Dietary approaches to stop hypertension diet and obesity: A cross-sectional study of Iranian children and adolescents

Sahar Golpour-Hamedani[(1)], Noushin Mohammadifard[(2)], Alireza Khosravi[(3)], Awat Feizi[(4)], Sayyed Morteza Safavi[(1)]

Original Article

Abstract

BACKGROUND: Few studies have investigated the effects of dietary approaches to stop hypertension (DASH) diet on obesity in children. The present study was conducted to examine adherence to the DASH diet in relation to obesity in children and adolescents, Isfahan, Iran.

METHODS: A cross-sectional study was carried out among 456 children aged 11-18 years who were selected by random cluster sampling method. Dietary intakes were assessed using a validated Food Frequency Questionnaire (FFQ). The DASH score was constructed based on food items emphasized or minimized in the DASH diet. Anthropometric measurements were conducted based on standard protocols. General and abdominal obesity were defined based on body mass index ≥ 95th percentiles and waist: height ratio of more than 0.5, respectively.

RESULTS: Higher adherence to DASH diet was inversely associated with general obesity (odds ratio$_{T1 \text{ vs. } T3}$ 3.34, 95% confidence interval 1.28-8.75); however, after controlling for confounding factors, this association disappeared. Furthermore, higher adherence to DASH diet was negatively associated with central obesity in children, but the relation was not statistically significant.

CONCLUSION: We concluded that there was an inverse nonsignificant association between adherence to DASH diet and general obesity indices after adjustment for potential confounders. Further, well-designed randomized clinical trial studies are suggested to find out the effect of DASH diet on obesity obviously.

Keywords: Dietary Approaches to Stop Hypertension, Obesity, Anthropometry, Hypertension, Adolescents, Children

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Introduction

Obesity is a public health concern affecting all age groups in the world.[1] Childhood obesity has increased dramatically in 3 past decades in both developed and developing countries,[2] and it is considered as the first nutritional problem in children and adolescents.[3] In Iran, as a developing country, approximately 15.1% and 8.3% of children are overweight and obese, respectively.[4] Children who are overweight and obese are at increased risk for serious long-term health complications including metabolic syndrome, insulin resistance, vascular disease, and various forms of cancer.[5,6] To reduce financial burden associated with the treatment of obesity-related complications, prevention and treatment of childhood overweight and obesity should become a public health priority.[7]

Obesity is a complex issue connected with individual and environmental factors.[8] Diet is a major determinant of childhood overweight and obesity.[7] Recently, it has been shown that unhealthy dietary habits such as high intake of sugar-sweetened beverages and sodium lead to increased obesity in adolescents.[9] Evidence shows that dietary patterns in comparison to food and nutrients are stronger predictors of chronic disease such as obesity.[10] Despite the proven effects of diet on obesity, few studies have examined effects of dietary patterns on obesity, especially in children.[11] One examination of food-based dietary patterns is dietary approach to stop hypertension (DASH) diet, emphasizing on high intake of fruits, vegetables,

1- Food Security Research Center AND Department of Clinical Nutrition, School of Nutrition and Food Sciences, Isfahan University of Medical Sciences, Isfahan, Iran
2- Isfahan Cardiovascular Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran
3- Hypertension Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran
4- Cardiac Rehabilitation Research Center, Cardiovascular Research Institute AND Department of Biostatistics and Epidemiology, School of Health and Isfahan University of Medical Sciences, Isfahan, Iran
Correspondence to: Sayyed Morteza Safavi, Email: safavi@hlth.mui.ac.ir

whole grains, nuts and legumes, and low-fat dairy products[12] with protective effects on metabolic syndrome, cancer and obesity.[10]

Most studies assessing the relation between DASH diet and obesity have been conducted in adults or populations with diabetes mellitus, metabolic syndrome, or cardiovascular diseases (CVDs) with favorably effects of DASH diet on weight control.[13,14] Despite the pressing concerns of childhood overweight and obesity and the relation between metabolic disorders with obesity in childhood, a limited number of observational studies have assessed the impact of following DASH diet on measures of adiposity in children to date. The present study was carried out to assess how conformity to DASH diet was associated with anthropometric measures among children and adolescents in Isfahan city, Iran.

Materials and Methods

Data for this cross-sectional study were collected between September 2015 and February 2016 on a representative sample of students aged 11-18 years who were selected by random cluster sampling method. A sample size of 300 was estimated with the assumption of 80% power and a 0.05 level of significance. Participants were recruited from 13 schools of 4 different districts of Isfahan city. We excluded those with a chronic disease that affected their regimen or weight including diabetes mellitus, hypertension, hypo- and hyperthyroidism, kidney diseases, and liver disorders. From 500 healthy students who participated in the study, after excluding the missing food frequency questionnaires (FFQs) based on reported energy intake outside the range of 700-4000 kcal/d, data on a total of 456 children remained for current analysis. Informed written consent was obtained from each participant. This study was approved by the Research and Ethics Committee of School of Health, Isfahan University of Medical Sciences (No. 394295).

Dietary intake was evaluated by a self-administrated 168-item FFQ with assessing the validity and reliability in previous studies.[15] Participants were asked to report frequency consumption of each food item during the past year on a daily, weekly, monthly, or yearly basis. Portion sizes of consumed foods were converted to grams using household measure.[16] Then, each food and beverage was coded according to the prescribed protocol and analyzed for content of energy and the other nutrients using Nutritionist IV software (version 3.5.2, N-Squared Computing, Salem, OR, USA).

The DASH score was constructed based on food items emphasized or minimized in the DASH diet, focusing on eight components: high intake of fruits, vegetables, nuts and legumes, whole grains, and low-fat dairy products and also low intakes of sodium, red, and processed meat and sweetened beverages.[10] Participants were classified based on quintile categories of consuming each mentioned food items. For fruits, vegetables, nuts and legumes, low-fat dairy products, and whole grains, those in the first (lowest) dietary intake quintile were given the score of 1 and those in the fifth (highest) quintile were given the score of 5. Other quintiles (second, third, and fourth) for these dietary intakes were given the related score (2, 3, and 4, respectively). For sodium, red, and processed meats and sweetened beverages, the lowest quintile of intake was given a score of 5 and the highest quintile was given the score of 1 with the score of 2, 3, and 4 for those in the fourth, third, and second quintiles of intake. The scores were then summed up to construct the overall adherence to the DASH diet score that ranged from 8 to 40; individuals with the highest DASH score were more likely to follow DASH diet.

Anthropometric parameters including weight and height were measured by following standard protocols. Height and weight were measured with subjects wearing light clothing and without shoes. Weight, body mass index (BMI), percent body fat (PBF), and lean body mass (LBM) were also measured by body impedance analysis (Omron, BF511, Kyoto, Japan). Waist circumference was considered the narrowest level and the hip circumference was measured at the maximum level over light clothing using non-stretchable tape, measurements were recorded to the nearest 0.1 cm. General and central obesity were defined based on BMI $\geq$ 95th percentiles[17] and waist: height ratio of more than 0.5,[18] respectively.

Additional variables including sociodemographic information of age, sex, parent's education level, household income, and medical history were obtained from a self-administrated questionnaire. Furthermore, the physical activity of children was assessed through a 7-day recall questionnaire (PAQ) with high validity and moderate reliability.[19] It contains 9 items; each scored on a 5-point scale. Once a value from 1 to 5 was obtained for each of the 9 items used in the physical activity composite score, the mean of these nine items results in the final PAQ activity score. The score of 1 indicates low physical activity; the score of 2-4 indicates moderate physical activity, whereas the score of 5 indicates high physical activity.

Participants were categorized based on tertiles of DASH dietary pattern scores. To compare general characteristics across tertiles, we used one-way analysis of variance for continuous variables and chi-square test for categorical variables. Dietary intakes (age and energy-adjusted) were compared using analysis of covariance. Association between tertiles of DASH score and obesity indices was evaluated using a multiple logistic regression controlling for age (years) and sex in model I; physical activity (low, moderate, and high) in model II; energy intake (kcal) in model III; and additionally for dietary intakes of sweets, refined grains, white meat, high-fat dairy products, oils, and eggs in model IV. In all multiple models, the highest tertile of DASH score was considered as the reference. All analyses were done with the SPSS Software (version 21, IBM Corporation, Armonk, NY, USA) and $P < 0.050$ was considered statistically significant.

Results

Baseline characteristics of study participants across tertiles of DASH scores are presented in table 1. A total of 456 children completed the study with mean ± standard deviation age of 14 ± 2.09 years and approximately 267 (59%) were girls. In total, 41 (9.0%) of children were obese, 22 (4.8%) boys and 19 (4.2%) girls. Furthermore, 39 (8.6%) were classified as central obese, 19 (4.2%) boys and 20 (4.4%) girls. As it is shown, significant differences were found in terms of all presented variables across tertiles of DASH score except for age and weight. Most participants had moderate physical activity level and there was no body with high physical activity level in our sample (Table 1).

Adherence to the DASH diet was significantly associated with greater intakes of fruits, vegetables, low-fat dairy, whole grains, and nuts and legumes (all $P < 0.001$). Individuals in the third tertile of DASH score had significantly lower intakes of sugar-sweetened beverages, red meat ($P < 0.001$), and refined grains ($P < 0.001$) compared with those in the first tertile. There was no significant association between adherence to the DASH diet and total energy, fat and oils intakes. Individuals in the last tertile of DASH diet score had significantly higher intakes of Ca, Mg, K, folate and total dietary fiber (all $P < 0.001$), and lower intake of Na ($P = 0.001$), mono-unsaturated fatty acid (MUFA) ($P = 0.004$) and polyunsaturated fatty acid (PUFA) ($P = 0.002$) compared with those in the first tertile (Table 2).

Table 3 indicates means of obesity indices across DASH tertiles among children and adolescents. As can be seen, there were no significant differences regarding all the anthropometric measurements across tertiles of DASH score except for PBF and LBM in the crude model.

Odds ratios (ORs) for obesity across tertiles of DASH diet scores are provided in table 4. Adherence to the DASH diet was associated with general obesity in the crude model [$OR_{T1\ vs.\ T3:}$ 3.34, 95% confidence interval (CI): 1.28-8.75]. When the models were further controlled for confounding variables, the association was positive but no longer significant ($OR_{T1\ vs.\ T3:}$ 3.30, 95% CI: 0.35-31.21).

Table 1. Baseline characteristics according to tertile of adherence to dietary approach to stop hypertension (DASH) diet score among children and adolescents aged 11-18 years

Participant characteristics	Tertile of DASH score			P*
	1	2	3	
	< 22	22-25	> 25	
Participants (n)	168	137	151	
Age (year)	14.3 ± 2.0	14.2 ± 2.1	14.6 ± 2.0	0.260
Weight (kg)	54.4 ± 16.2	50.9 ± 13.3	53.5 ±12.7	0.090
BMI (kg/m^2)	21.4 ± 4.8	20.3 ±3.7	20.6 ± 3.6	0.040
Waist circumference (cm)	75.5 ± 11.5	72.4 ± 9.6	74.3 ± 8.8	0.030
Sex [n (%)]				
Boy	60 (31.9)	54 (28.7)	75 (39.4)	0.040
Girl	108 (40.4)	83 (31.1)	76 (28.5)	
Physical activity** [n (%)]				
Total	168 (36.9)	137 (30.1)	150 (33.0)	0.030
Low	73 (45.1)	43 (26.5)	46 (28.4)	
Moderate	95 (32.4)	94 (32.1)	104 (35.5)	
High	None	None	None	

Values are presented as mean ± SD and frequency (percentage). * Obtained from ANOVA for continuous variables and χ^2 test for categorical variables. ** Physical activity was calculated using PAQ score which score of 1 indicates low physical activity, score of 2-4 indicates moderate physical activity, and score of 5 indicates high physical activity. DASH: Dietary approach to stop hypertension; BMI: Body mass index; PAQ: Physical activity questionnaire; SD: Standard deviation; ANOVA: Analysis of variance

Table 2. Dietary intakes according to tertile of adherence to dietary approach to stop hypertension (DASH) diet score among children and adolescents aged 11-18 years

Daily intakes	Tertile of DASH score			P*
	1	2	3	
	< 22	22-25	> 25	
Participants (n)	168	137	151	
Food groups (g/day)				
Fruits	180 ±105	244 ± 138	286 ± 125	< 0.001
Vegetables	176 ± 66	208 ± 83	253 ± 109	< 0.001
Red and processed meat	48 ± 25	36 ± 22	30 ± 18	< 0.001
Low-fat dairy	254 ± 153	320 ± 139	377 ± 143	< 0.001
Sugar-sweetened beverages	56 ± 43	39 ± 42	32 ± 36	< 0.001
Oils	13 ± 9	13 ± 8	12 ± 7	0.280
Whole grains	14 ± 21	12 ± 16	22 ± 26	< 0.001
Nuts and legumes	30 ± 15	37 ± 19	50 ± 27	< 0.001
Sweets	65 ± 31	64 ± 28	59 ± 21	0.110
Refined grains	342 ± 138	305 ± 97	297 ± 109	< 0.001
High-fat dairy	98 ± 77	102 ± 93	82 ± 63	0.060
White meat	16 ± 8	15 ± 8	14 ± 9	0.760
Eggs	19 ± 10	22 ± 13	20 ± 9	0.170
Nutrients				
Energy (Kcal)	1684 ± 361	1665 ± 298	1699 ± 242	0.650
Protein (g/day)	56 ± 13	57 ± 11	60 ± 10	0.020
Total fat (g/day)	53 ± 14	52 ± 13	50 ± 10	0.240
Saturated fatty acid (mg/day)	17 ± 5	17 ± 5	17 ± 4	0.550
Mono-unsaturated fatty acid (mg/day)	14 ± 4	14 ± 4	13 ± 3	0.040
Poly-unsaturated fatty acid (mg/day)	11 ± 3	10 ± 3	10 ± 3	0.020
Sodium (mg/day)	2872 ± 1019	2688 ± 1254	2498 ± 1185	0.010
Potassium (mg/day)	2199 ± 579	2463 ± 595	2720 ± 562	< 0.001
Calcium (mg/day)	793 ± 243	887 ± 226	950 ± 198	< 0.001
Magnesium (mg/day)	187 ± 43	202 ± 44	220 ± 39	< 0.001
Folate (mg/day)	205 ± 51	225 ± 64	256 ± 65	< 0.001
Total dietary fiber (g/day)	9 ± 2	11 ± 3	13 ± 3	< 0.001

Values are presented as mean ± SD. Nutrients and food intakes have been adjusted for age and total energy intake using residual model.
* Obtained from ANCOVA. DASH: Dietary approach to stop hypertension; ANCOVA: Analysis of covariance; SD: Standard deviation

Furthermore, there was direct association between lower adherence to DASH diet and central obesity but not statistically significant in study participants.

Table 3. Means of obesity indices across tertiles of adherence to dietary approach to stop hypertension (DASH) diet score among children and adolescents aged 11-18 years

Variables	Tertiles of DASH score			P
	1	2	3	
	< 22	22-25	> 25	
Waist to hip ratio				
Crude*	0.82 ± 0.06	0.81 ± 0.06	0.82 ± 0.05	0.280
Adjusted**	0.82 ± 0.00	0.81 ± 0.01	0.82 ± 0.00	0.280
Waist to height ratio				
Crude	0.48 ± 0.06	0.46 ± 0.06	0.47 ± 0.06	0.170
Adjusted	0.48 ± 0.00	0.46 ± 0.00	0.47 ± 0.01	0.310
Percent of body fat (%)				
Crude	26.55 ± 10.50	23.63 ± 9.22	23.49 ± 9.86	0.010
Adjusted	26.50 ± 0.83	23.60 ± 0.81	23.40 ± 0.81	0.280
Lean body mass (%)				
Crude	32.06 ± 5.39	33.87 ± 6.76	34.66 ± 7.24	< 0.001
Adjusted	32.00 ± 0.43	33.80 ± 0.59	34.60 ± 0.60	0.170

* Values are presented as mean ± SD and P value obtained from ANOVA in crude model. ** Values are presented as mean ± SE. Adjusted for age, sex, physical activity, and energy intake and P value obtained from ANCOVA in adjusted model. DASH: Dietary approach to stop hypertension; ANOVA: Analysis of variance; ANCOVA: Analysis of covariance; SD: Standard deviation; SE: Standard error

Table 4. Odds ratio (OR) confidence interval (95% CI) for association of obesity and adherence to dietary approach to stop hypertension (DASH)diet score among children and adolescents aged 11-18 years

Variables	Tertiles of DASH score		
	1	2	3
	< 22	22-25	> 25
	OR (95% CI)	OR (95% CI)	
General obesity			
Crude	3.34 (1.28-8.75)	1.24 (0.40-3.85)	1
Model I	3.76 (1.41-10.06)	1.26 (0.40-3.94)	1
Model II	3.44 (1.15-10.30)	1.02 (0.28-3.70)	1
Model III	2.79 (0.75-10.40)	0.62 (0.14-2.77)	1
Model IV	3.30 (0.35-31.21)	0.86 (0.11-6.59)	1
Abdominal obesity			
Crude	1.56 (0.92-2.70)	1.3 (0.78-2.2.17)	1
Model I	1.56 (0.92-2.70)	1.28 (0.76-2.13)	1
Model II	1.35 (0.76-2.44)	1.11 (0.64-1.92)	1
Model III	1.43 (0.75-2.78)	1.35 (0.55-1.92)	1
Model IV	1.26 (0.64-2.50)	0.81 (0.40-1.63)	1

General obesity and abdominal obesity were defined as BMI ≥ 95th percentiles and WHtR > 0.5, respectively. Model I: Adjusted for age and sex. Model II: Also adjusted for physical activity score. Model III: Additionally adjusted for energy intake. Model IV: Additionally adjusted for intakes of refined grains, sweets, white meat, oils, high-fat dairy and eggs. WHtR: Waist height ratio; BMI: Body mass index; DASH: Dietary approach to stop hypertension, OR: Odds ratio; CI: Confidence interval

Discussion

Despite the protective effects of DASH diet on obesity indices in current study, we failed to find a statistically significant association between adherence to DASH diet and general/abdominal obesity. To our knowledge, this is one of the first observational studies investigating the association between adherence to DASH diet and general and abdominal obesity in Iranian children.

Although there are few observational studies that have directly assessed the association between adherence to the DASH diet and obesity, especially in children, there are several reports addressing the linkage between DASH diet and obesity. In two studies conducted by Azadbakht et al., in two study[13,14] protective effects of DASH diet on central and general obesity were observed in patients with metabolic syndrome and diabetics. Furthermore, a greater adherence to the DASH diet was associated with lower mean values of waist-to-hip ratio and BMI among women in Folsom et al. study[20] as well as the protective effects of DASH diet on general obesity on female nurses in another study.[21] The favorable effects of DASH diet on children abdominal obesity were observed in Asghari et al. study.[22] Furthermore, a study of Canadian children has shown that a higher DASH adherence is associated with lower abdominal obesity.[5] However, in two studies assessing the role of adherence to the DASH diet on adiposity in a sample of youth with diabetes,[23,24] no association was found between adherence to the DASH diet and measures of adiposity. Furthermore, a cross-sectional study[25] of Korean preschool children found that a DASH-style diet was not associated with measured weight status. Different findings might be explained by the different definition of the DASH diet among studies, sample size, validity of the dietary assessment tools, and study population. Furthermore, we adjusted other dietary factors which were not included in DASH score, and it can effect on study results.

The biological mechanisms of DASH diet on obesity are not fully established yet. The high amounts of fiber, dairy, and Ca of DASH diet are inversely related to obesity.[26,27] DASH diet stimulates satiety as a low-glycemic index and low-energy density diet.[28] Furthermore, the influence of fiber intake on insulin and incretin hormones secretion, such as glucagon-like peptide-1, can reduce fat storage.[29] Furthermore, the lack of relation between adherence to DASH diet and general obesity after adjustment for energy intake in this study, indicates DASH dietary pattern depends on energy intake reduction to exert protective effects on obesity management.

Despite some strengths of our study including a large sample size and school-based population, there are some limitations which should be noted. Due to the cross-sectional study design, a causal relationship cannot be inferred. There are some

misclassifications of biases because of an FFQ usage to assess the dietary intakes. In addition, since the study was only conducted in Isfahan, it is difficult to generalize the results of the study to the whole populations of adolescents in Iran.

Conclusion

We concluded that adherence to DASH diet had an inverse association with general obesity, but not abdominal obesity which was attenuated after adjustment for potential confounders. Overall, protective effects of DASH diet are visible and it can be suggested as a healthy diet to weight management. Further well-designed randomized clinical trials are needed to discover the effect of DASH diet on obesity.

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Conflict of Interests

Authors have no conflict of interests.

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