Original Article

Which food groups and macronutrients are more associated with central obesity in Iranian children?

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Abstract

Background: Better understanding of the macronutrients consumption and relationships between food group and total and central body fat among children is necessary for the effective prevention and management of obesity in youth. Therefore, the objective of this study was to evaluate macronutrients and food group intake and the associations between the portion size of food groups and anthropometric indices including waist circumference (WC) and body fat percentage (BF%) among schoolchildren in Babol, North of Iran.

Methods: This cross-sectional study was conducted on 205 boys and girls aged 7-11 from the urban and rural areas of Babol. The data on food consisted of a 24-hourrecall and food frequency questionnaire obtained via interviewing the children and their mothers. Waist circumference and body fat was measured based on the standard protocols. Dietary analysis and other data analysis were performed using the Nutritionist IV and SPSS -18.

Results: The top sources of energy for schoolchildren were carbohydrate and fat with about 63% and 23% of total energy, respectively. In contrast to boys, girls who consumed more cereals, meat and dairies had the lower central and total adiposity. There was no association between obesity and fruit, oil and vegetable consumption. Besides, the low consumption of vegetables and dairy products and the high intake of cereals and oils was found in both genders.

Conclusion: According to higher consumption of macronutrients like as carbohydrate and protein and lower intake of dairy products, vegetables and fruits which had different association with central obesity in these students, recommended food groups intake should be highlighted to promote the importance of age appropriate portion sizes and frequency of eating and provide guidance for the students and parents.

Keywords: Macronutrients, Food groups, Waist circumference, Body fat, Schoolchildren, Central obesity.

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Today the prevalence of malnutrition in children and adolescents becomes two times higher than last decade especially in developing countries (1).

Today the prevalence of malnutrition in children and adolescents becomes two times higher than last decade especially in developing countries (1). A national study in Iran highlighted a high prevalence of overweight and obesity among children and adolescents living in the North of Iran (2,3). Childhood can be encouraged to adopt healthy eating behavior to unhealthy dietary practices which can persist into their adulthood, and leads to an increase in the incidence of overweight, obesity and other related diseases (4). Low intake of fruits, vegetables and whole grains along with the high intake of saturated fat and refined grains increase the risk of obesity and cardiovascular diseases in later life (5). The individual and environmental barriers which influence the lifestyle of children and adolescents are the families that show unhealthy role models for behavior (6) and furthermore, a rapid nutrition transition to a high-fat and high sugar diet and meals, which link with non-communicable diseases. However, food choices are available for some kids' meals that can achieve a widely accepted level of nutrient quality and the consumption of all food groups is higher at home rather than outside the home (7-9). The composition of the diet is an important factor to prevent body fat increase. Therefore, several studies suggested that a diet with higher fat and lower carbohydrates, independent of total energy intake, may contribute to an increase in waist size and body fat among children and adolescents. Moreover, the food groups intake can be related to body fat distribution (10-12).

Many studies showed that children consumed a large amount of low energy nutrient dense food and low consumption of five major food groups– cereals, fruit, vegetables, meats and dairy products that do not provide the essential nutritional requirements (7, 13, 14). Therefore, to prevent unhealthy lifestyle behaviors proper attention was needed within the family and school (15). The most effective interventions which can manage this problem, while improving eating habits, reducing energy consumption, and increasing in the nutrient density of the diet are behavior modification and education (16). In order to achieve these goals and promote effective strategies, awareness of food and beverage sources of energy and nutrients among children and adolescents is necessary (13).

Moreover, this information can be helpful to develop rational policies and programs in order to promote optimal nutritional status among children, as well as a guide which can be used and applied for public health for Iranian student in Northern of Iran. Therefore, the purpose of this study was to assess daily macronutrients and food groups intake and their relationship with waist size and body fat changes among the elementary schoolchildren in Babol, North of Iran to make a way to identify and screen food quality of children groups using careful planning for a problem an achievable possibility.

Methods

This cross-sectional study was took place in Babol primary schoolchildren aged 7-11 years- old in 2012 which were selected by stratified random sampling among 3647 children who were studied in first part of this research in 2011 (3). Totally, 205 schoolchildren (girls and boys) from rural and urban areas of Babol were recruited in this study. All participants' parents completed and signed the informed consent form. Anthropometric assessment including measurements of weight, height waist circumference (WC) and body fat percentage (BF%) was done under standard condition. The weight was measured wearing light clothing without shoes in the morning before eating breakfast, using digital scale of Omron BF-511 model with a precision of 0.1 kg and height was measured standing shoeless using SECA height gauge with an accuracy of 0.5 cm. WC was measured using a non-elastic tape with an accuracy of 0.1cm at midpoint between the lower end of the rib cage and top of the iliac crest in a standing position. Body fat percentage was measured using Bioelectrical Impedance Analysis (BIA) method and Omron Digital scale with a precision of 0.1% in the morning.

The subjects who had missing data for WC or BF% had any chronic diseases and on special diet according to their medical records and parents information were excluded. The study instruments included demographic information of schoolchildren, a 24-hour dietary recall and a food frequency questionnaire (FFQ). The 24- hour dietary recall was used to assess food and beverage intake of the previous day. To assess food intake precisely the common cooking instruments and scales (Ghaffarpour, Hoshyar-Rad, and Kianfar 1999) were shown during interview. The serving sizes were described in household measures and for processed food products the manufacturer information was used and then converted to grams. Moreover, FFQ consisting of seven food items was used to assess the frequency of food consumption monthly during last year. For

these children, the interview was conducted in the presence of their mothers who were invited to attend at the nutrition ward of Rohani Hospital on the day of the study. Due to the fact that the participants had a limited knowledge of food portions and lacked conceptualization skills, the questionnaire was completed by a trained nutritionist based on protocol. Each interview was lasted about 30 minutes. The diet records were coded and entered into Nutritionist IV software. Macronutrients and food groups intake were calculated from the food quantities consumed.

Statistical analysis was carried out using SPSS version 18. The significance of differences between means was calculated using t-test and one- way ANOVA where appropriate. The multiple linear regression was applied to assess the association between the mean intakes of several food groups with WC and BF%. P-values < 0.05 were considered to be significant. The project protocol was approved by the Ethical Committee of Babol University of Medical Sciences.

Results

Totally, 205 schoolchildren participated in this study. About 48.2% (n= 99) were boys and 45.8% (n = 94) were from urban areas. According to age, 12.3% (n=25) of students were 7 years old, 19.7% (n=40) were 8, 17.2% (n=35) were 9, 34% (n=69) were 10 and 16.7% (n=34) of students were 11 years old. The mean energy intake among students was 1923.9±711.8 kcal/d that was higher among boys than girls (1972.3± 680.7 vs. 1878.7 ± 740.0 kcal/d). This difference was not statistically significant. The mean for WC was 68.09±13.69 cm and for BF% was 23.83±10.83 in which no significant difference was found in WC and BF% between boys and girls (boys: 68.24±14.17 cm vs. girls: 67.95±13.31cm and boys: 24.34±10.59 vs. girls: 23.38±22.5, respectively). According to Table 1, the mean intake of protein was higher in girls (14.00±3.33 g/d) than in boys (13.43±3.02 g/d) while, boys consumed more carbohydrate and fat than girls but these differences were not statistically significant. Moreover, carbohydrate, protein and fat were highly consumed by rural children. There were no significant differences between macronutrient consumption and habitat and among age groups. It can also be seen that about 14% of total daily energy among children in all ages and regions were related to protein consumption and nearly 63% and 23% of daily energy intake were related to carbohydrate and fat, respectively. Table 2 depicts the daily mean intake of food groups. Based on gender, boys (2.80±2.39 serving/d) significantly consumed more fruit than girls (2.11±2.24 serving/d) (P=0.03). Furthermore, cereals, oils and fats were the most commonly consumed daily food products among students and intake of dairy products and vegetables were very low in both sexes.

This trend remained consistent for urban and rural children and all age groups. Among boys the intake of cereals was positively associated with both measures of WC and BF% (CI: 0.145-1.173 and CI: 0.101- 1.123 respectively) (Table 3). In contrast, negative associations were found between cereal consumption and these both indices among girls (Table 3). Neither meat nor milk intake was associated with WC and BF in boys while, the girls with the highest WC and BF% consumed the highest amount of meat (CI: 0.179-2.434 and CI: 0.357-2.237 respectively) (Table 3). In addition, milk was inversely associated with WC in girls [CI: -6.211-(-0.760)] but not with BF% (Table 3).

Table 1. The mean daily intake of total energy, macronutrients and their distributions among schoolchildren based on gender, habitat and age groups in Babol.

Macronutrients Characteristics		Protein (g/d)	Protein (%E)	Carbohydrate (g/d)	Carbohydrate (%E)	Fat (g/d)	Fat (%E)	Total Energy (Kcal/d)
Gender	Boy	68.1±28.3	13.43±3.0	317.3±113.2	62.9±7.1	53.3±25.2	23.6±6.9	1972.3± 680.8
	Girl	68.0±37.8	14.00±3.3	304.2±124.1	63.3±7.2	48.3±24.5	22.4±7.4	1878.7± 740.0
Habitat	Rural	70.5±33.9	13.8±3.3	315.9±118.2	63.1±7.7	52.3±26.9	22.9±7.3	1967.9± 738.8
	Urban	66.1±33.1	13.7±3.	305.9±119.7	63.1±6.7	49.3±23.1	23.0±7.1	1886.6± 689.3
Age (year)	7-9	68.1±35.3	13.6±3.2	315.6±122.2	63.3±7.0	51.1±24.9	22.9±7.1	1950.9± 715.6
	9-11	68.1±31.7	13.8 ±3.2	305.5±115.8	62.9±7.3	50.3±25.0	23.0±7.3	1897.7± 710.7

%E: Percent of energy; all differences were not significant (p>0.05)

Table 2. Daily mean intake of food groups among 7-11 years old girls and boys in Babol, 2012.

Food groups (serving/d)	Gender	Mean± SD	Pvalue	Habitat	Mean± SD	Pvalue	Age groups	Mean± SD	Pvalue
Dairy products (Milk, Yogurt, Cheese)	Boy	1.18±1.10	0.91	Urban	1.05±1.10	0.96	7-9	1.01±0.96	0.61
	Girl	0.94±0.95		Rural	1.05±0.95		9-11	1.09±1.08	
Vegetables (Dark green leafy and Cruciferous vegetables, Tomatoes, Cucumbers, Onion)	Boy	1.97±1.85	0.81	Urban	1.89±1.96	0.76	7-9	2.06±1.93	0.31
	Girl	1.91±1.85		Rural	1.96±1.74		9-11	1.80±1.75	
Fruit (Citrus, Banana, Apple, Kiwi)	Boy	2.80±2.39	0.03	Urban	2.28±2.20	0.37	7-9	2.39±2.38	0.78
	Girl	2.11±2.24		Rural	2.57±2.43		9-11	2.48±2.28	
Cereals (Rice, Bread, Pasta)	Boy	14.76±6.08	0.81	Urban	15.17±6.04	0.29	7-9	14.93±6.86	0.53
	Girl	14.53±7.18		Rural	14.18±7.12		9-11	14.35±6.45	
Meat and meat products	Boy	2.95±2.59	0.88	Urban	3.15±2.80	0.33	7-9	2.85±2.34	0.51
(Red meat, Sausages, Hamburgers, Poultry and fish)	Girl	3.00±2.52		Rural	2.81±2.29		9-11	3.08±2.72	
Oils and fats	Boy	8.26±4.15	0.21	Urban	8.05±4.40	0.58	7-9	8.11±4.38	0.83
(Vegetable fats, Animal Fats, Butter, cooking oils)	Girl	7.52±4.28		Rural	7.73±4.09		9-11	7.65±4.08	

P <0.05 means significantly differed.

Table 3. Association of food group intake with waist circumference (WC) and Body fat Percent (BF%) among boys and girls (7-11y) in Babol.

Food groups	Boys						Girls					
	WC			BF%			WC			BF%		
	Beta	T	CI (95%)	Beta	T	CI (95%)	Beta	T	CI (95%)	Beta	T	CI (95%)
Dairy products	-0.026	-0.225	-3.271-2.605	-0.007	-0.055	-2.320-2.195	-0.247	-2.538	-6.211-(-0.760)*	-0.161	-1.646	-4.189-0.391
Vegetable	0.026	0.248	-1.361-1.749	0.025	0.231	-1.054-1.322	-0.117	-1.142	-2.296-0.619	-0.067	-0.649	-1.627-0.825
Fruit	0.074	0.632	-0.922-1.782	-0.055	-0.457	-1.280-0.802	-0.067	-0.702	-1.535-0.733	-0.122	-1.263	-1.550-0.344
Cereals	0.288	2.547	0.145-1.173*	2.13	2.015	0.101-1.123*	-0.241	-2.014	-0.840-(-0.031)*	-0.307	-2.570	-0.832-(-0.107)*
Meat	-0.030	-0.268	-1.380-1.052	-0.021	-0.182	-0.987-0.821	0.247	2.299	0.179-2.434*	0.296	2.738	0.357-2.237*
Fat and oils	-0.128	-1.003	-1.300-0.428	-0.092	-0.701	-0.885-0.424	0.031	0.299	-0.548-0.742	0.041	0.388	-0.436-0.648

WC: Waist Circumference, BF: Body Fat; B=Regression coefficient (a positive coefficient implies greater adherence to the pattern);
CI =Confidence interval. * was considered as significant (P. value <0.05)

Discussion

The present research explores macronutrients and food group intake among schoolchildren. The mean of daily calorie intake from protein among schoolchildren in Babol was close to the Recommended Dietary Allowance (RDA), while the percentage of carbohydrate (63%) and fat (23%) was higher and lower than RDA, respectively (RDA, 2014). No significant differences were found in macronutrients intake among boys and girls and between age groups and residential areas. The study among Bahraini students showed that the mean daily intake of carbohydrate and fat was higher among boys than girls (276.8 ± 73.3 and 75.7±22.5g/d vs. 232.4±60.7 and 67.0 ±19.5 g/d, respectively). Moreover, it showed the percentage of energy intake from carbohydrate was 52.5% (52.9% for boys and 52.1% for girls), protein about 15.4 % (boys 15.6% and girls 15.2%) and fat was 33.0% (32.4% for boys and 33.6% for boys).To compare to this study, Bahraini children consumed more fat but less carbohydrate (5). Besides, the percentage of energy intake from fat among Italian children was 41% and from

carbohydrates was 45% (17) that was higher and lower than our study. While another study among Mexican students depicted that the median intakes of protein, carbohydrate and fat were 42.5 g/d, 233 g/d and 45.2 g/d, respectively. This study also highlighted that carbohydrate accounted for 63% of energy intake, protein 11.4% and fat 28% (18). The study among Chinese children showed that in 2009, boys consumed more carbohydrate (273.7±9.4 g/d), fat (67.6±3.2g/d), and protein (61.9±1.5g/d) than girls (233·0±9·3, 62·1±3·2 and 51·8±1·4 g/d, respectively). In addition, the total energy intake was higher in boys than girls (1945.3±39.8 vs.1697.9 ±47.5 kcal/d) (9).

The results from this study are consistent with previous studies that showed no significant differences between boys and girls in terms of the percentage of energy from carbohydrate, fat, and protein (19, 20). According to food pyramid for children (USDA, 2005), the results showed that milk consumption was very low among children especially among girls with lower than 2 serving/d and also the intake of vegetable among both girls and boys were lower than the recommended levels and about 2 serving/d. The consumption of fruit, fat and meat groups was close to the recommendations, while the intake of bread, rice and cereals was very high. Similarly, a study in Germany illustrated that schoolchildren consumed vegetables lower than the recommended levels and also showed the significant differences in fruit and vegetable intakes between girls and boys (21). As consuming vegetables in schoolchildren group is essential for the physical and cognitive development as well as the prevention from nutrition-related diseases, hence, it is important to focus on vegetable consumption among children to ensure a large variety of nutrient intake.

Furthermore, the current study evaluated the relationship of food group intake with waist circumference and BF% and figured out that among boys cereal consumption was negatively associated with BF%, whereas it was positively associated with WC. Among girls, cereal and milk is negatively associated with BF% and WC, whilst meat is positively associated with these two measures. Similarly, the study by Bradlee et al. (2009) found negative association with central obesity and dairy consumption among children and adolescents (11). Furthermore, they illustrated that grains and combination of fruit and vegetables were negatively related to levels of body fat while it was not significant in our study (11). The effects of bread, cereals and whole grains on total and central body fat can be related to their soluble fiber content, which is associated with an increased satiety, delayed gastric emptying, calorie-restricted, and enhanced insulin sensitivity. Accordingly, improved body composition reduced fat mass reduction (%) and serum levels of inflammatory biomarkers and adipocytocines decreasing (22-26). A study in Latin America put on view that the intake of dairy products, fruits, vegetables and cereals significantly was higher in boys. Moreover, the study showed no significant association between food groups and anthropometric changes except dairy products that had an inverse association (27). The relationship between dairy intake and anthropometry changes is controversial.

Although many studies highlighted the significant protective and beneficial association between dairy intake and an increase in WC and body fat through calcium content has effect on lipogenesis (28-32). Some other studies did not find any significant relationship (33-35). Additionally, similar to our study Fiorito et al. (2006) found that intake of dairy products (at least 3 serving/d) is related to lower BF% among girls (36). Thus, further researches are needed to better understand the relationship between milk and dairy products consumption with body fat and waist circumference in children.

Consistent with this study, a study in UAE among students 12 to 17 years old, found a statistically significant difference between the meat groups consumption and an increase in anthropometric measurements in girls but not in boys (37). Although, meat groups are a rich source of iron, protein and support child cognitive development (38) high meat consumption significantly is related to an increase in waist circumference due to their higher energy and fat contents (39, 40). In addition, the type of meat consumption is more important than the proportion of meat in contrast (41).

In summary, the current study highlighted the infrequent intake of vegetables, and dairy products, and high cereals and oil intake than RDA recommendations and food pyramid among schoolchildren in Babol. In addition, in boys, the intake of bread and cereals was positively related to WC and BF% while in girls, cereals and dairy was negatively related to WC. Likewise, in girls meat was positively associated to BF% and WC, while it was not significant among boys. Hence, nutrition education programs should be concentrated more on school settings for students and their parents to provide knowledge on nutrients, healthy balanced diet for

growth and development healthy lifestyle choices as well as preventing diseases.

To the best of our knowledge, the existing study is the first study carried out in the North of Iran which has food diversities different from other parts of Iran. Besides, this study examined food effects on excess central and total body fatness relied on both 24- hour recall and FFQ that provided more up-to-date estimates of food serving and portion size from all sources. The present study had a cross-sectional design that allowed us to report observations but not cause and effect. A longitudinal study would be required to confirm the contribution of each food group and an increase in WC and BF% among children. Moreover, the self-reported dietary record has the possibility of response biases and misrepresentation of food intake. Although the single day dietary recall limits the precision of the estimated dietary intakes of individuals it provides accurate estimation of mean dietary intake within groups (42).

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