Original Article

Diet composition and body mass index in Tehranian adults

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Human studies investigating the relationship between macronutrients intake and obesity, have failed to achieve consistent findings. This study was undertaken to assess the relationship between macronutrients intake and body mass index in a group of Tehranians. From 15005 participants of the Tehran Lipid and Glucose Study, 1290 subjects aged over 10 years (565 males and 725 females) were selected randomly for dietary survey. Anthropometric indices were measured according to standard protocols and BMI was calculated. Dietary data were collected by trained interviewers using two non-consecutive 24-hour dietary recalls. Data on smoking habits, educational level and physical activity were compiled. Under- and over-reporting of energy intake were defined as EI: BMR<1.35 and >=2.4, respectively. Calorie-adjusted amounts of macronutrients were calculated by the residual method, following which energy intakes from all calorie-adjusted macronutrients were simultaneously included in the multiple regression models controlling for age, physical activity, educational level and smoking and mutual effects of macronutrients. Total energy intake was not included to avoid collinearity. BMI increased with age in either gender. Controlling for confounding variables, energy intake from fat was positively associated with BMI in males in the 10-18, 19-24, 25-50 and 51+ year age categories (β=0.06, 0.13, 0.33, 0.48, P<0.05 for all, respectively) and females in the 19-24, 25-50 and 51+ age categories (β=0.17, 0.43, 0.52, P<0.05 for all, respectively). This relationship remained after excluding misreporters (β=0.06, 0.15, 0.36, 0.50 for males and β= 0.21, 0.46, 0.54 for females in the corresponding age categories, respectively). The correlation of fat intake to BMI was not significant in younger females (10-18 year). No association was seen between energy intake from protein and carbohydrate with BMI in subjects before and after exclusion of misreporters. In conclusion, energy from fat was found to be independently and positively associated with obesity in adults. No other association was observed between energy from protein and carbohydrate with BMI.

Key Words: carbohydrate, fat, protein, macronutrients, obesity, BMI, Tehran Lipid and Glucose Study, Iran

Introduction

Overweight and obesity result from an imbalance that occurs when the calories consumed exceed the calories expended.[1] Recent data in Iran have shown a high prevalence of obesity[2-6], which is expected to rise in future years with increased urbanization, unless appropriate interventions aimed at improving lifestyles and enhancing nutritional awareness for people, are implemented. Prevention of obesity should, therefore, be a major health policy in Iran.

It is believed, mostly, that obese and overweight subjects consume more energy than normal people. Although some studies showed higher energy intakes in obese people as compared to normal ones,[7-9] others have suggested a role for an imbalanced intake of energy-generating nutrients in the development of obesity.[10,11] Complexity of energy metabolism in the body needs to evaluate the differential role of macronutrients in the development of obesity. Although animal studies have demonstrated that high-fat diets without excess energy lead to obesity, human studies investigating the relationship between obesity and diet composition, have failed to achieve consistent findings.[12-16] Some investigators contradict the relation of macronutrients to BMI independent of their energy content.[17,18] Others have suggested a positive relationship between fat intake and obesity,[19] whereas yet some others have rejected the relation of fat and carbohydrate intake to BMI and introduced protein intake to be a dietary factor conducive to obesity.[20,21] Most of these studies used absolute intake of macronutrients to find an association with BMI, while we know that energy intake is an important predictor of body mass index and this could confound the relation of macronutrients and BMI. Therefore it is more appropriate in epidemiologic studies to employ a measure of nutrient intake that is independent of total energy intake.[22] The aim of this study was, therefore, to assess the relationship between energy-adjusted amounts of macronutrients intake and body mass index in a group of Tehranian individuals.

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Methods and Materials

This cross-sectional study was conducted within the framework of Tehran Lipid and Glucose Study (TLGS), a prospective study aimed at determining the prevalence of non-communicable disease risk factors and developing a healthy lifestyle to curtail these risk factors in residents of district-13 of Tehran.[23]

The TLGS provides a repre-sentative sample of urban population of Tehran.[23] More than 15005 subjects aged over 3 years selected by multi-stage cluster random sampling method, 1475 individuals were randomly selected for dietary survey. In the present study data on 1290 subjects (565 males and 725 females) aged over 10 years, whose dietary data was available, were analyzed. This study was approved by the Ethical Committee of the Endocrine Research Center of Shaheed Beheshti University of Medical Sciences and informed written consent was obtained from all subjects.

Data collection

Subjects were interviewed face-to-face by trained dietitians using pretested questionnaires. Initially information on age, physical activity, educational level and smoking habits was collected. Weight was then measured while the subjects were minimally clothed and without shoes using a Seca 707 weighing machine (range: 0.1-150 kg) and recorded to the nearest 100g. The machine was repeatedly checked using a standard weight after every ten measurements. Height was measured with the subjects in a standing position without shoes and with shoulders in a normal position using tape meter with a minimum measurement of 1 mm.[24] To avoid subjective error, all measurements were taken by the same person. Body mass index was calculated as the ratio of weight in kilograms to the height in meters squared.

Dietary data was collected using two non-consecutive 24-hour dietary recalls. Trained dietitians, who had at least 5 years of experience in the Nationwide Household Food Consumption Survey Project, completed the recalls. The first recall was completed at the subject's home and the second by the same interviewer at the TLGS research unit within 3 days after the first recall. Individual family members were asked to recall the type and quantity of all foods and beverages consumed during the preceding 24-hours. To assist the subjects to recall accurately, household utensils were used. The questionnaires were validated 12 years ago in the Nationwide Household Food Consumption Survey Project, which has been reported in Farsi.[25] We revalidated them with 10 families before this study was begun (unpublished data). Portion sizes of con-sumed foods were converted to grams using household measures.[26] Each food and beverage was then coded according to the prescribed protocol and linked to a nutrient database using Nutritionist III software program designed for Iranian foods.

The basal metabolic rate (BMR) was calculated based on weight, height, age and sex according to the Harris and Benedict equation.[27] Under- and over-reporting of energy intake were defined according to Goldberg *et al.*,[28] and Black *et al.*,[29] as the ratio of energy intake (EI) to BMR <1.35 and ≥2.4, respectively. Educational level of subjects was scored as follows: illiterate=0, Nehzat (persons able to read and write) =2, elementary school=5, guidance school=9, high school graduate=12, intermediate=14, bachelors=16, masters and GP=18 and specialist=20. Based on the educational level scoring, subjects were grouped as low (<5), moderate- (6-12) and highly-educated (>12) persons. With regard to smoking habits, subjects were categorized as: daily-smokers, ex-smokers, occasional smokers and non-smokers. Data on physical activity, which has been reported earlier[30], was obtained using the Lipid Research Clinic (LRC) questionnaire. This questionnaire is a simple and comprehensible measure including four questions; no special education is needed to complete this questionnaire. Subjects were classified as having low, moderate and high levels of physical activity based on their oral responses to the questionnaire.

Statistical analysis

Subjects were divided into four age-categories: 10-18, 19-24, 25-50, >=51 years. Data were analyzed separately by sex, first for all subjects and then after excluding under- and over-reporters. Descriptive data on subjects' BMI was reported as cut-offs of quartiles. Distribution of subjects from different age groups in various categories of physical activity, education and smoking was calculated by cross tabulation. One-way analysis of variance was used to compare the absolute intake of macronutrients and their contribution to energy intake between different age groups. If there was a significant main effect, the Bonferroni test was used to determine the pairwise difference. Multiple linear regressions were used to evaluate the effects of energy-generating nutrients on BMI. As energy intake is one of the determinants of BMI, calorie-adjusted amounts of macronutrients were considered using standard methods as recommended by Willett.[22] Then, energy intakes from all calorie-adjusted macronutrients were simultaneously included in multiple regression models adjusting for age, physical activity, educational level and smoking habits. Total energy intake was not included to avoid collinearity, the so-called energy partition model.[22] In the results section, regression coefficients express changes in BMI for an increment of energy intake from the respective nutrient of 100 kcal. All the analyses were performed with the SPSS 9.05 (SPSS Inc. Chicago; IL). Significancy level was set at $P<0.05$.

Results

Mean ± standard deviation of age for men and women was 31.1±16.6 and 27.9±14.8 years, respectively. From among 725 females, 391 (54%) were under 25 years old, 261 (36%) between 25-50 years old and 73 (10%) over 50 years old. Of 565 males, 251 (44%) were aged under 25 years, 231(41%) were between 25-50 and 83(15%) were over 50 years old. Mean (± standard deviation) of body mass index in the age categories of 10-18, 19-24, 25-50 and 51+ y in men were 19.3 ± 3.8, 22.6 ± 4.2, 26.0 ± 4.1 and 25.7 ± 3.6 kg/m^2, respectively. After excluding under- and over-reporters, these figures changed to 19.3 ± 3.7, 22.3 ± 4.2, 25.7 ± 4.0 and 25.6 ± 3.6 kg/m^2, respectively. In women, mean body mass index for corresponding age categories were 20.1 ± 4.1, 22.8 ± 4.1, 27.6 ± 5.4 and 29.4 ± 3.9 kg/m^2, respectively, which changed to 19.6 ± 3.9, 22.1 ± 3.9, 26.4 ± 5.0 and 28.7 ± 3.9 kg/m^2, respectively, after excluding under- and over-reporters. Table 1 presents BMI quartiles by sex in various age groups. BMI increased with age in men until the age of 50. In the 10-18 year old group, a median of 18.4 kg/m^2 increased to a median of 25.5 among the 25-50 year age group. Such a trend was also seen in female subjects aged over 50, where a median of 19.6 among the 10-18 year group increased to a median of 29.6 among the over 50 year age group. Excluding under- and over-reporters had no significant effect on the median of BMI in males, but caused a decrement of approximately one unit in the BMI of females in the 19-24 and 25-50 year age-categories. Misreporting of energy intake increased with age and BMI. Distribution of subjects in various categories of smoking habits, educational levels and physical activity levels are presented in Table 2, separately by sex and age groups. Smoking was more common in men than in women. The proportion of daily-smoker in men increased with age until 50. Among men aged over 50 years, the proportion of ex-smokers was higher than in other groups. Almost all women were never-smokers. Most men and women of all age groups were moderately educated, except for those aged over 50, especially females, who had lower levels of education. Most men in the younger age-groups (10-18 and 19-24 years) had high levels of physical activity, while most of men in the 25-50 and 51+ age-categories had low levels of physical activity. Most of women in all age-categories had low levels of physical activity. The proportion of subjects with moderate levels of physical activity decreased with age for both men and women.

Mean and standard deviation of macronutrients intake (as gr/d) and their contribution to total energy intake (as percentage) are shown in Table 3. No significant difference was seen between different age-categories of men with regard to the percentage of energy from macronutrients.

Table 1. Cut-off points of quartiles of body mass index (in kg/m^2) by sex and age groups.

Age-groups (years)	Men				Women			
		Cut-offs of quartiles				Cut-offs of quartiles		
	N	1st	2nd	3rd	*N*	1st	2nd	3rd
All participants								
10-18	199	16.7	18.4	21.5	271	16.8	19.6	22.7
19-24	52	19.1	22.4	25.2	120	19.8	22.2	25.5
25-50	231	23.4	25.5	28.4	261	23.8	27.2	30.8
51+	83	23.7	25.0	27.5	73	29.6	29.6	31.9
Excluding under and over-reporters								
10-18	154	16.8	18.5	21.6	184	16.5	19.2	22.4
19-24	37	18.8	22.4	25.2	73	19.4	21.2	24.1
25-50	170	23.0	25.4	27.8	141	22.6	26.0	29.9
51+	58	23.6	24.8	27.5	38	25.6	28.9	31.8

Table 2. Smoking habits, educational levels and physical activity in 1290 Tehranians.

		Men				Women			
		Age-groups (years)				Age-groups (years)			
		10-18	19-24	25-50	51+	10-18	19-24	25-50	51+
Smoking									
	Daily	1.3 (1.5)*	10.6 (15)	26.5 (25.0)	13.5 (15.0)	0 (0)	0 (0)	1 (2)	2 (2)
	Occasionally	1.3 (1.5)	2.1 (3.0)	1.4 (1.0)	1.4 (2.0)	0 (0)	1 (1)	1 (0)	0 (0)
	Ex-smoker	1.3 (1.5)	2.1 (3.0)	12.1 (12.0)	20.3 (21.0)	1 (0)	0 (0)	1 (1)	0 (0)
	Never-smoker	96.0 (95.5)	85.1 (79.0)	60.0 (62.0)	64.9 (62.0)	99 (100)	99 (99)	97 (97)	98 (98)
Educational score									
	≤5	47 (46)	2 (3)	14 (15)	45 (41)	41 (44)	1 (2)	23 (24)	73 (73)
	6-12	53 (54)	96 (94)	66 (63)	38 (39)	59 (56)	89 (88)	67 (65)	23 (23)
	>12	0 (0)	2 (3)	20 (22)	17 (20)	0 (0)	10 (10)	10 (11)	4 (4)
Physical activity									
	Low	30 (33)	37 (36)	62 (66)	64 (64)	36 (35)	53 (54)	67 (70)	56 (52)
	Moderate	25 (24)	20 (19)	15 (14)	11 (15)	32 (33)	19 (15)	11 (10)	8 (8)
	High	45 (43)	43 (45)	23 (20)	25 (21)	32 (32)	28 (31)	22 (20)	36 (40)

*Numbers represent the percentage of subjects for all participants and figures in parenthesis represent the percentage of subjects after excluding under- and over-reporters.

Table 3. Mean and standard deviation of macronutrients intake (gr/d) and their contribution (%) to energy intake, by sex and age group

	Men				Women			
	Age-groups (years)				Age-groups (years)			
	10-18	19-24	25-50	51+	10-18	19-24	25-50	51+
All participants								
Protein (g)	75 ± 20	88 ± 29*	83 ± 23*	75 ± 24	63 ± 15†	59 ± 17	59 ± 17	53 ± 15
Protein (%)	11.1 ± 1.6	11.7 ± 1.8	11.3 ± 1.8	11.7 ± 1.9	11.1 ± 1.8†	11.6 ± 2.0	11.3 ± 2.1	12.0 ± 2.1
Carbohydrate (g)	4.4 ± 113	441 ± 122†	425 ±101†	379 ± 106	309 ± 87†	293 ± 84	310 ± 95†	273 ± 73
Carbohydrate (%)	59.3 ± 6.2	58.8 ± 6.5	58.4 ± 6.8	59.2 ± 7.2	57.4 ± 7.6†	56.9 ± 7.9†	58.1 ± 7.2†	60.9 ± 6.2
Fat (g)	91 ± 34	99 ± 39	100 ± 41†	83 ± 36	77 ± 32†	74 ± 31†	73 ± 31†	55 ± 24
Fat (%)	29.5 ± 6.6	29.3 ± 7.0	30.1 ± 7.1	28.9 ± 7.8	31.5 ± 7.5†	31.5 ±7.8†	30.5 ± 7.5†	26.9 ± 6.6
Excluding under- and over-reporters								
Protein (g)	75 ± 18	85 ± 21*	86 ± 21*	76 ± 17	68 ± 31	64 ± 15	67 ± 12	63 ± 14
Protein (%)	11.1 ± 1.5	11.4 ± 1.7	11.3 ± 1.8	11.6 ± 2.0	11.0 ± 1.7	11.2 ± 1.8	10.9 ±1.8	11.4 ± 2.1
Carbohydrate (g)	401 ± 94	438 ± 81*	438 ± 76*	391 ± 84	330 ± 64	324 ± 59	361 ± 71‡	325 ± 53
Carbohydrate (%)	59.2 ± 6.2	59.1 ± 6.5	57.9 ± 6.6	59.6 ± 7.5	57.0 ± 7.2	56.4 ± 7.9	57.8 ± 7.1	59.3 ± 6.7
Fat (g)	90 ± 31	97 ± 31	104 ± 33*	83 ± 29	84 ± 27	84 ± 26	87 ± 28†	71± 21
Fat (%)	29.6 ± 6.6	29.2 ± 7.2	30.6 ± 6.8	28.5 ± 8.3	32.2 ± 7.1†	32 ± 7.6†	31.2 ± 7.4	29.1 ± 6.8

*P<0.01 compared to the 10-18 and 51+ year age group. † P<0.01 compared to the 51+ year age category. ‡ P<0.01 compared to the 10-18, 19-24 and 51+ year age group

Women aged 10-18 years obtained lower percentage of their energy from protein compared to females aged over 51 (11.1± 1.8 vs 12.0±2.1, P<0.01). Women aged over 51, obtained more percentage of their energy from carbohydrate and less from fat, compared to females in other age groups. After excluding misreporters, the difference among females with regard to the percentage of energy from protein and carbohydrate ceased, while there was still significant difference between younger women (the age categories of 10-18 and 19-24) and older ones (the age category of 51+) with regard to the contribution of fat to total energy (32.2 ± 4.1 and 32.0 ± 7.6 vs 29.1 ± 6.8, respectively, P<0.01).

Table 4 presents the regression coefficients expressing changes of BMI for men per 100 kcal increments of energy intake from a particular macronutrient, adjusting for mutual effects of macronutrients, age, physical activity, smoking and educational levels. There was a significant positive relationship between fat intake and BMI in all age categories both in total subjects and after excluding of misreporters. This relationship was weak in lower age categories and tended to strengthen with age. After excluding of misreporters, the regression coefficients increased in all age groups, except for the 10-18 year age category. No significant association of protein intake to BMI was seen in different age groups, even after excluding for misreporters. Carbohydrate intake has a non-significant inverse association to BMI in various age groups of males, but after excluding misreporters it has a significant inverse association to BMI in the 10-18 year age category.

Table 5 presents the regression coefficients expressing changes of BMI for women per 100 kcal increments of energy intake from a particular macronutrient, adjusting for mutual effects of macronutrients, age, physical activity, smoking and educational levels. There was a significant positive relationship between fat intake and BMI in all age categories, except for the 10-18 year age category, both in total subjects and after excluding of misreporters. This relationship was weak in lower age categories and tended to strengthen with age. After excluding of misreporters, the regression coefficients increased in all age groups. No significant association of protein and carbohydrate intake to BMI was seen in different age groups, even after excluding misreporters.

Discussion

Overweight and obesity are major health problems worldwide. Although investigations conducted in the second half of the 20th century, have increased our information about their etiology, pathophysiology and treatment, efficient procedures for prevention and treatment are still lacking.

The present study conducted on an urban popu-lation of Tehran showed a direct and positive relationship between fat intake and BMI, controlling for confounding variables. The findings of this study are based on observational and cross-sectional data, as are the specified limitations of these studies.[22,31]

We used calorie-adjusted amounts of macronutrients that were simultaneously included in the model and observed a positive relationship between fat intake and BMI both in all subjects and after excluding of misreporters in all age categories, except for the adolescent female group, as adolescence is a period of life associated with growth and development, when it is difficult to observe the relationship between fat intake and BMI. Other investigators also reported the relationship between fat intake and BMI. Satia-About *et al.*,[19] in a cross-sectional study of men, aged 55-79, pointed out that after controlling for demographic and health-related characteristics, BMI increased by 0.53 and 0.14 kg/m^2 for every 500 kcal of fat and total energy consumed, respectively. This result emphasizes the more significant contributing effect of fat in obesity as compared to energy. Other human[32-34] and animal studies[35], also, showed such findings.

Table 4. Regression coefficients expressing changes of BMI for an increment of 100 kcal of energy intake from the specified nutrient among men, controlling for age, physical activity, educational level, smoking and mutual effects among the nutrients

	Age-groups (years)			
	10-18	19-24	25-50	51+
All participants				
Protein	0.08 (-0.02, 0.18)*	0.05 (-0.02, 0.12)	0.06 (-0.03, 0.15)	0.02 (-0.04, 0.08)
Carbohydrate	-0.02 (-0.06, 0.02)	-0.05 (-0.11, 0.01)	-0.03 (-0.09, 0.03)	-0.09 (-0.2, 0.02)
Fat	0.06 (0.01, 0.11)	0.13 (0.06, 0.20)	0.33 (0.27, 0.39)	0.48 (0.41, 0.55)
Excluding under and over-reporters				
Protein	0.07 (-0.01, 0.15)	0.06 (-0.02, 0.14)	0.08 (-0.02, 0.18)	0.03 (-0.02, 0.08)
Carbohydrate	-0.04 (-0.07, -0.01)	-0.07 (-0.15, 0.01)	-0.03 (-0.08, 0.02)	-0.1 (-0.21, 0.01)
Fat	0.06 (0.02, 0.10)	0.15 (0.07, 0.23)	0.36 (0.29, 0.43)	0.50 (0.44, 0.56)

*Figures represent regression coefficients (β) and figures in parenthesis show 95% confidence intervals.

Table 5. Regression coefficients expressing changes of BMI for an increment of 100 kcal of energy intake from the specified nutrient among women, controlling for age, physical activity, educational level, smoking and mutual effects among the nutrients.

	Age-groups (years)			
	10-18	19-24	25-50	51+
All participants				
Protein	0.04 (-0.02, 0.1)*	0.03 (-0.02, 0.08)	0.06 (-0.06, 0.16)	0.03 (-0.01, 0.07)
Carbohydrate	-0.10 (-0.21, 0.01)	0.06 (-0.04, 0.1)	-0.03 (-0.08, 0.02)	-0.11 (-0.25, 0.04)
Fat	0.09 (-0.02, 0.2)	0.17 (0.09, 0.25)	0.43 (0.31, 0.55)	0.52 (0.39, 0.65)
Excluding under and over-reporters				
Protein	0.05 (-0.03, 0.11)	0.05 (-0.03, 0.13)	0.1 (-0.04, 0.24)	0.06 (-0.02, 0.14)
Carbohydrate	-0.12 (-0.25, 0.01)	0.08 (-0.06, 0.22)	-0.06 (-0.14, 0.02)	-0.09 (-0.23, 0.05)
Fat	0.13 (-0.01, 0.27)	0.21 (0.13, 0.29)	0.46 (0.36, 0.56)	0.54 (0.43, 0.63)

*Figures represent regression coefficients (β) and figures in parenthesis show 95% confidence intervals.

In contrast to our findings, some researchers contradict the relationship between fat intake and obesity. Willett[17,18] suggested that despite decline in energy from fat in the United States, during the past 25 years, the prevalence of obesity has increased significantly. It should be noted that the decrement of energy from fat was only 3-5% and would not necessarily be associated with a decline in body weight.[33] Moreover, obesity has causes other than an inappropriate diet and is a multifactorial disease. On the other hand, these researchers ignore the effect of underreporting in their study. Other studies in European[36] and Asian countries[37] also, found no relationship between fat intake and obesity. The findings of these studies have several limitations, such as lack of control for the effect of physical activity level, smoking and cultural attitudes to body fat. In addition, some of these studies[37] used food balance sheet data that may be inaccurate. Fat intake could be assessed by several methods such as 24-hour recalls, food frequency questionnaires or weighed records. The differences in validity and reliability of these methods could explain, to some extent, the different findings.

The mechanism by which fat intake increases body fat, is not precisely known. Several mechanisms have been suggested by physiological studies. 1) Energy from fat is less satiating than energy from carbohydrate and a high fat: carbohydrate ratio in the diet promotes passive over consumption and finally a positive energy balance and weight gain. 2) Fat is more readily absorbed from the intestine and fecal energy loss is much lower with a high-fat diet. 3) The thermogenic effect of fat is lower than that of other macronutrients. 4) Increasing the intake of non-fat nutrients stimulates their oxidation rates proportionally but an increase in fat intake does not stimulate fat oxidation and eventually positive fat balance results.[38]

We observed a significant weak and inverse association of carbohydrate intake to BMI in the lower age category after excluding misreporters; whereas such an association was not found in other age categories. Also, we found no evidence that protein intake is associated with obesity. This finding is in contrast with some studies[20,–21] that have found a strong positive relationship between protein intake and obesity and introduced protein as the main underlying reason for the increasing prevalence of obesity in the western countries.[39]

Difference in design, analysis and dietary assessment methods used could, to some extent, explain this controversy. Also the effect of ethnicity on the association of body mass index and diet composition should be kept in mind. Ethnic groups differ with respect to their susceptibility to certain diseases and to the severity of their expression. Moreover, differences among different races in body composition are being documented systematically. However, a recent study showed that the relation between macronutrients intake and central adiposity was not modified by ethnicity.[40]

There are several limitations that should be considered when examining the results of this study. The primary ifficulty with the study is using a cross-sectional design to find the association of macronutrients intake with BMI. It must, however, be kept in mind that appropriate analy-sis of cross-sectional data represent a valuable initial step in identifying relationships between diet and disease. Moreover prospective cohort studies and clinical trials have their own weaknesses. The second limitation of the study is the reliance on two days of recall as a measure of usual dietary intake. The 24-hour recall method is susceptible to recall bias, both for identification of foods eaten and for quantification of portion sizes. Collecting dietary data by highly trained interviewers in this study reduce this type of error. Although recalling two days cannot cover all day-to-day variations in dietary intake, using non-consecutive days extends their coverage.[41] Finally obesity is a heterogeneous and multifactorial disease and besides dietary factors, other variables such as hereditary factors and metabolic conditions must be considered.

Given the aforementioned limitations, we have found evidence indicating that fat intake is independently and positively associated with obesity. No other association, positive or inverse, was seen between protein and carbohydrate intake and BMI.

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Original Article

Diet composition and body mass index in Tehranian adults

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尽管有许多研究人体常量营养素的摄入与肥胖症的关系的实验，但结论却不一致。本项研究的目的是为了研究常量营养素对德黑兰成人的体重指数的影响。我们从德黑兰脂肪和葡萄糖课题中随机选取 15005 名志愿者，从中任意选了 1290 名年龄大于 10 岁（男女组分别为 565 个和 725 个）的志愿者进行饮食普查。依据标准实验设计对这些试验者的人体测量指标进行测量以及计算 BMI。饮食资料是经受训过的会见者通过两次不连续的 24 小时回忆法收集的。同时对这些志愿者的吸烟情况，教育水平以及体育活动等情况进行了汇集。能量摄入不足或过量报告分别定义为 EI: BMR 的比值小于 1.35 或大于或等于 2.4。卡路里调整过的常量营养素的量是用剩余法计算的，然后从所有卡路里调整过的常量营养素的能量摄入被自动地包括在对年龄、体力活动、教育水平以及吸烟和常量元素之间的相互作用影响控制的多重回归模型里，为了避免共线性总能量的摄入就不包括在里面。不管男性还是女性 BMI 值随着年龄而增加。控制各种混消变量后，脂肪源性能量分别与男性 10-18, 19-24, 25-50 以及大于 51 的四个年龄段 (β=0.06, 0.13, 0.33, 0.48, 对全体 $P<0.05$)，与女性 19-24, 25-50 以及大于 51 的三个年龄段(β=0.17, 0.43, 0.52, 对全体 $P<0.05$)的 BMI 成正向相关。这种关系在排除错误记录后仍然成立（在相应的年龄段对男性 β=0.06, 0.15, 0.36, 0.50，对女性 β= 0.21, 0.46, 0.54）。脂肪摄入与 BMI 的相关性在年青女性不显著（10－18 岁）。不管在排除错误记录前和后蛋白质源性能量和碳水化合物源性能量与 BMI 值之间没有相关性。结论：在成年人脂肪源性能量与肥胖症独立地正向相关，而蛋白质和碳水化合物所提供的能量与肥胖症无关。

关键词：碳水化合物、脂肪、蛋白质、大量元素、肥胖症、BMI、德黑兰脂类和糖类研究报告、伊朗。