned by permuted blocks randomization of size two to one of two 8-week intervention groups. The allocation sequence was concealed from the researchers who enrolled and assessed participants. Allocation concealment will be ensured, as the service will not release the randomization code until the end of trial, which takes place after all baseline measurements have been completed and outcomes were measured. The conventional or probiotic soy milk were provided for the participants every 3 days. Each day, the subjects received, in a double-blinded fashion, probiotic soymilk or soy milk to supplement their usual diet. The probiotic soy milk and soy milk were identically packed and coded by the producer to guarantee blinding. The 8-weeks probiotic intervention consisted 200 ml soy milk/day. All subjects were included in a 2-weeks run-in period during this time they had to stop taking any probiotic food or probiotic supplements. A total of 48 patients (22 males and 26 females) with T2D and age range 35-68 years old were recruited into the study they were randomly assigned to receive either probiotic soy milk (n = 24, i.e., 12 males and 12 females) as intervention group or the soy milk (n = 24, i.e. 10 males and 14 females) as placebo group for 8 weeks. All subjects had to have stable dietary habit, physical activity (PA), and medication during intervention and consume milk instead of yogurt and any other fermented dairy products. Compliance with the soymilk and dairy product consumption was monitored by the use of 24 h diet recall completed every 2 weeks throughout the study. Information on PA levels and micro and macronutrients intakes were gathered at beginning of study and every 2 weeks throughout the study by International PA Questionnaires [16] and a 24 h diet recall respectively. Subjects who intended to change their dietary habits, PA, body weight, and consume fermented product except probiotic soymilk during the intervention period were excluded from the study. The Ethical Committee of Isfahan University of Medical Sciences approved the study, and informed written consent was taken from all participants. (The trial has been registered in the Iranian Registry of Clinical Trials, identifier: IRCT: IRCT201405265062N8 available at: http://www.irct.ir).

The probiotic soy milks were enriched with L. plantarum A7. Conventional soy milk and probiotic soy milk were produced by Isfahan Soy Milk Company every 3 days and distributed to the participants. At the time of production and after 3 days refrigerating at 4 °C probiotic soy milks were sampled and microbiologically analyzed every 2 weeks. We used MRS Broth (MRS agar: Merck, Darmstadt, Germany and bile: Sigma–Aldrich, Inc., Reyde, USA) and pour plate method for counting L. plantarum A7. Microbiological analyses of probiotic soy milk approved the probiotic soymilk had that the average colony counts of L. plantarum A7 on day 1 and day 3 about 2×10^7 therefore; bacteria indicated a steady survival rate in soy milk during 3 days storage time.

Weight was recorded by digital scale (Seca, Germany) with an accuracy of 100 g and standing height was recorded by non-stretchable tape (Seca,

Germany) with an accuracy of 0.1 cm. Body mass index (BMI) was obtained by dividing weight by the square of height. Waist and hip circumference was measured using a flexible measuring tape. Waist circumference was measured at the midpoint between the lower ribs and the iliac crest. Hip circumference was measured horizontal at the largest circumference of the hip. BP was measured using mercury sphygmomanometer after the participants had been seated quietly for 5 min and the right arm supported at heart level. A cuff bladder encircling at least 80% of the arm was used to ensure accuracy. Two readings were obtained with a 1-min interval. A third BP was measured if more than 5 mmHg difference in SBP between the two readings was noted, and the mean of the two closest was taken as the valid BP.[17]

To ensure the normal distribution of variables, histogram and Kolmogrove–Smirnov test were applied. For non-normally distributed variables, log-transformation was applied. Means ± standard error of means for general characteristics of the study participants were reported. Data on dietary intakes were compared by paired t-test and independent samples test. For comparing PA and sex in two groups we used chi-square test and the duration of disease and age were compared using independent t-test. For detecting within-group differences in anthropometric measures paired-sample t-tests were used and analysis of covariance (ANCOVA) was used for determining any differences between two groups and was adjusted by baseline values and confounding factors. Possible confounding factors were calorie and carbohydrate intake and baseline values. $P < 0.050$ was defined to be statistical significance and all experimental data were analysis by using the SPSS for Windows (version 20, SPSS Inc., Chicago, IL, USA).

Results

This study was carried out from November 2013 to February 2014, and 48 diabetic patients participated in this study. Among individuals in the placebo group, 4 patients (need for antibiotic treatment, n = 1; changing drug, n = 2; poor compliance, n = 1) were excluded. Four patients in probiotic soy milk group were excluded (need for antibiotic treatment, n = 2; changing diet, n = 1; poor compliance, n = 1). Finally, 40 subjects (soy milk, n = 20; probiotic soy milk, n = 20) completed the trial (Figure 1).

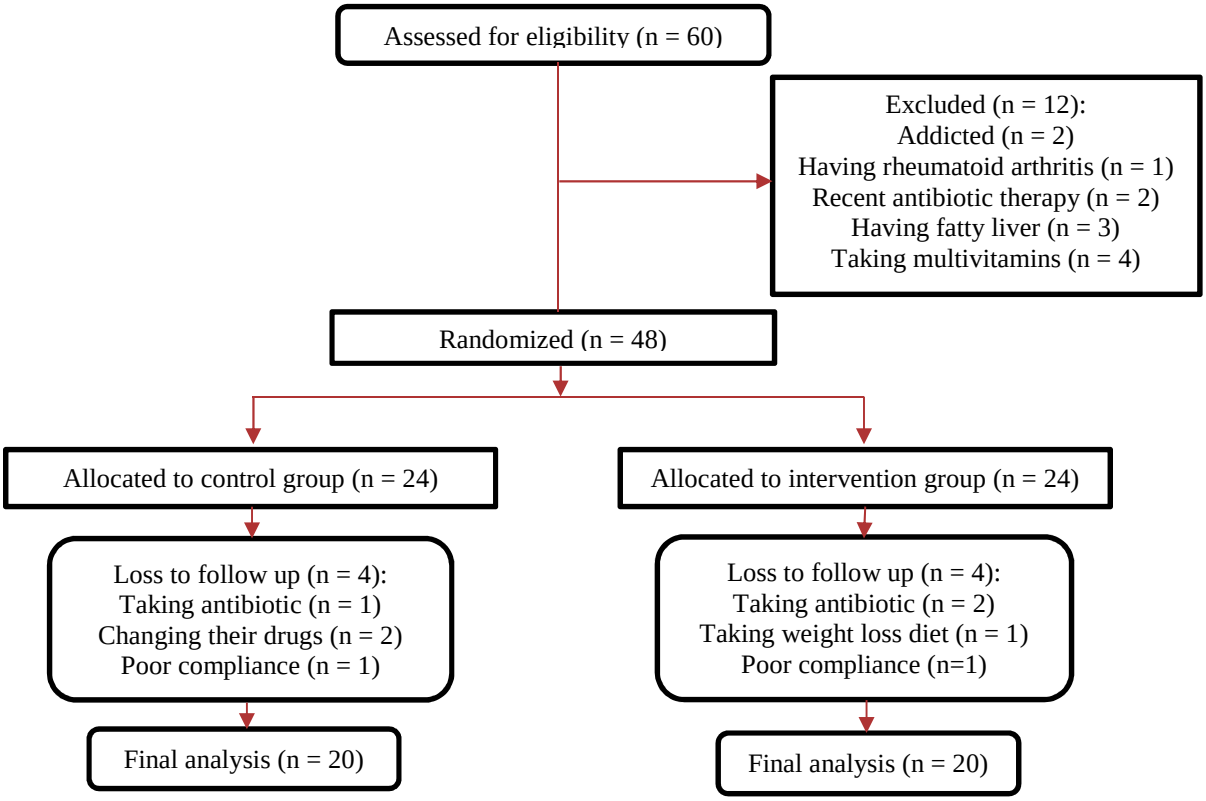

Figure 1. Summary of patient flow

Table 1. Baseline characteristics of the study participants

Variables	Intervention (n = 20)	Placebo (n = 20)	P
Age (year)*	56.90 ± 1.81	53.60 ± 1.60	0.182***
The duration of disease*	8.70 ± 2.10	6.90 ± 4.90	0.467***
Height (cm)*	162.95 ± 1.47	163.60 ± 1.35	0.747***
Sex (F/M) (%)**	11/9 (55/45)	10/10(50/50)	0.752€
PA (low/moderate) (%)**	16/4(80/20)	13/7** (65/35)	0.288€
BMI (kg/m^2)*	26.68 ± 0.71	26.58 ± 0.73	0.925***
WHR*	1.52 ± 0.09	1.59 ± 0.11	0.610***
Weight (kg)*	70.84 ± 2.41	71.61 ± 2.55	0.828***
Systolic BP*	14.70 ± 0.48	14.30 ± 0.71	0.310***
Diastolic BP*	10.00 ± 0.70	10.70 ± 0.90	0.281***

* Data are based on mean ± standard error; ** Percent, or frequency; *** Obtained from independent t-test; € Obtained from chi-square test; BP: Blood pressure; PA: Physical activity; BMI: Body mass index; WHR: Waist to hip ratio

Table 2. Reported nutrient intake of participants on probiotic soy milk and soy milk at baseline and throughout the study

Variables	Intervention			Placebo			P**
	Before	Throughout the study€	P*	Before	Throughout the study	P*	
Carbohydrate (g/day)	275.50 ± 5.53	269.00 ± 5.01	0.349	309.70 ± 6.54	307.72 ± 5.75	0.663	< 0.001
Protein (g/day)	61.60 ± 1.80	62.42 ± 1.33	0.457	62.22 ± 1.19	63.13 ± 0.98	0.419	0.777
Fat (g/day)	90.55 ± 1.92	90.60 ± 1.95	0.980	92.89 ± 2.59	92.23 ± 2.18	0.699	0.473
Calorie (Kcal/day)	2105.85 ± 33.48	2095.19 ± 20.09	0.790	2173.45 ± 32.11	2182.65 ± 30.95	0.727	0.023
Calcium (mg/day)	1147.00 ± 10.01	1168.63 ± 9.25	0.359	1089.06 ± 11.14	1127.61 ± 9.21	0.582	0.331
Magnesium (mg/day)	340.75 ± 7.32	319.32 ± 5.10	0.406	312.16 ± 4.19	329.67 ± 8.30	0.214	0.521
Potassium (g/day)	4.20 ± 0.47	4.10 ± 0.22	0.361	4.38 ± 0.54	4.40 ± 0.36	0.601	0.311

Data are means ± standard error; * Obtained from a paired t-test; ** Obtained from independent sample t-test for the comparison of dietary intakes throughout the study between the two groups; € The means of all 24 h food recall that was gathered every 2 weeks at throughout study

No serious adverse reactions were reported following the consumption of multispecies probiotic supplements in patients throughout the study. Table 1 shows the baseline characteristics of the participants in the two groups. The two groups were similar in their initial characteristics and there was not any significant difference in the number of male and female (P = 0.750) and PA levels (P = 0.280) in both groups. At the beginning of the study, no significant differences were found between the two groups in terms of dietary intakes except for carbohydrate (P < 0.001), furthermore; statistically significant difference was found between the two groups for dietary intakes of energy and carbohydrate at throughout of study. Comparing the dietary intakes at the beginning of study and throughout the study separately in each group, showed any significant differences (Table 2). There were not any significant differences in terms of BMI (P = 0.920) and waist to hip ratio (WHR) (P = 0.610) at the beginning of study between two groups, but after intervention in probiotic soy milk a significant within group reduction was found in BMI (P < 0.010) and WHR (P < 0.050). But we did not find a significant difference between two groups after adjusting by baseline values, confounding factors with ANCOVA (Table 3). There were any significant difference for systolic (P = 0.310) and diastolic BP (P = 0.280) in both group at the beginning of study. However, probiotic soy milk significantly reduced systolic (P < 0.001) and diastolic BP (P < 0.050) even after adjusting by cofounding factors and baseline values with ANCOVA (P < 0.001), but systolic and diastolic BP didn't show any significant changes in soy milk group (P = 0.120 and 0.670, respectively).

Table 3. Anthropometrics measures at baseline and after 8 weeks of study

Variables	Intervention (n = 20)			Placebo (n = 20)			P**
	Before	After	P*	Before	After	P*	
Weight (kg)	70.84 ± 2.41	70.40 ± 2.33	0.018	71.61 ± 2.55	71.21 ± 2.56	< 0.001	0.964
BMI (kg/m^2)	26.68 ± 0.71	26.65 ± 0.68	0.003	26.58 ± 0.73	26.33 ± 0.74	< 0.001	0.309
WHR	1.52 ± 0.09	1.49 ± 0.08	0.019	1.59 ± 0.11	1.54 ± 0.10	0.070	0.175
Systolic BP	14.70 ± 0.48	13.05 ± 0.16	0.001	14.30 ± 0.71	14.40 ± 0.23	0.120	0.002
Diastolic BP	10.00 ± 0.70	9.10 ± 1.00	0.031	10.70 ± 0.90	10.50 ± 0.12	0.670	< 0.001

Data are means ± standard error; * Obtained from a paired t test; ** Obtained from ANCOVA after adjusted with calorie and carbohydrate intake and baseline values; BMI: Body mass index; WHR: Waist to hip ratio; BP: Blood pressure

Discussion

Our study revealed that the consumption of probiotics soy milk and soy milk for 8 weeks among patients with T2D decreased BP and anthropometric measures, however; we did not find any significant differences between two groups in term of anthropometric measures after adjusting with covariates.

Recently, researchers have found that polyphenols played an important role in the treatment of obesity, through a mechanism involving the anti-oxidative function and scavenging of free radicals.[18] Polyphenols promote the transport of unsaturated fatty acids (FA), which increases the gene expression of enzymes that related to thermogenesis, adipogenesis or FA oxidation and causing weight loss.[19] In one cross-sectional study by Wang et al. indicated that people with low frequency of soybean intake had significantly higher risk to overweight and obesity.[20] Hu et al. reported that soy fiber had favorable effects on anthropometric measures, and fasting low-density lipoprotein cholesterol levels in overweight and obese adults.[21] Keshavarz et al. showed that soy milk can play an important role in reducing waist circumference among over weight and obese patients.[22] Similar our results were shown in one study by Kadooka et al.[23] They indicated Lactobacillus gasseri SBT2055 in fermented milk did not reduce abdominal obesity in adult, after 24 weeks, mean weight loss did not show significant difference between the probiotic and placebo groups; however, in one study by Sharafedtinov et al., the probiotic L. plantarum TENSIA significantly reduced BMI in the probiotic cheese group versus the control cheese group.[11] Difference in findings of these studies can be described by distinction between probiotic strain and dosage or differences between participants.[24] In our study, probiotic soy milk significantly reduced anthropometric measures in compared with the beginning of study but there were not any differences between two groups after adjusting by covariates. Therefore, we fail to show significant reduction in term of anthropometric measures by soy milk fortified with L. planetarium A7. It should note that the properties of different probiotic species vary and can be strain-specific. Therefore, the effects of one probiotic strain should not be generalized to others without confirmation in separate studies. It was for the first time that the effect of L. planetarium A7 was studied on human and it is possible that this strain of probiotics does not have any effect on anthropometric measures.

Our study revealed that probiotic soy milk can reduce BP in diabetic patients. Numerous randomized clinical trials of Lactobacillus helveticus have indicated that supplementation with this species has antihypertensive effects in human.[25-27] It is not surprising that other studies with different probiotic strains and species found different results, because the effect of probiotic bacteria is highly strain specific.[28] Although other studies indicated that soy milk reduces BP,[29,30] but in our study, soy milk did not reduce BP in diabetic patients.

Short duration of intervention, the absence of control group that consumed no soy milk, and 24 h diet recall instead of 3-day food record were our limitations in this study that must be considered while interpreting the results. Therefore for confirming the positive effects of probiotics soy milk on the anthropometric measures among diabetes patients more investigations with longer duration and control group without soy milk should be done.

Studies have been published before suggested that probiotics reduced anthropometric measures in humans. However, those studies used another species of probiotics and enrolled participants with higher BMI in comparing with our participants. In our randomized controlled trial, L. planetarium A7 could not reduce anthropometric measures among diabetic patients, and like other studies we indicated that this kind of probiotics can reduce BP.

Conclusion

As the intervention was implemented for both sexes and all ages among diabetic patients, results indicate

that diabetic patients may benefit from using probiotic soy milk for decreasing BP. However, we need more studies for determine the effect of this strain of probiotic on anthropometric measures.

Acknowledgment

We are grateful to the Isfahan soy milk company that provided soy milk products for the present study. We would like to express our special thanks to all patients that participate in our study.

Conflict of Interests

Authors have no conflict of interests.

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How to cite this article: Hariri M, Salehi R, Feizi A, Mirlohi M, Kamali S, Ghiasvand R. **The effect of probiotic soy milk and soy milk on anthropometric measures and blood pressure in patients with type II diabetes mellitus: A randomized double-blind clinical trial.** ARYA Atheroscler 2015; 11 (Suppl 1): 74-80.

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

Date of submission: 16 Aug 2014, ***Date of acceptance:*** 18 Nov 2014

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.

Acknowledgments

We thank Isfahan University of Medical Sciences. The authors express our thankfulness to participants.

Conflict of Interests

Authors have no conflict of interests.

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How to cite this article: Heidari-Beni M, Golshahi J, Esmaillzadeh A, Azadbakht L. **Potato consumption as high glycemic index food, blood pressure, and body mass index among Iranian adolescent girls.** ARYA Atheroscler 2015; 11 (Suppl 1): 81-7.

Comparison of soymilk and probiotic soymilk effects on serum high-density lipoprotein cholesterol and low-density lipoprotein cholesterol in diabetic Wistar rats

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Original Article

Abstract

BACKGROUND: Soy milk (SM) and its fermented products are identified as rich sources of bioactive compounds helping to manage and to reduce the risk of chronic disease. This study aimed to compare the effects of SM and probiotic SM (PSM) consumption on serum low-density lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C) in diabetic Wistar rats.

METHODS: Probiotic SM was prepared by fermentation of the plain SM with a native strain of Lactobacillus plantarum. 20 streptozotocin-nicotinamide-induced diabetic Wistar rats were divided into two groups based on the type of administered SM (SM group and PSM group). The animals were fed with 1 ml/day of either soy or PSM for 21 days. The serum lipoprotein levels were analyzed at baseline and the end of the intervention period.

RESULTS: HDL-C increased significantly in PSM group. Furthermore, this group showed more percent of change in increased HDL-C in compression with SM group ($P < 0.050$). Regarding LDL-C level, rats fed with SM was not significantly different from the PSM group ($P > 0.050$); though, this biomarker was reduced in both group.

CONCLUSION: Probiotic SM could modulate blood lipoprotein levels. Thus, it may be considered in managing diabetes complications and atherosclerotic risks.

Keywords: Lactobacillus, Probiotic, Low Density Lipoprotein Cholesterol, High Density Lipoprotein Cholesterol, Soy Milk

Date of submission: 22 Aug 2014, ***Date of acceptance:*** 27 Nov 2014

Introduction

Diabetes is a chronic metabolic disease with growing prevalence and incidence throughout the world.[1] Apart from impaired glucose homeostasis, its complications usually occurred as a range of abnormalities in lipoprotein metabolism which results in dyslipidemia. Diabetic dyslipidemia is most commonly characterized by elevated levels of triglycerides, low levels of high-density lipoprotein cholesterol (HDL-C), and postprandial lipidemia. In addition, the low-density lipoprotein cholesterol (LDL-C) particles in diabetic dyslipidemia tend to convert a smaller and denser type which raises their atherogenicity.[1] The increasing rate of population suffered from diabetes (from 382 million to 592 million in 2035),[2] aging population, lack of sufficient physical activity, disobedience principles of appropriate nutrition,[2-4] and an economic burden on the health care system[5] highlights the necessity of doing more research on prevention and treatment of this disease.

Some bioactive ingredients in soy milk (SM) showed a protective effect against diabetes.[6,7] Their intake through SM consumption was usually resulted in regulation of blood glucose and insulin levels and rising insulin sensitivity.[8,9] On the other hand, SM fermentation increases the bioavailability of its isoflavones, as the beneficial effects of ultimate fermented product get higher than those of unfermented.[10] Furthermore, soy proteins

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cooperation with soy isoflavones have demonstrated a positive role in reducing some atherogenic lipid and lipoproteins serum levels.[11] In addition, fermentation of SM probability associated with regulation of lipid metabolism genes expression.[12] From another point of view, fermented products with probiotic bacteria could decrement complications associated with diabetes.[13-15] Probiotics are living microorganisms which modulate the specific function of an organism by activation of specific molecular pathways.[16] Among various species of these microorganisms, Lactobacillus and Bifidobacterium genera are commonly used in the preparation of probiotic products.[17] Lactobacillus plantarum A_7 (KC 355240, LA7) is a native strain with proven probiotic properties.[18-20] This strain of bacteria was found to be capable of decreasing serum total cholesterol, LDL-C and triglyceride in mice.[19] The present study designed to evaluate the effects of probiotic SM (PSM) fermented by LA7 serum HDL-C and LDL-C in streptozotocin (STZ)-nicotinamide (NA)-induced diabetic rats.

Materials and Methods

In the present study, pasteurized plain SM was bought from Shir Soya Isfahan Company in Iran. Its composition and energy are shown in table 1. A strain of L. plantarum A7 (KC 355240, LA7) which was obtained from microbial collection of food microbiology laboratory in School of Nutrition and Food Science, Isfahan University of Medical Sciences, was used for preparation PSM. Overnight cultures were provided with 1% inoculums in de-Mans–Rogosa broth (MRS) (Merck-Germany) and aerobically incubation at 37 °C for 24 h (Irankhodsaz-Iran). Active bacteria were obtained through 2 successive overnight cultures. Bacterial pellet was achieved by three steps centrifugation at 6000, 8000, 10,000 rpm each took 15 min (Sequrita-B. Braun, Hamburg, Germany) following by washing with normal saline. Then suspension of bacterial prepared with 0.5 optical density at 620 (λ) wavelength determined by spectrophotometer (Jenway-UK). A flask containing SM (200 ml) was added with 1% (v/v) of the active culture, and the cultured samples were undergone fermentation at 37°C in an aerobic condition. Base of our study on pH and the growth of LA7 in SM revealed that cell numbers of LA7 can pick to 10^9 colony form unit (CFU)/ml in the presence 9 h fermentation that followed in the preparation of PSM samples in the presented study (Figures 1 and 2).

Table 1. Nutrient composition and energy content of soy milk used in this study*

Content	Mean value
Fat (g/100g)	1.20
Protein (g/100g)	2.10
Carbohydrate (g/100g)	1.50
Energy (mJ/kg)	1.06

* Declared by producer: Shir Soya Isfahan Company

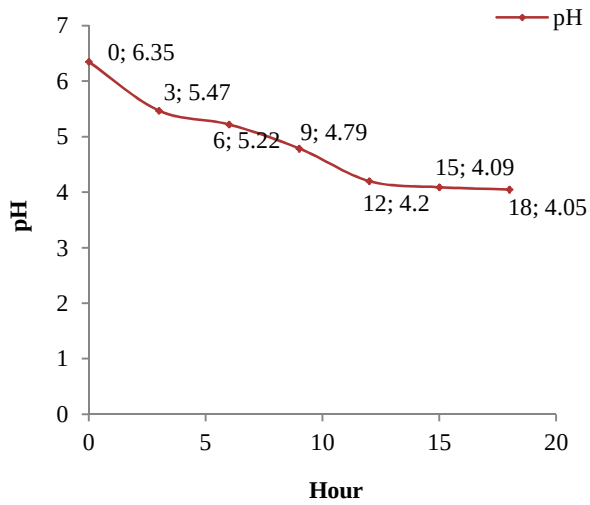

Figure 1. Variation curve of pH in fermentation time

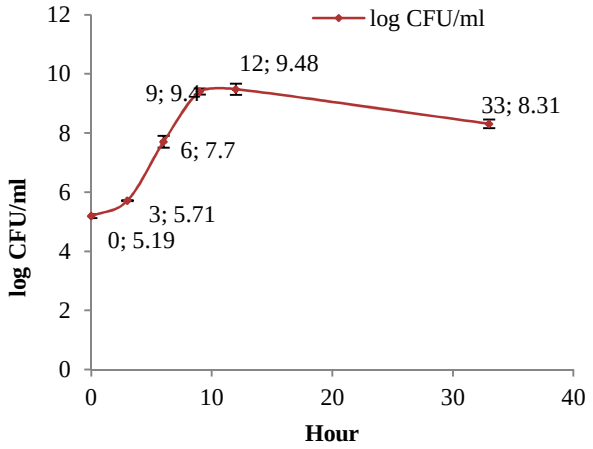

Figure 2. Growth curve of LA7 in fermentation time
CFU: Colony form unit

16-week-old male Wistar rats weighing about 185 ± 25 g which grew in the animal house of Isfahan School of Pharmacy and Pharmaceutical Sciences were housed in cages and subjected to a 12 h light/dark cycle with a maintained relative humidity of 45-55%, and temperature at 22 ± 2 °C. The animals were given free access standard pellet rat diet (Table 2) (Behparvar Company, Tehran, Iran) and water.

Table 2. The chemical composition and energy content of the standard pellet rat diet*

Contents	Value**
Protein (g/100 g)	19.50-20.5
Fat (g/100 g)	3.50-4.5
Fiber (g/100 g)	4.00-4.5
Ashe (g/100 g)	Maximum 10
Calcium (g/100 g)	0.95-1.0
Phosphorus (g/100 g)	0.65-0.7
Salt (g/100 g)	0.50-0.5
Moisture (g/100 g)	Maximum 10
Lysine (g/100 g)	1.15
Methionine (g/100 g)	0.33
Threonine (g/100 g)	0.72
Tryptophan (g/100 g)	0.25
Energy (mJ/kg)	16.16-17.0

* Declared by producer: Behparvar Company, Tehran, Iran; ** Data presented in ranges show minimum and maximum values

Diabetes was induced in overnight fasted rats by administering a single intraperitoneal injection of freshly prepared STZ (Sigma-Aldrich Company, Germany) 50 mg/kg b.w. followed 15 min later by 100 mg/kg of NA (Sigma-Aldrich Company, Germany) in 0.1 M citrate buffer (pH = 4.5).[21-24] Diabetes was confirmed in the STZ-NA-treated rats by measuring fasting blood glucose levels after one week of induction. Rats with fasting blood glucose of more than 200 mg/dl were considered as diabetics.[24] Then they were randomly divided into two separate groups of SM and (PSM) PSM groups of 10 rats in each.

The study was carried out according to the guidelines of Research Ethics Committee for animal experiments set forth by Isfahan University of Medical Sciences.

During the study period, the SM and PSM groups of rats were gavaged 1 ml/day by plain SM and PSM samples, respectively. Blood samples were collected by microcapillary tube from orbital sinus plexus under light ether anesthesia[25] after overnight starvation at 1st day and 21st day of the study. For analysis of blood lipoprotein, serum was obtained by centrifugation at 3000 rpm for 20 min and stored in a freezer at −80 °C until analysis. HDL-C and LDL-C concentrations were determined by using commercial kit (Biosystems, Spain) on A_{15}-Autoanalyzer set (Biosystems, Barcelona, Spain).

The data were expressed as mean ± standard error. Values were evaluated by IBM SPSS for Windows (version 20, SPSS Inc., Chicago, IL, USA). The percent change for each variable was also obtained by the formula (E–B)/B × 100, where E is the end-of-treatment values and B is the baseline values. The values of HDL-C and LDL-C in the two groups were compared using independent sample t-tests. The changes in the level of variables between the beginning and end of the intervention were compared by paired sample t-test. Differences with $P < 0.050$ were considered to be statistically significant.

Results

Serum HDL-C levels of PSM group were significantly increased in comparison with the relevant levels in SM group at the end of the intervention period ($P = 0.013$) (Table 3). Furthermore, at the end of the study, PSM group demonstrated a significant increase in serum HDL-C levels compared to the values in the baseline ($P = 0.044$) (Table 3). Moreover, in this group, more percent change in serum HDL-C level was calculated than that of SM group (16.8 vs. 9.036%) (Table 3).

Table 3. Serum levels of low-density lipoprotein cholesterol (LDL-C) and High-density lipoprotein cholesterol (HDL-C) in the study groups

Variable	Soy milk	Probiotic soy milk	P*
HDL-C (mg/dl)			
Baseline	30.71 ± 3.33	32.66 ± 2.44	0.608
After intervention	32.14 ± 1.89	39.48 ± 2.14	0.013
Percent change	9.36 ± 7.70	16.80 ± 5.10	0.491
P**	0.693	0.044	
LDL-C (mg/dl)			
Baseline	9.33 ± 1.65	15.33 ± 3.96	0.143
After intervention	7.10 ± 0.63	10.01 ± 4.48	0.407
Percent change	3.30 ± 20.77	-13.31 ± 19	0.688
P**	0.159	0.376	

Values are presented as mean ± standard error; * P values refer to mean comparisons between groups (independent t-test); ** P values refer to variation from day 0 to day 21 within groups (paired t-test); LDL-C: Low-density lipoprotein cholesterol; HDL-C: High-density lipoprotein cholesterol

LDL-C levels in both groups of rats were relatively decreased through the study period. This reduction was not sufficient to meet the statistical difference neither between the groups (P = 0.407) nor among each of the SM group (P = 0.159) and PSM group (P = 0.376). However, LDL-C percent change in PSM group were more than SM group (13.31 vs. 3.3%, P = 0.688) (Table 3).

Discussion

In this study, although serum LDL-C concentration in both treated groups of rats was not significantly reduced, but in PSM group, administration of fermented product led to more change in serum LDL-C concentration. PSM group, also, developed more percent change in increased HDL-C level than SM group.

The results of present study were in accordance with the results of those studies that claimed on SM inhibition effects against diabetes progression and its complications exacerbation through glycemic control.[26-28]

According to some previous studies, SM isoflavones enhance lipoprotein clearance and HDL-C biogenesis through the regulation of gene expression related to nuclear receptors of peroxisome proliferator-activated receptor and can improve glucose and lipid metabolism.[12,29-32] Furthermore, they regulate beta-cell secretory pattern partially by activating the signal transduction pathway, CAMP/protein kinase.[33] In addition, soy peptides may lead to inducing the expression of LDL-C receptors in liver and decreased the levels of serum cholesterol.[34]

Fermentation process led to structural and functional changes in soy bean which provided the production of a diverse mix of peptides and amino acids with advantageous physiological effects.[35-37] Furthermore, fermentation converts glucoside isoflavones to aglycone one that has higher physiological activity.[38] Inhibitory activity against the enzyme glucosidase and alpha-amylase in fermented SM is more than SM.[8]

Xie et al. Showed that supplementation of L. plantarum 9-41-A and Lactobacillus fermentum M1-16 in rats under high cholesterol diet a 6 week feeding period impose beneficial effects in triglycerides, total cholesterol, and LDL-C which are associated with positive impacts on intestinal Lactobacillus and Bifidobacterium bacteria population as well as more body weight lost.[39] In that study, L. plantarum 9-41-A was more effective than L. fermentum M1-16 in above-mentioned effects, since; authors proposed that L. plantarum may be involved in lipid metabolism.

Results of this study are consistent with the results of Rossi et al. In that intake of the soy product fermented by Enterococcus faecium and Lactobacillus jugurti cause a 17.8% increase in the level of the HDL-C fraction in hypercholesterolemic rabbits during 30 day.[35] Though, in the present study less percent change in HDL-C enhancement, about 7.8% was resulted that might be due to shorter study period than the above-mentioned study.

Wang et al. demonstrated that 4 weeks consumption of 2 ml of fermented SM by L. plantarum P-8 in experimental hyperlipidemic rats caused significant changes in the serum LDL-C and HDL-C comparing the control group having only physiological slain but not in the group of rat that was fed with plain SM. In that study, a notable decrease in LDL-C serum and an increment of HDL-C were observed in the rats treated with fermented soy compared with control group. These changes only relatively were occurred in the plain soy group. Furthermore, fermented SM enhanced total bile acids and lipid levels in fecal hyperlipidemic rats.[40] In comparison to our results, the trends in LDL-C reduction and HDL-C increase are comparable to the latter study, however, in the present study, HDL-C enhancement by fermented SM was definitely shown to be more effective than the unfermented relevant product.

It can be concluded that PSM could be more effective in increasing HDL-C level and decreasing LDL-C level than SM.

Development of human studies on PSM is suggested in the future that could improve the finding of this study. Furthermore, formulation of PSM for human consumption considering the society's attitudes toward drinkable SM can be considered in future studies.

A noticeable difference in serum LDL-C levels (9.33 vs. 15.33) between compared groups in the baseline could be regarded as a limitation of this study which may interfere with the obtained results on serum LDL-C. Characterization of serum LDL-C and HDL-C in the tested rats before their grouping would have rectified such a source of error. Nevertheless, this may restrain the sampling randomization.

Conclusion

Probiotic SM by LA7 could provide higher HDL-C levels and lower LDL-C levels in comparison with

plain SM. It seems PSM may be more effective in controlling diabetes and reduction its complications associated with atherosclerosis.

Acknowledgments

The authors would like to thank the staff of Food Security Research Center and The Research Center Of Agricultural Science And Natural Resources, Isfahan, for their valuable assistance in this project. This study was extracted from MSc. dissertation which was approved by School of Nutrition and Food Sciences, Isfahan University of Medical Sciences (code 392322).

Conflict of Interests

Authors have no conflict of interests.

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How to cite this article: Babashahi M, Mirlohi M, Ghiasvand R, Azadbakht L. **Comparison of soymilk and probiotic soymilk effects on serum high-density lipoprotein cholesterol and low-density lipoprotein cholesterol in diabetic Wistar rats.** ARYA Atheroscler 2015; 11 (Suppl 1): 88-93.

Soy product consumption and association with health characteristics and dietary quality indices in Isfahan, Iran

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Original Article

Abstract

BACKGROUND: To determine the average intake of soy products and its association with socio-demographic, general and health characteristics, and dietary quality indices among the population of Isfahan, Iran.

METHODS: In this descriptive cross-sectional study conducted on 491 subjects in 2013-2014, grocery stores, nuts stores, chain stores, and supermarkets from different areas of Isfahan Municipality were visited. Shop owners were asked to report the amounts of soy products sales (soy nut, processed soy protein, soy milk and soy yogurt). Furthermore, a food frequency questionnaire was completed from 496 customers by an experienced nutritionist. Mean sales and intake of soy products and dietary intakes including dietary quality indices and mean adequacy ratio (MAR) as well as anthropometric and socio-demographic variables were assessed.

RESULTS: Soy protein and soy yogurt are the highest [673 ± 81 (g/month)] and lowest [420 ± 148 (g/month)] purchased soy products, respectively. While soy nut [63 ± 10 (g/month)] was consumed to the lowest amount, soy protein [236 ± 39 (g/month)] was the most consumed soy product. Subjects with higher consumption of soy products were older and had higher intake of protein, vitamin C, zinc and iron, and lower intake of whole grains, legumes, and vegetables as well as greater values of MAR and dietary diversity score as well as nutrient adequacy ratio for vitamin C.

CONCLUSION: Soy protein is the most purchased and consumed soy product among people living in Isfahan. More intakes of whole grains and vegetables among those with higher consumption of soy foods could define greater quantities of zinc, iron and vitamin C in the diet. Soy consumption had a reverse correlation with body mass index.

Keywords: Soy Products, Isoflavones, Food Frequency Questionnaire, Iran

Date of submission: 27 Aug 2014, ***Date of acceptance:*** 22 Nov 2014

Introduction

Soy products are considered as a functional food having beneficial effects on the heath as they are rich in phytoestrogens, notably isoflavones.[1,2] Besides phytoestrogens, other contents of soy foods including fiber, lipid and peptides are also responsible for these healthy benefits.[3] Epidemiologic studies suggest that soy foods are reverse contributors to many diseases including Type 2 diabetes,[4,5] blood pressure,[6] chronic diseases,[3,7,8] certain cancers,[9-11] and menopausal flushes.[12]

Several reports based on the average intake of soy products and phytoestrogens are available worldwide. Higher intake of phytoestrogens were observed in northern European countries (non-Mediterranean countries) than southern countries (Mediterranean countries), with a maximum intake in UK.[13] A cohort of patients participated in European prospective investigation into cancer and nutrition study found that consumption of soy foods is low in Western European countries and only 1.5% of males and 2.1% of females reported soy consumption.[14] Moreover, reports from Asian

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population showed a much more amounts of intake compared with western population. Japanese adults consume approximately 6-11 g of soy protein and 25-50 mg of isoflavones per day[15] and daily intake of total isoflavones was 7.8 ± 5.6 mg among midlife Chinese women in Hong Kong.[16] Besides the average intake of soy products, the sources of soy foods are also different worldwide. Dairy products are the most used soy substitutes among European subjects,[14] while it is traditional soy products for Asian individuals.[17,18]

Earlier studies revealed that higher dietary diversity score (DDS) were associated with healthier dietary intake in Iran.[19] High intake of soy products among western individuals may be a marker of healthier habitual lifestyle.[14] However, it is not determined whether it is true in Iran or not. Moreover, there was a reverse association between DDS and obesity.[20] Furthermore, it was always believed that soy foods are more consumed among low-income adults, and that is not related to healthy eating.

Although the average intake of soy products has been estimated in Asian population, few reports have been published from the Middle-East countries. Considering the fact that beneficial effects of these products on risk factors of chronic diseases have been proved by many clinical trials in Iran,[3,8,21,22] it is not yet determined how many percent of Iranian population are soy consumers.

Therefore, we conducted this study to determine the average consumption of soy products in Esfahan city of Iran and to evaluate its association with general and health characteristics and dietary quality indices.

Materials and Methods

In this descriptive cross-sectional study conducted on 491 subjects in March 2013 to September 2014, grocery stores, nuts stores, chain stores, and supermarkets from different areas of Isfahan, Iran, Municipality were visited. Isfahan Municipality was divided into five areas considering people's socio-economic status. Considering the population of Isfahan city, five grocery stores, nuts stores, chain stores (including Refah, Kowsar, and Etka shops or any available hypermarket in that area) or supermarkets were randomly selected from each area using a computer based program. When the stores' locations were reconciled with all areas of Isfahan Municipality, at least two stores accepted to cooperate in every municipality area, and they reached to three in some areas. Some areas included all grocery stores, nuts stores, chain stores or supermarkets but some others included only one grocery store or one of the three nuts store, chain store or supermarket. Eventually, 39 grocery stores, nuts stores, chain stores, and supermarkets agreed to report their sales statistics. Every available soy product in Iran (soy nut, processed soy protein, soy milk, and soy yogurt) were listed in a questionnaire so that the amounts of monthly soy products sales were asked after interviewing shop owner or supervisor.

We included all customers aged 20-60 years who agreed to participate in this study. Finally, 496 subjects agreed to complete a food frequency questionnaire (FFQ). Under reporters (< 800 kcal/day) and over reporters (> 4200 kcal/day) of energy intake or those not reported more than 40 items of FFQ were excluded from the study and the analysis were performed on 491 subjects. A paper containing nutritional recommendations was given to the individuals accepted to participate in this study to thank their cooperation. This study was approved by the Isfahan University of Medical Sciences, and it was ethically confirmed.

To assess the usual daily intake, a semi-quantitative FFQ with 168 items was used. The reliability and validity of this questionnaire has been approved previously.[23] The four mentioned soy products were added specifically into this FFQ. Therefore, the final items were 172 items in the FFQ. The frequency of consumption was reported according to a given serving of each food item during the previous year on a daily (e.g., bread), weekly (e.g., rice, meat), or monthly (e.g., fish) basis. Daily intake of all food items from FFQ was computed. Then we used household measures to convert consumed foods to grams. A registered dietitian was responsible for fulfilling the questionnaires. We analyzed the data obtained from FFQ using Nutritionist III 7.0 (N-Squared Computing, Salem, OR, USA) refined for Iranian foods.

To calculate nutrient adequacy ratio (NAR), we used the ratio of daily individual intakes to standard recommended amounts for each group of the subject's sex and age.[24] Since the recommended dietary allowances (RDA) revises every 10 years and the new form of RDA is dietary reference intake (DRI) and RDA includes DRI, we used RDA and DRI and daily individual intakes to collect the standard recommended amounts using FFQ. The NAR for nine nutrients important to us including vitamin E, vitamin B6, vitamin A, vitamin B2, vitamin C, calcium, iron, zinc, selenium, the most deficient micronutrients previously mentioned,[19] was estimated. Mean adequacy ratio (MAR) was

calculated as the sum of NARs divided by the number of nutrients (n = 9).[19]

The method described by Kant et al. was used to score dietary diversity.[25,26] According to the food guide pyramid of the U.S. Department of Agriculture (USDA), we propounded five groups including bread grains, vegetables, fruits, meats, and dairy.[27] The main groups were divided into 23 subgroups. The maximum and minimum scores of diversity for each five main food groups were 2 and 0. The sum of these five scores showed the total score which means the total DDS varies from 0 to 10.

Healthy eating index (HEI) was calculated according to Kennedy et al. method,[28] based on 9 components indicating different aspects of a healthy diet. Grains, vegetables, fruits, milk and meat groups were considered as the first five components of the HEI. Components number 6, 7, and 8 represent the total percent of fat, saturated fatty acids, and cholesterol intake, respectively. Component number 9 was used to calculate the dietary variety score. Diets with < 30% energy from fat, < 10% energy from saturated fat and < 300 mg cholesterol received a full score of 10 points. To determine the dietary variety, total number of different foods and food groups consumed over 2 days was counted to calculate HEI score. Of all food groups, foods were counted only if they contributed at least one-half of a serving. The frequency of the number of food items eaten was calculated over the FFQ. We contributed 18 and 8 to the most and least frequent value of variety, respectively. Therefore, the score of 10 was considered for the value of 18 and more, and the score of 0 was considered for the value of 8 and fewer. The total score of HEI was 90. Higher score indicates better compliance of subjects to recommendations of the food guide pyramid and dietary guidelines. The calculation method of HEI score was modified according to the USDA procedures.[29] Considering the numbers of foods consumed by the population of this study, we assessed the variety score.[30]

Digital scales were used to measure weight while subjects were clothed minimally. A tape measure was used to measure height while subjects were standing in a position which their heels, but, shoulders and head backed against the wall. Weight (in kg) divided by height (in m^2) to calculate body mass index (BMI).

Some individuals did not cooperate even though our dietitian was equipped with the scale and meter. Hence, we used the self-administered method to ask the anthropometric characteristics of all the subjects. Of 496 invited customers, 412 individuals accepted to be measured by the dietitian and the rest of them did not. Hence, we gathered the self-administered method for the remained subjects. By the way, a favorable correlation was observed between statements and measures, therefore, the same statements were considered for the rest.

Subjects were asked for the socio-economic situation by a pre-tested question including the number of family members, education, being a homeowner or tenant, kind of job and having a car. Subjects were scored according to the mentioned variables. Good socio-economic were used for subjects in the third tertile of the score. Those in the first and second tertiles were categorized as poor and moderate socio-economic status, respectively.

To ensure the normal distribution of variables, we used histogram and Kolmogorov–Smirnov tests. We first categorized soy products according to the tertiles of consumption. Then we used analysis of variance for comparing different groups. Analysis of covariance was used for those adjusted for energy intake and other confounders. All the individual intakes of soy products and tertiles of soy products intake among subgroups of general and health characteristics, DDS and HEI were adjusted for energy intake We described continuous variables as means and standard deviations and categorical variables as numbers or percent's. $P < 0.05$ was considered as significant. Using the χ^2 test, distribution of participants in terms of categorical variables was examined. Statistical analyses were carried out by the use of Stata, (version 11.2, Stata Corp, College Station, TX).

Results

Table 1 exhibits the amount of purchased soy products according to the seller's report as well as the quantities of soy food intakes based on the reports of the individuals in response to FFQ. Accordingly, soy protein (g/month) and soy yogurt (g/month) are the highest (673 ± 81), and lowest (420 ± 148) purchased soy products, respectively. While soy nut (63 ± 10) was consumed to the lowest amount, soy protein (236 ± 39) was the most consumed soy product.

Table 2 includes information about socio-demographic characteristics of subjects according to the tertiles of soy products. The findings show that older persons consume higher amounts of soy products. However, there was no significant difference for sex, socio-economic status, and number of children among tertile of soy consumption.

General and health characteristics of participants are reported in table 3. While there was no significant difference for family history of the

subjects, mean BMI was lower among those subjects in the highest tertiles of soy products.

We explained the dietary intakes of subjects in table 4 according to the tertiles of soy products. Those subjects in the higher tertile of soy products intake had higher protein consumption (P = 0.03). The results demonstrated that the intakes of vitamin C, zinc, and iron were higher in the third tertile of soy consumption compared with the first tertile. Subjects in the lowest tertile of soy products intake consumed less whole grains, legumes, and vegetables.

Table 5 describes the dietary quality indices for participants' diet according to the tertiles of soy product consumption. Those with higher amounts of soy products intake had greater values of MAR as well as NAR for vitamin C. Although there was no significant association between other indices of dietary quality, the findings for DDS are marginally significant.

Table 1. The amount of purchased and consumed soy products during a month*

Soy products**	Purchased (mean ± SD)***	Consumed (mean ± SD)§,€
Soy nut (g/month)	661 ± 52	63 ± 10
Soy protein (g/month)	673 ± 81	236 ± 39
Soy milk (cc/month)	480 ± 53	193 ± 69
Soy yogurt (g/month)	420 ± 148	105 ± 54

* ANCOVA test was used for analysis of the amount of soy product consumption while were adjusted for energy intake; ** As the amounts of different packages of soy nut, soy protein, and soy yogurt were not equal, we calculated the amount of packages and reported in grams; *** Values are based on the amount of purchased products obtained from sales statistics; § All intakes of subjects were adjusted for energy intake; € Values are based on individual intakes reported as FFQ; FFQ: Food frequency questionnaire; SD: Standard deviation

Table 2. Sociodemographic characteristics of subjects according to the tertiles of soy products*

Variables	Tertiles of soy products**			P
	1	2	3	
Age (year)	39.1 ± 3.8	45.3 ± 4.3	58.5 ± 4.9	0.01
Sex				
Male [n (%)]	51 (31.0)	60 (38.0)	51 (31.0)	0.21
Female [n (%)]	109 (33.0)	110 (33.5)	110 (33.5)	
Socioeconomic status [n (%)]				
Good	21 (12.9)	29 (16.9)	38 (23.6)	0.09
Moderate	111 (69.5)	124 (73.2)	113 (70.3)	
Poor	28 (17.6)	17 (9.9)	10 (6.1)	
Number of children [n (%)]				
≤ 2	64 (39.9)	77 (45.6)	81 (50.1)	0.23
3-4	88 (55.1)	93 (55.4)	75 (46.7)	
> 4	8 (5.0)	0 (0.0)	5 (3.2)	

* ANCOVA which was adjusted for energy intake was used for quantitative variables and χ^2 was used for qualitative variables; **All the tertiles of soy intakes were adjusted for energy intake by ANCOVA

Table 3. General and health characteristics of subjects according to the tertiles of soy products*

Variables	Tertiles of soy products**			P
	1	2	3	
BMI (kg/m^2)	26.1 ± 3.5	26.2 ± 3.7	25.1 ± 3.3	0.01
Weight (kg)	79.8 ± 16.3	74.6 ± 11.4	67.3 ± 10.1	0.01
Family history of diseases n (%)				
Diabetes	56 (35.2)	66 (38.7)	63 (39.3)	0.42
Obesity	58 (36.5)	61 (35.6)	61 (37.6)	0.38
High blood pressure	66 (41.1)	67 (39.5)	62 (38.7)	0.43
Osteoporosis	69 (43.3)		63 (38.9)	0.33

* ANCOVA test which was adjusted for energy intake was used for quantitative variables and χ^2 was used for qualitative variables; ** All the tertiles of soy intakes were adjusted for energy intake; BMI: Body mass index

Table 4. Dietary intakes of subjects according to the tertiles of soy products*

Dietary intakes	Tertiles of soy products**			P
	1	2	3	
Energy	2871.0 ± 131.0	2639.0 ± 142.0	2730.0 ± 170.0	0.11
Carbohydrate (% of calorie)	56.5 ± 16.7	58.5 ± 13.9	57.3 ± 15.1	0.16
Fat (% of calorie)	37.1 ± 901	34.2 ± 8.5	30.1 ± 79	0.05
Protein (% of calorie)	6.4 ± 2.0	7.3 ± 1.9	12.6 ± 2.3	0.03
Vitamin C (mg/d)	49.6 ± 19.2	40.3 ± 20.0	56.1 ± 17.0	0.01
Vitamin B2 (mg/d)	2.6 ± 1.1	2.3 ± 1.0	2.4 ± 1.2	0.21
Vitamin B6 (mg/d)	2.5 ± 1.2	2.4 ± 1.5	2.3 ± 1.1	0.23
Calcium (mg/d)	933.5 ± 129.2	896.1 ± 134.5	910.2 ± 156.3	0.16
Iron (mg/d)	9.0 ± 2.3	8.1 ± 2.0	11.9 ± 3.6	0.01
Zinc (mg/d)	256.6 ± 93.2	217.6 ± 80.6	299.3 ± 78.6	0.01
Food groups				
Whole grains (g/d)	33.6 ± 51.5	30.1 ± 34.3	61.1 ± 51.5	0.01
Refined grains (g/d)	399.1 ± 109.5	363.3 ± 98.5	370.1 ± 100.9	0.16
Fruits (g/d)	291.1 ± 80.5	393.2 ± 67.6	381.3 ± 59.3	0.31
Vegetables (g/d)	229.2 ± 31.3	301.2 ± 39.6	279.6 ± 29.7	0.03
Red meat (g/d)	84.3 ± 11.6	71.2 ± 9.3	70.3 ± 10.5	0.05
Fish and poultry (g/d)	44.3 ± 10.3	32.5 ± 9.3	38.7 ± 9.5	0.17
Dairy (g/d)	339.5 ± 101.3	306.2 ± 90.0	311.7 ± 96.5	0.27
Legumes	29.1 ± 6.1	39.2 ± 5.3	53.2 ± 7.9	0.01

* ANCOVA was used for energy adjustment in quantitative variables; ** All the tertiles of soy intakes were adjusted for energy intake except for reporting the amount of energy

Table 5. Dietary quality indices of subjects' diet according to the tertiles of soy products*

Dietary intakes	Tertiles of soy products**			P
	1	2	3	
Energy density (Kcal/g)	1.50 ± 0.40	1.30 ± 0.40	1.20 ± 0.30	0.06
DDS	5.90 ± 1.00	6.70 ± 1.20	6.80 ± 1.20	0.03
HEI	56.10 ± 7.90	61.20 ± 8.30	60.30 ± 8.60	0.16
MAR	10.00 ± 1.70	11.20 ± 2.10	12.60 ± 2.00	0.02
NAR of different nutrients				
Zinc	0.91 ± 0.23	0.87 ± 0.29	0.89 ± 0.31	0.24
Vitamin B6	0.89 ± 0.16	0.89 ± 0.19	0.87 ± 0.18	0.53
Iron	0.88 ± 0.17	0.85 ± 0.21	0.83 ± 0.19	0.41
Calcium	0.93 ± 0.26	0.91 ± 0.27	0.90 ± 0.25	0.32
Vitamin C	0.87 ± 0.19	0.90 ± 0.21	0.96 ± 0.21	0.03
Vitamin B2	1.11 ± 0.21	1.23 ± 0.26	1.24 ± 0.29	0.16
Vitamin E	1.59 ± 0.36	1.57 ± 0.33	1.61 ± 0.39	0.17
Vitamin A	1.59 ± 0.33	1.60 ± 0.30	1.61 ± 0.31	0.22
Selenium	1.23 ± 0.36	1.36 ± 0.37	1.32 ± 0.34	0.26

* ANCOVA test was used for energy adjustment in quantitative variables; ** All the tertiles of soy intakes were adjusted for energy intake except for reporting the amount of energy; DDS: Dietary diversity score; HEI: Healthy eating index; MAR: Mean adequacy ratio; NAR: Nutrient adequacy ratio

Discussion

The results show that soy protein is the most purchased and consumed soy products among people living in Isfahan. The same findings of both the most purchased and consumed soy product indicate the conformity of the reported information. The least purchased and consumed products are soy yogurt and soy nut, respectively. By the age raises, the consumption of soy products increases. There is an inverse association between BMI and soy intake. More intakes of soy products are related to higher consumption of protein, vitamin C, zinc and iron intake and increased NAR, MAR, and DDS. Low intake of soy products is associated with lower consumption of whole grains and vegetables.

Studies have shown that soy intake is based mostly on easily accessible and ready-to-eat products in Western Europe and thus different from traditional soy products consumed by Asian population.[14] Our results revealed that the most

purchased and consumed soy product was soy protein. This shows an increasing approach toward modern soy products among Isfahan's people. However, soy nut were consumed at the minimum level, probably due to being a new product among Iranians and the fact that soy nut is not a baking form of soy products and is mostly used as a snack.

A Chinese study revealed that women aged 41-50 years had lower consumption of soy products compared with both younger and older women. Education level had also a direct relationship with soybean intake due to better understanding of soybean benefits. Moreover, women without a medical history of chronic disease consumed more soy foods than those engaged in chronic or digestive diseases.[31] Another study on Korean housewives demonstrated that the degree of perception and accompanied intake frequency had meaningful differences by age, education level, and economic level. Furthermore, taste and flavor showed great influence on the intake frequency of certain foods.[32] In contrast to previous findings, in this study we revealed a positive association between age and the consumption of soy products. But there was no significant relationship for sex, health, and economic conditions as well as number of children. High intake of soy products among older patients could be due to age-related diseases or health concerns regarding the prevention of chronic diseases. In agreement with previous studies,[33,34] we found that women consuming more soy products have lower BMI.

Among macronutrients, protein intake was higher in the last tertiles of soy consumption, but there were no changes in fat and carbohydrate intake. Iron, zinc, calcium, riboflavin, pyridoxine, and vitamin C were measured in the diet. More consumption of soy products is associated with higher intake of vitamin C, iron, and zinc. Studies have shown that women with higher intakes of soy foods were more likely to consume fruits and vegetables. Furthermore, they had a higher intake of total calories, fat, protein, dietary fiber, calcium, and folic acid, but a lower intake of carbohydrates.[35,36] Outcomes from our data revealed that subjects in the higher tertiles of soy consumption were likely to have higher intake of zinc, iron, and vitamin C which is because of higher intake of whole grains, rich in zinc and iron, and vegetables, rich in vitamin C. Although the consumption of animal sources of protein is low in the third tertile of soy intake, legumes are significantly consumed more among subjects with higher intake of soy products. Therefore, the vegetable sources of proteins may define the greater share of proteins in their diets.

To assess the quality of diet based on nutrient intake, we measured 4 indices including energy density (kcal/g),[37] DDS for food security detection, HEI for food guide conformance assessment and MAR. There were higher values of DDS and NAR for vitamin C and MAR but not HEI for those in a higher amount of soy consumption. More consumption of vegetables and whole grains in the highest tertiles of soy intake indicates higher values of MAR. Since the HEI is based on food groups, and we could not bring out any significant results for most of the HEI components, no significant finding was obtained for HEI in higher amount of soy intake.

Higher intake of carbohydrates is significantly associated with many risk factors of cardiovascular diseases. The consumption of potato and other carbohydrates are considerably increased among Iranian population.[38] Therefore, adding healthy foods including soy products as a substitute can decrease the consumption of simple carbohydrates.

Some strength could be considered for the current study. First, this is the first study which reports the whole intake of soy products and their subgroups as well as socio-demographic characteristics and individual intakes among the Iranian population. Second, since current study covers all municipalities of Isfahan city, the results represent the average intake of Isfahan's people. Although there are no data from other cities of Iran, the same distribution of soy products can generalize our results to other states. Prior studies considered a substantial role for soya preventing multiple chronic diseases,[7] so the results are expected to be used in improvement of nutrition education programs in order to recommend a sufficient intake of soy products and this is another strength of our findings. Although we asked all the individuals to participate in the study, few people did not accept to cooperate. This will reduce the generalization of study to some extent. Low cooperation of the subjects and shop owners as well as the possible not considered confounders are other limitations of our study.

Conclusion

In conclusion, soy protein is the most purchased and consumed sot product among Isfahans' residents. Inverse association was seen between BMI and soy intake. Higher intake of soy products is associated with more consumption of whole

grains and vegetables defining the greater share of zinc, iron, and vitamin C in the diet. Future analysis of the phytoestrogen content of separate consumed foods needs to be performed on the Iranian population. Moreover, assessment of soy products consumption in the other cities of Iran can provide a comprehensive data.

Acknowledgments

We thank the shop owners and those people who cooperate in this project, and the Food Security Research Center provided the facility to perform this study.

Conflict of Interests

Authors have no conflict of interests.

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How to cite this article: Sadeghian M, Hajishafiee M, Izadi V, Vahidianfar F, Azadbakht L. **Soy product consumption and association with health characteristics and dietary quality indices in Isfahan, Iran.** ARYA Atheroscler 2015; 11 (Suppl 1): 94-101.

Association of chemerin levels with anthropometric indexes and C-reactive protein in obese and non-obese adolescents

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Original Article

Abstract

BACKGROUND: Obesity is a low-grade chronic inflammation. This epidemic is growing in different age groups including adolescents. It is accompanied with a decrease in the age for incidence of obesity-related disorders. Chemerin, as a chemokine and stimulator of anti-inflammatory adiponectin, links immune system, adipose tissue and inflammation. It may be useful in predicting obesity in the hit phase of life. This study aims to assess serum chemerin and adiponectin in relation to the inflammation and obesity indices.

METHODS: This case-control study was conducted on 82 adolescent girls, aged12-18 years. They were categorized based on the percentiles of the body mass index (BMI).Serum chemerin, adiponectin, high-sensitive C-reactive protein (Hs-CRP), body fat mass and its percent, waist circumference (WC) ,hip circumference (HC) were measured; BMI and waist-to-hip ratio (WHR)were calculated. Data were analyzed by independent Student's t-test and Pearson correlation; path analysis was conducted, as well.

RESULTS: We found a negative significant association between chemerin and adiponectin levels in both obese and non-obese groups($r = -0.387$, $P = 0.014$ vs. $r = 0.362$, respectively, $P = 0.018$). Serum chemerin was higher in obese than in non-obese adolescents (441.83 ± 47.79 vs. 409.30 ± 66.12 µg /l, respectively, $P = 0.012$), whereas mean adiponectin level was lower in obese participants than in the other group (4.79 ± 0.94 versus 5.2 ± 0.53µg/ml, respectively, $P = 0.016$). Chemerin concentrations had significant positive correlation with Hs-CRP levels, BMI, WC, HC, WHR, body fat mass and its percent ($P < 0.05$).

CONCLUSION: Chemerin concentrations were associated with and adiponectin levels in obese girl adolescents, negatively. Hs-CRP, BMI, WC, HC, WHR, body fat mass and its' percent were in positive relation with chemerin levels, and inverse association with serum adiponectin concentrations. Our findings suggest that chemerin can be considered as an early marker of the inflammatory process in obesity.

Keywords: Chemerin, Adiponectin, Obesity, Inflammation, Adolescents

Date of submission: 1 Sep 2014, ***Date of acceptance:*** 15 Nov 2014

Introduction

Obesity is a growing health problem which is accompanied with increasing the rate of morbidity and mortality.[1] During the recent decades, the prevalence of obesity in childhood and adolescent is doubled.[2] The probability of being obese adults is higher in obese adolescents and this risk is much higher in girls.[3] Unfortunately, the incidence of obesity-based diseases is increasing sharply in recent years and its' control need to urgent programming among adolescents.[4]

Obesity is an excess of white adipose tissue (WAT) which is known by chronic inflammation of adipose tissue.[5] The pathophysiologic mechanisms that link the inflammation of obesity and obesity-related disorders to the innate and adaptive immune system may be based on the multifunctional roles of adipose mass. Adipose tissue is a fat supply[6] and endocrine organ. It can be effective in energy balance and macronutrient metabolism.[6,7]

One of its' pro-inflammatory adipokine is chemerin which has autocrine and paracrine roles in

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enhancing the adipocyte differention[1,7] and lipolysis of WAT.[1,7] It reflects chemokine roles in leukocytes direction and the recruitment of antigen presenting cells[1,8] such as macrophage[1,9,10] dendritic cells (DC),[9,10] and natural killer cells.[9,10] Furthermore, chemerin is an adiponectin secretion stimulator and adiponectin gene expression is reduced in chemerin knockdown cells.[7]

Adiponectin is characterized as an anti-inflammatory[11] and anti-atherogenic adipokine.[12] It can suppress adipocytes differention[12] and it's effect is mediated by increasing cyclic adenosine monophosphate (cAMP) accumulation,[13] while chemerin effects in managing cell metabolism, mediated by stimulating calcium release and inhibiting cAMP accumulation supply.[14,15]

The controversial observation about the functions of mediated second massagers attracted us to study serum levels of these adipokines in obese adolescents. Hence, the main goal of this study is assessing chemerin levels in relation to adiponectin concentrations and general and central obesity and inflammation index in girl adolescents for the first time.

Materials and Methods

This is a case–control study which was conducted on 82 healthy non-athlete and non-smoker girl adolescents sampled from Sadigheh-Tahereh Hospital, Isfahan, Iran.[16] They were between 12 and 18 years old. Detailed medical and family history was checked. Participants had been matched based on their mentioned variables, individually. Their exclusion criteria were determined as having any history of chronic, inflammatory, infective, metabolic or endocrine diseases and taking any drugs or supplements. The informed written consent was achieved from the parents of all of the adolescents and participants who accepted to participate.

The survey was performed from August 2010 to December 2010. The participants were divided by CDC percentiles of body mass index (BMI) according to the age and sex.[2,17] The obese group is defined based on BMI percentile > 95th and the normal-weight group is described as having BMI percentile 5-85th, they were matched according to age and sex.[18]

The height was assessed using calibrated Seca meter to the nearest 0.1 cm at maximal respiration (SECA, Hamburg, Germany).[2] Their weight was measured by Seca scale closest to 0.1 kg in barefoot and light dress, after emptying urinary and GI apparatuses (Seca Model 770, Hamburg, Germany). BMI was calculated as dividing weight by the square of height (kg/m^2).[19]

The waist circumstance (WC)[2] was determined at the point midway between the superior border of the iliac crest and lower border of the rib cage using non-elastic tape nearest to 0.5 cm at the normal expiration, and their hip circumstance (HC) was measured to the nearest 0.5 cm at the widest part of the hip at the levels of the greatest trochanter by a non-stretchable tape meter.[2] The waist to hip ratio (WHR) was computed from dividing waist by HC.[17]

The body fat percent was measured by bioelectrical impedance analysis (BioScan 916 Maltron, Rayleigh, UK).[20] The participants puberty were assessed according to the criteria of Tanner stage by general physician.[17,21] All of the measurements were performed by informed expert.

The blood sample was taken from the antecubital venous after 10 h of overnight fast between 8 and 10 AM. Blood sample were centrifuged for 15 min at 4500 g within 30 min of sampling and frozen at −70 °C.[22]

Serum chemerin levels were determined by an enzyme-linked immunosorbent assay (ELISA) (BioVendor Research and Diagnostic Products, Inc., Modrice Czech Republic). The detection limit of the assay was 0.13 μg/l, and the intra-assay and inter-assay coefficient of variation (CV) were 7 and 6.9%, respectively.[23-25]

Serum adiponectin was measured by ELISA method, Orgenium Laboratories, Inc. (AviBion Human Adiponectin (Acrp30) ELISA Kit, Helsinki, Finland) the intra-and inter assay CVs are ≤ 10 and ≤ 12% respectively.[19] High sensitive C-reactive protein (Hs-CRP) was measured by ELISA (DRG-Diagnostica, Marburg, Germany); the intra- and inter assay CVs are 5.1 and 14.3%, respectively.[26]

Data were analyzed using SPSS software (version 15.0, SPSS Inc., Chicago, IL, USA) and AMOS software (version 16, ADC, Chicago, IL). Distribution of parameters were checked for normality using Kolmogrov–Smirnov test. All variables were compared using independent Student's t-test between two groups. Pearson correlation tests were used to analysis the bivariate associations of variables. Path analysis was performed using weighted least squares procedures to explore whether Hs-CRP mediated the relation between adiposity and adipokines. Variables without normal distribution had been transformed, statistically. Standardized path coefficients and t-values are provided. The final model was completely saturated, with degrees of freedom equal to zero.

Descriptive fit indices, comparative fit index, root mean square error of approximation and goodness-of-fit for the models were acceptable. The threshold for analysis assess was set at $P < 0.05$.

Results

A sample consisted of 40 obese and 42 normal-weight girl adolescents were studied. Demographic and clinical characteristics of the population are presented in table 1. Participants were categorized in post-pubertal stage (Stage V). There was not significant difference between demographic characteristics of participants (data not shown). There was a negative association between chemerin and adiponectin levels in both groups (Pearson correlation, $r = -0.387$, $P = 0.014$ vs. $r = -0.362$, $P = 0.018$, respectively). Chemerin levels were higher in obese group than normal-weight adolescents. There was a positive association between chemerin levels and BMI in all of the adolescents, significantly. The same association was seen between chemerin concentrations and WC (Pearson correlation, $r = +0.451$, $P = 0.004$ vs. $r = 0.317$, $P = 0.041$, respectively), HC (Pearson correlation, $r = +0.338$, $P = 0.036$ vs. $r = +0.349$, $P = 0.027$, respectively), WHR (Pearson correlation, $r = +0.419$, $P = 0.007$ vs. $r = +0.325$, $P = 0.036$, respectively), body fat mass (Pearson correlation, $r = +0.366$, $P = 0.020$ vs. $r = +0.352$, $P = 0.028$, respectively) and its' percent (Pearson correlation, $r = +0.416$, $P = 0.008$ vs. $r = +0.423$, $P = 0.005$). We found a positive correlation between serum chemerin and Hs-CRP levels in obese adolescents (Pearson correlation, $r = +0.325$, $P = 0.047$). There adiponectin levels were higher in normal-weight girls than obese group ($P = 0.018$). Adiponectin concentrations was inversely correlated with BMI (Pearson correlation, $r = -0.369$, $P = 0.019$ vs. $r = -0.421$, $P = 0.018$, respectively), WC (Pearson correlation, $r = -0.427$, $P = 0.007$ vs. $r = -0.423$, $P = 0.005$, respectively), HC (Pearson correlation, $r = -0.390$, $P = 0.014$ vs. $r = -0.333$, $P = 0.036$, respectively), WHR (Pearson correlation, $r = -0.361$, $P = 0.022$ vs. $r = -0.312$, $P = 0.044$, respectively), body fat mass (Pearson correlation, $r = -0.528$, $P < 0.0001$ vs. $r = -0.346$, $P = 0.031$, respectively) and its' percent (Pearson correlation, $r = -0.386$, $P = 0.014$ vs. $r = -0.340$, $P = 0.028$, respectively) in obese and normal-weight girls ($P < 0.05$).We observed a negative association between adiponectin and Hs-CRP concentrations in obese adolescents (Pearson correlation, $r = -0.361$, $P = 0.026$). Estimated value for the standardized regression weights of the relation between chemerin and adiponectin levels with general, central obesity indices and Hs-CRP are shown in table 2. Path analytical diagram between chemerin, adiponectin and obesity indices is represented in figure 1.

Table 1. Anthropometric, demographic and biochemical data from the study girl adolescents (n = 82)

Variables	Groups		P
	Obese adolescents (n = 40)	Non-obese adolescents (n = 42)	
Age (year)	13.90 ± 1.80	14.63 ± 2.22	0.1070
Weight (kg)	75.70 ± 7.55	49.20 ± 3.10	< 0.0001*
BMI (kg/m^2)	29.50 ± 2.22	19.00 ± 0.77	< 0.0001*
Body fat mass (kg)	27.20 ± 4.03	11.80 ± 3.20	< 0.0001*
Body fat (%)	37.80 ± 2.94	23.80 ± 4.86	< 0.0001*
WC (cm)	95.30 ± 6.85	73.90 ± 5.03	< 0.0001*
HC (cm)	110.00 ± 5.30	92.50 ± 4.20	< 0.0001*
WHR (cm/cm)	0.85 ± 0.04	0.79 ± 0.46	< 0.0001*
Hs-CRP (mg/dl)	3.80 ± 2.42	0.78 ± 0.68	< 0.0001*
Adiponectin (µg/ml)	4.79 ± 0.94	5.20 ± 0.53	0.0160*
Chemerin (µg/l)	441.83 ± 47.49	409.30 ± 66.12	0.0120*

* Statistically significant differences between obese and normal-weight participants ($P < 0.05$ is significant); The comparisons were done using independent Student's t-test; Results are presented as mean ± standard deviation; BMI: Body mass index; WC: Waist circumstance; HC: Hip circumstance; WHR: Waist to hip ratio; Hs-CRP: High sensitive C-reactive protein

Table 2. Estimated value for the standardized regression weights of the relation between chemerin and adiponectin levels with general, central obesity indices and Hs-CRP

Variables	BMI (kg/m^2)	HC (cm)	WC (cm)	Hs-CRP (mg/dl)	P
Chemerin (µg/l)	0.03	0.05	0.06	0.01	< 0.05
Adiponectin (µg/dl)	-1.62	-3.66	-5.16	-1.00	< 0.05

BMI: Body mass index; HC: Hip circumference; WC: Waist circumference; Hs-CRP: High sensitive C-reactive protein

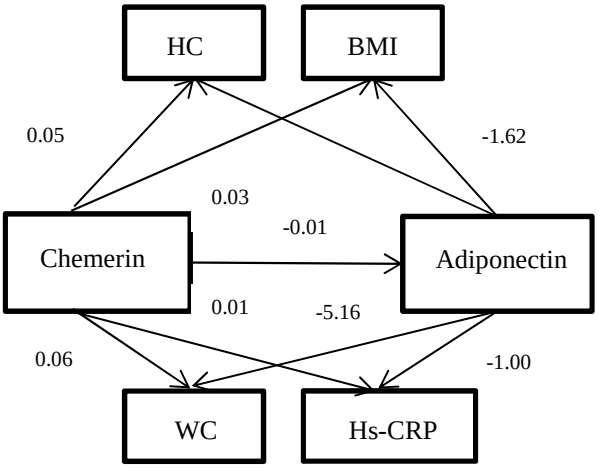

Figure 1. Path analytical diagram between chemerin, adiponectin and obesity indices
HC: Hip circumference; BMI: Body mass index; WC: Waist circumference; Hs-CRP: High sensitive C-reactive protein

Discussion

To our knowledge, it is the first study that found a negative relation between chemerin and adiponectin levels in girl adolescents. A negative association was seen between chemerin and adiponectin mRNA expression in epicardial adipose tissue of patients.[3] Similar negative association was observed, peviously. However, Weigert et al. found non-significant association between these two adipokines.[27] Goralski et al. showed that chemerin knockdown gene decreased adiponectin expression,[7] and chemerin is introduced as a stimulator of adiponectin gene expression. Chemerin and its receptor secretion and function changes during adipogenesis, and its' gene transcription increases and chemokine like receptor 1 expression decreases during 3T3-L1 cells differention, and it could be compared with leptin resistance in obese subjects.[6] Higher concentrations of chemerin may be accompany with the desensitization of its receptor or obstruction of chemerin signaling during adipocytes differention.[7] The indirect association between chemerin and adiponectin concentrations may be based on a compensatory increase of chemerin levels. General obesity increases serum chemerin levels and chemerin gene expression is higher in obese subjects in comparison with leans and this observation were similar to the previous studies.[6,23,24,28] Similar to the previous findings, we seen positive association between chemerin levels and BMI,[3,22,27,29] central obesity indices including WC,[3,29-31] HC,[31] body fat mass[24,32] and its' percent.[6,28,31] Adolescents with higher central fat area had higher serum chemerin concentrations.[24,27,29,32] Serum Hs-CRP and chemerin levels were correlated positively and it is based on that low-grade inflammation of obesity,[5] which associated with increasing acute-phase proteins and pro-inflammatory cytokines levels[5] and increasing inflammatory markers release as the immune cells reflection.[5,12] The macrophage act as an antigen presenting cell and the existence of chemerin receptors on immature DCs shows the chemerin roles in the recruitment and migration of macrophage and premature DCs which can be known as a link between immune system functions and excessive adipose tissue.[33] Interleukin 6 production which can increase after infiltration of macrophages to adipocytes.[5,12] Induces CRP secretion, indirectly or there may be possibility that WAT act as the source of these factors.[12] Direct relation between BMI and CRP was seen, previously, too.[22,27,30-32,34] Our data indicated that girls with higher BMI percentile according to the age and sex had lower adiponectin levels like other studies.[11,16-17,35-38] This finding is as the same as negative correlation between adiponectin levels and BMI.[11,17,35,37-38] The negative correlation between serum adiponectin and WC was similar to Bottner et al. observation,[17] however, Vikram et al.[35] and Snehalatha et al. surveys[39] reflected no significant association that can be raised from not paying attention to the pubertal stages of subjects or different species of participants. There was a negative relationship between adiponectin levels and HC, like observation of Bottner et al. assessment.[17] Body fat mass and its percent showed a negative association with serum adiponectin concentration. Adolescents with higher body fat showed a lower adiponectin levels. This relation is as the same as findings of Vikram et al.,[35] Panagopoulou et al.,[11] Bauche et al.[37] and Snehalatha et al. studies.[39]

There was a negative association between serum adiponectin and CRP levels. This observation confirmed by a negative relation between adiponectin expression and CRP levels, and it can reflect the adipose tissue roles in the circulation source of CRP.[5] Adiponectin suppresses macrophage phagocytosis process[5,12] and it can affect on its cytokine expression. Several studies confirmed our finding,[40-42] while Wagner et al. study showed that CRP levels are lower in children group and it can be the base of non-significant association between CRP and adiponectin.[43] There were some limitations in the present study including the nature of cross-sectional study and small size of

participants, and hence future study on the larger number of the participants and in prospective study are recommended.

Conclusion

In conclusion, our study shows that serum chemerin concentrations were associated with general and abdominal obesity indices, adiponectin and Hs-CRP levels in obese adolescents. It may be based on a potent pathophysiologic link between adipokines and inflammation. These findings suggest that chemerin may be an mediated marker which reflect central and general obesity in response to the immunity status. Further research is suggested to confirm these observations and to assess serum chemerin levels in younger age and in various chemerin and adiponectin isoforms.

Acknowledgments

We wish to thank all the participants and their parents to participate in all study process, patiently.

Conflict of Interests

Authors have no conflict of interests.

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How to cite this article: Maghsoudi Z, Kelishadi R, Hosseinzadeh-Attar MJ. **Association of chemerin levels with anthropometric indexes and C-reactive protein in obese and non-obese adolescents.** ARYA Atheroscler 2015; 11 (Suppl): 102-8.

Is there any association between rice consumption and some of the cardiovascular diseases risk factors? A systematic review

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Review Article

Abstract

BACKGROUND: White rice is considered as a staple food in most population in the world, and there may be an association between rice intake and cardiovascular disease (CVD) risks. The present article was reviewed the correlation between rice intake and CVD and some of its risk factors.

METHODS: We searched in PubMed, Google scholar, and SCOPUS to February 2015 by using several keywords such as low and high density lipoprotein, triglyceride, total cholesterol, fasting blood glucose, CVD or risks, metabolic syndrome, diabetes, obesity, lipid profile, and refined grains or rice and white rice. Finally, 14 studies were included in our systematic review.

RESULTS: There was found a positive association between white rice intake and risk factors of CVD including metabolic syndrome and type 2 diabetes. Furthermore, it seems that there is no any significant correlation between white rice consumption and incidence of CVD and its mortality.

CONCLUSION: Finding from available data suggested the important roles of higher white rice consumption on CVD risk factors.

Keywords: White Rice, Refined Grains, Cardiovascular Disease, Metabolic Syndrome, Type 2 Diabetes

Date of submission: 15 Sep 2014, ***Date of acceptance:*** 22 Nov 2014

Introduction

Cardiovascular disease (CVD) is one of the main causes of mortality among the several population.[1] The incidence of CVD can be occurred results of many chronic problems including obesity, type 2 diabetes, and metabolic syndrome.[2] The mortality rate of CVD is rising not only in developed countries, but also in developing countries.[1] CVD mortality among men and women were 43% and 55% in developed countries, respectively.[1] Recent evidence suggested several risk factors contributing CVD including smoking, less physical activity, obesity, high blood pressure, and dyslipidemia.[3,4] Lifestyle related factors including dietary components are associated with the incidence of CVD. It seems that high-quality diet consumption is associated with lower risks of overweight and obesity which have the important role on CVD incidence.[5] High consumption of total carbohydrates is positively related to CVD risk factors.[6] Furthermore, as the refined grains (like white rice) increase, the serum glucose and lipid levels (risk factors of CVD) elevate.[7]

White rice is the most important sources of carbohydrate which is considered as the staple food in Asian people.[8,9] For example, white rice is one of the most predominant sources of energy and carbohydrate in Iranian population.[10] In additional, Koreans consume 37.9% of their total energy from rice.[11] Rice provides 43% of carbohydrate consumption in Japan.[6] Furthermore, the consumption of rice is reached to 6-8.5 serving per day in some countries.[12] In contrast, whole grains are the major components of healthy pattern and could able to prevent systemic inflammation and CVD, which are less consumed in these countries.[13] In contrast, whole grains are rich in many nutrients including dietary fiber, magnesium, vitamins, and phytoestrogen.[1,14] But white rice because of refining process and separation outer layer of bran, only contains the starch (endosperm) which may have unfavorable impacts on cardio-metabolic risk factors.[1]

Several studies have emphasized the role of energy density of foods on obesity, metabolic syndrome, and CVD risk.[15-18] The amount of dietary

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fiber is the main determinant of dietary energy density. Since white rice is poor in fiber and mineral because of the polishing process, could mention as the high energy-dense food.[5,8] In addition, quality of carbohydrate i.e. glycemic index (GI) and glycemic load (GL) have emerged as an important factor for development of chronic diseases like CVD.[19-21] The mean GI of white rice is approximately 64 which can be diverse according to the degree of processing, amylose content, and cooking time.[22] Several studies were searched into the correlation between refined rice and risk of CVD in different kinds of population Asian and western, but their results are inconsistent.[1,6,8-11,13,14,23-30] Consumption of refined rice was associated to lower risk of CVD mortality.[6] Furthermore, several investigations have not shown any significant association between rice intake and risk of coronary heart disease and total CVD.[31,32] Furthermore, there was no relation between refined rice and risk factors of CVD such as fasting blood glucose and serum lipid profile.[1] Whereas higher consumption of refined rice have led to metabolic syndrome, type 2 diabetes, and CVD.[8,9,23] Given the high prevalence of CVD and its components in the world and also importance of rice as the staple foods for many people in several countries especially in Asia and the probable correlation in this regard, we aimed to focus on available data regarding the association between white rice consumption and cardiovascular risk factors.

Materials and Methods

In order to investigate the association between white rice consumption and CVD and some of the risk factors of CVD, we searched in PubMed, Google scholar, and SCOPUS search engines from 1970 to February 2015, using the following key words for the topic: CVD or risks, metabolic syndrome, diabetes, obesity, overweight, dyslipidemia, lipid profile in combination with refined grains or rice and white rice.

Articles were screened by their title, and abstract and/or full texts were read when needed. Any human cross-sectional, clinical trial and prospective studies investigating the correlation between white rice and CVD risks were included in this systematic review. Studies and articles with an investigation of any type of rice such as brown rice and whole grains were not included. We settled to exclude studies which have examined the relation between white rice and some of the CVD risk factors.

We extracted data on publication (the first author's last name and year of publication), study design, gender, age, name of country that study were conducted, duration of study, number of participants, aim of study and results. Studies that investigated among association between white rice consumption and CVD risk factors are observed in table 1.

Results

Totally, our search retrieved 298 related papers. We found 25 papers as the duplicated papers. From 273 papers, 14 studies were included in our systematic review and others were excluded because they did not meet our inclusion criteria (Figure 1).

Results from studies evaluated the association between white rice consumption and risk of metabolic syndrome has shown positive results.[8,24-26]

In a study of 1476 Iranian adults, aged 19-70 years, showed that consumption of rice (if consumed ≥ 25.6% of total energy) were significantly related to greater risks of metabolic syndrome.[8] One cross-sectional study conducted among 6845 Korean adults shown that white rice intake in women were associated to greater levels triglyceride and fasting blood glucose and lower level of high-density lipoprotein (HDL).[25] Results from one cross-sectional study among a population of Korean adolescents revealed the lower level of HDL-cholesterol in girls with white rice consumption. Furthermore, rice intake was substantially correlated to increase risks of insulin resistance and metabolic syndrome in girls.[24] Boys with high dietary GL also had a greater level of fasting blood sugar.[24] In addition, higher consumption of refined grains such as white rice was related to metabolic syndrome in 2042 Asian Indians.[26] Rice eating with beans or multi-grains was associated with reduction in metabolic syndrome risk factors particularly in postmenopausal women.[11]

Finding from several studies regarding the correlation between CVD and CVD mortality have reached contradictory results.[6,9,27] In one prospective cohort examination among 207556 US individuals from the Nurse's Health Study, consumption of refined rice was not significantly associated with CVD risk. Their results were largely similar between Whites and Asians.[9] Furthermore, in another study conducted among 91223 Japanese male and female with obesity, aged 40-69 years, authors did not find any substantial correlation between white rice consumption and risk of CVD

Table 1. Studies regarding the association between white rice consumption, diabetes, and metabolic syndrome as the cardiovascular disease (CVD) risk factors

Reference	Country	Participants/gender	Age	BMI	Design	Aim of study	Duration of study	OR/HR/Percent change	Results
Murak et al.[9]	US	207555 female 73228 male	31-64	20-30	Cohort	Effect of rice consumption on CVD	4393130 (person-year)	0.98 (0.8-1.14)	No significant association
Sun et al.[30]	US	157463 female 39765 male	26-87	20-25	Cohort	Effect of white rice on diabetes	3318196 (person-year)	1.17 (1.02-1.36)	Positive association
Eshak et al.1[6]	Japan	64327 female 46465 male	40-79	-	Prospective	Effect of white rice on CVD mortality	14.1 (year)	0.82 (0.7-0.97) for men	Negative association in men
Bahadoran et al.[8]	Iran	1476 adults	19-70	-	Prospective	Effect of white rice on metabolic syndrome	3 (year)	1.66 (1.04-2.66)	Positive association (higher TG and S and DBP and lower HDL with rice consumption)
Khosravi-Boroujeni et al.[1]	Iran	3006 male	19-65	-	Cross-sectional	Association between white rice and CVD risk factors	-	1.25 (0.72-2.18) for metabolic syndrome 1.06 (0.47-2.43) for diabetes 0.96 (0.68-1.34) for hyperlipidemia	No significant association With rice intake and level of lipid profile, FBs, and blood pressure)
Ahn et al.[11]	Korea	26006 male	40-69	-	Cross-sectional	Association between rice-eating pattern and metabolic syndrome risks	-	0.85 (0.73-0.98) in women and 1.03 (0.89-1.19) in men in white rice with multi-grains group in comparison with white rice (OR = 1)	negative association with white rice consumption with beans and multi-grains and metabolic syndrome
Song et al.[24]	Korea	1164 boys 1045 girls	10-18	-	Cross-sectional	Association with white rice and metabolic syndrome risk factors	-	-	Rice intake reduced HDL-cholesterol levels in girls an increased risk of insulin resistance and the metabolic syndrome in girls but not in boys
Song et al.[25]	Korea	2631 male 4214 female	30-65	-	Cross-sectional	Association with white rice and metabolic syndrome risk factors	-	-	Triglyceride, high-density lipoprotein cholesterol, and fasting blood glucose levels were associated with the percentage of energy from carbohydrates in men and white rice intake in women
Zuniga et al.[29]	Singaporean Chinese	2728 male and female	24-92	-	Cross-sectional	Association with white rice and insulin resistance and hyperglycemia	-	1.67% (0.44-2.92) for FBS 6.17% (0.49-12.16) For HOMA-IR 9.17% (3.44-15.22) For TG	Positive association
Eshak et al.[27]	Japan	91223 male and female	40-69	-	Cohort	Association between white rice and CVD mortality	15-18 (year)	0.97 (0.84-1.13)	No significant association
Mohan et al.[28]	India	15	25-41	≥ 23	Randomized cross-over	Effect of white rice and other rice on blood glucose and insulin response	5 (day)	Fasting insulin 57% lower in brown rice in compared to white rice	Brown rice help reduce the insulin and FBS compared to white rice
Kolahdouzan et al.[10]	Iran	212 male and female	18-65	≥ 25	Cross-sectional	Association between white rice and central obesity	-	0.04 (−1.46-2.73) for BMI and −0.01 (−5.87-4.78) for waist circumference	No significant association
Nanri et al.[23]	Japan	33622 female 25666 male	45-75	21-27	Prospective	Association between rice intake and diabetes	5 (year)	1.65 (1.06-2.57)	Positive association
Villegas et al.[33]	China	64227 female	40-70	-	Cohort	Association between rice intake and diabetes	4.6 (year)	1.78 (1.48-2.15)	Positive association

BMI: Body mass index; OR: Odds ratio; HR: Hazard ratio; CVD: Cardiovascular disease; HDL: High-density lipoprotein; DBP: Diastolic blood pressure; FBS: Fasting blood sugar; HOMA-IR: Homeostasis model assessment-estimated insulin resistance; TG: Triglycerides

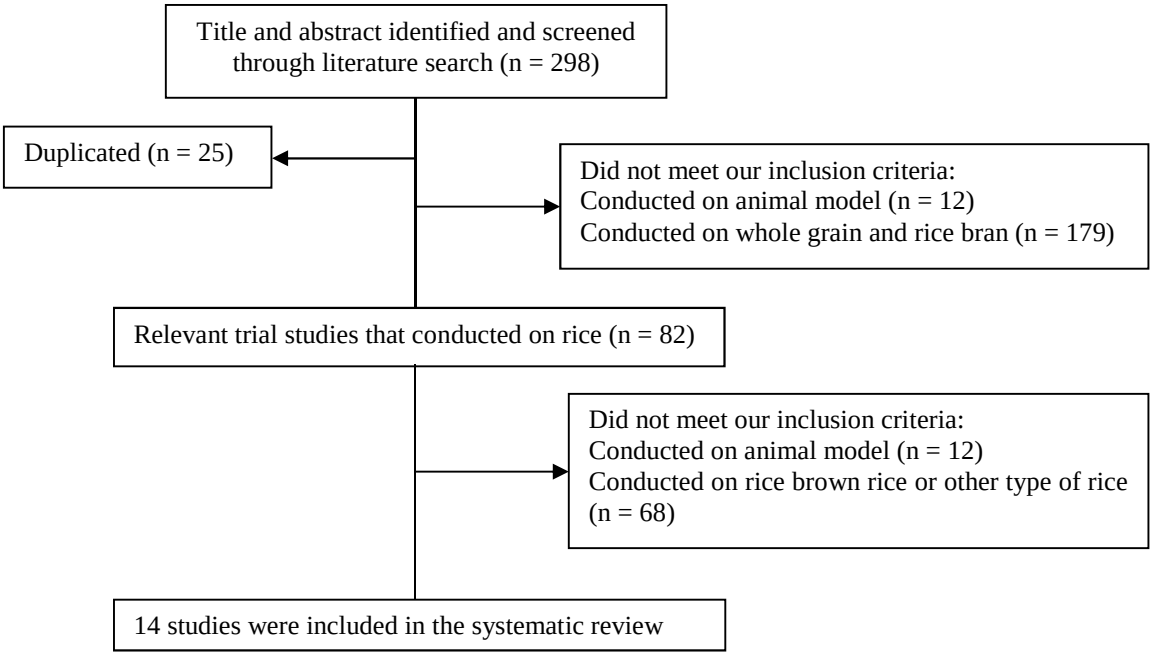

Figure 1: Flow diagram of study selection processes

morbidity and mortality.[27] These results were consistent with other study examining the relation between white rice consumption and CVD risk factors such as fasting blood glucose and lipid profile which conducted among 3006 samples of Iranian men.[1]

In contrast, in one prospective study among 83552 samples of Japanese men and women, consumption of rice was associated with reduced risk of CVD mortality in Japanese men.[6] But there was not find any substantial correlation between rice intake and risk of mortality from CVD in women after adjustment for potential confounders.[6]

Finding from several studies regarding the effect of white rice consumption on type 2 diabetes suggested the positive association in this regard.[14,28,29,33] One systematic review and meta-analysis published in 2012 by Hu et al., indicated that for each serving per day of rice consumption, the relative risk of diabetes was 1.11 (1.08-1.14, T_{rend}< 0.001).[14] They concluded that rice intake of was significantly correlated with augmentation risk of type 2 diabetes, especially in Japanese and Chinese population.[14] Furthermore, consumption of rice among 2728 Singaporean Chinese were substantially associated with hyperglycemia and insulin resistance according to one cross-sectional study.[29]

Discussion

Finding from several studies suggested the positive relation between white rice consumption and diabetes and metabolic syndrome but not CVD mortality.[8,14,24,25] Studies regarding the association between rice consumption and risk of diabetes have reached consistent results.[23,29,33] Most of the studies conducted regarding the metabolic syndrome risk[8,11,24,25] and they showed the consistent results.

White rice is mentioned as the important source of carbohydrates for most people in the world especially in Asia. White rice is poor in nutrients including insoluble fiber, magnesium, vitamin E, folate, and other components.[34] The U.S. Preventive Services Task Force detected inadequate evidence on the favorable multivitamins to reduce the risk of CVD or cancer.[35] The consumption of rice in Asian people like Korea, Japan, Iran, etc., is more than 39% of their total energy from rice.[6,11,12] In contrast, the consumption of white rice in western countries is less than Asian people.[14] Phytoestrogens have the positive effects on regulating serum lipid metabolism, arterial vessels, cytokine levels, and coagulation/fibrinolysis system and may be used to prevent CVD.[36] Refined rice because of refining process is poor in fiber content and has high density of energy.[1]

Several studies suggested that fiber-rich carbohydrate diet such as whole grains and brown rice tend to a positive effect on prevention of diabetes and metabolic syndrome.[37,38] In one study, replacing of 50 g/day of white rice with brown rice and whole grains could reduce the risk for type 2

diabetes 16% and 36%, respectively.[30] Consumption of dietary fiber (≥ 14 g/1000 kcal) with white rice intake can attenuate the unfavorable impact of rice on metabolic syndrome.[8] But it seems that higher white rice intake may be related to weaker adherence to consumption of dairy products, nuts, vegetables, and fruits. In other hand, those with high consumption of refined rice may consume less of other these mentioned foods. The average intake of fruits and vegetables are less than guidelines recommendations in 90.9% of the population.[39]

Quality of carbohydrate i.e. GI and GL have considered as one of the major factors for development of chronic diseases like CVD.[19] The GI of white rice and brown rice are 64 ± 7 and 55 ± 5, respectively.[22] Furthermore, the GI of the various white rice varieties in the world may be different, and it depend on several factors including amylose content, other botanical structures, and processing method.[40] Foods with high GI and GL can cause a quick postprandial increase in serum glucose and insulin secretion.[1] People who consumed white rice as a staple food especially have a high GL and GI of meal time, and it can lead to CVD and related disorders.[41] Consumption of high GI foods could tend to insulin resistance and hyperglycemia through enhancement free fatty acid levels as soon as decline concentration of HDL cholesterol.[42]

One of the important factors contributed to the relation between white rice intake, and CVD risk factors are the amount of consumption. Consumption of white rice more than 25% of total energy intake/day can augment the risk of metabolic syndrome nearly up to 66% according to one study.[8] According to one other study conducted among Japanese women indicated that women who consumed ≥ 300 g/day of rice had 1.8 fold greater risk of diabetes than women with < 200 g/day rice consumption.[33] Results from recent cohort analysis suggested that intake of ≥ 5 serving/day of white rice is not significantly associated with CVD risks.[9] They did not support the report of Consumer Reports magazine regarding to limitation of white rice intake to 2 serving/weeks or less.[43] The average consumption of refined rice in India and China is 8.5 and 6 serving/day, respectively, and it may be related to diabetes and CVD epidemic especially in India.[12]

Obesity, as an important health problem in the world, leads to insulin resistance, dyslipidemia and metabolic syndrome, systemic inflammation, type 2 diabetes, and CVD.[44] Individuals with excess weight had greater risk of metabolic disorders if they consumed more refined rice based on one study.[8] One investigation indicated that individuals with normal BMI, who intake white rice may have a higher risk for diabetes. It seems that white rice consumption may tend to diabetes and risk of CVD independent of obesity.[45]

Physical activity is considered as one of the important factors contributed to the correlation between white rice and CVD risk factors. Physical activity may counterbalance the increased serum glucose because of white rice consumption and may diminish the adverse effect of white rice on CVD risk factor.[23] Sedentary life and less physical activity can affect the association between rice consumption and diabetes and CVD risk factors.[23]

Hence, we did not face to only white rice consumption as the contributing diet-related factor to incidence CVD and its related disorders. In other hand, beside the assessment of white rice intake, we should consider the status of physical activity, intake of dietary fiber available in fruits, vegetables, nuts and legumes, and the amounts of white rice in one day. Among the reasons for the discrepancies of the results of studies, we can mention the diverse consumption of the several types of white rice with different GI. Furthermore, dietary patterns in total such as amount consumption of the low-fat dairy product, legumes, fruits, and vegetables have the important role on CVD risk factors. Several investigations supported the positive effect of whole grains, as a major component of healthy pattern, on prevention against systemic inflammation and CVD because of its many nutrients including dietary fiber, magnesium, vitamins, and phytoestrogen.[13] It is suggested to examine more studies regarding the association between rice consumption and lipid profile, blood pressure and CVD.

Conclusion

In conclusion, we found the significant association between white rice consumption and several risk factors of CVD including type 2 diabetes and metabolic syndrome, but results regarding the correlation between refine rice intake and CVD mortality had not shown the consistent results. More studies are needed to clarify this association.

Acknowledgments

We express our thankfulness Isfahan University of Medical Sciences, Iran.

Conflict of Interests

Authors have no conflict of interests.

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How to cite this article: Izadi V, Azadbakht L. **Is there any association between rice consumption and some of the cardiovascular diseases risk factors? A systematic review.** ARYA Atheroscler 2015; 11 (Suppl 1): 109-15.