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Dietary Factors and Body Mass Index in a Group of Iranian Adolescents: Tehran Lipid and Glucose Study-2

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Abstract: *Objective:* To study the prevalence of overweight and obesity in an adolescent population in Tehran and to determine possible association with energy and nutrient intake and distribution of energy over the day.

Method: A cross-sectional study on 177 boys and 244 girls between 10–19 years old was performed. Overweight and obesity were defined by using recommended body mass index (BMI) cut-off values for adolescents. Total energy intake, percent of energy derived from protein, carbohydrate and fat and percent of energy supplied by each meal and snack were assessed by means of two 24-hour dietary recalls.

Results: Prevalence of overweight and obesity was 10.7 and 5.1 in boys and 18.4 and 2.8 in girls, respectively. The composition of diet was not different between overweight/obese and normal weight subjects. BMI was related with breakfast energy percentage in girls ($r = -0.18$, $p < 0.01$), with total energy intake in boys ($r = 0.23$, $p < 0.01$), and with lunch energy percentage in both sexes. In boys ($r = 0.16$, $p < 0.05$) and in girls ($r = 0.22$, $p < 0.01$).

Conclusion: High prevalence of overweight and obesity among adolescents was seen. In boys some relationship between total energy intake, distribution of energy over the day and BMI was seen. In girls BMI was only related with distribution of energy over the day.

Key words: Obesity, adolescents, dietary survey, energy intake, breakfast

Introduction

Obesity is defined as an excess amount of body fat. The prevalence of obesity has increased over the past three decades, in children as well as in adults [1]. Obesity in growing years has many short and long-term adverse effects. Compared with normal weight children, obese children have higher blood pressure, higher plasma insulin levels, and a more atherogenic lipid pattern [1–4]. Also obesity has a variety of adverse psychosocial consequences such as completion of fewer years of education, higher rates of poverty, and lower rates of marriage and household income [5]. The greatest health burden of overweight in children and adolescents arises from long-term consequences. Obese children are at increased risk for obesity as adults and approximately 50% of obese adolescents become obese adults [5]. Obesity present in childhood or adolescence seems to increase the likelihood of adult morbidity and mortality. In men who were obese during adolescence, all cause mortality and mortality

from cardiovascular disease and colon cancer were increased [5].

Although obesity has strong genetic determinants, the increasing prevalence of obesity in populations around the world suggests that environmental factors are promoting or exacerbating the problem. One of the major environmental factors that contribute to obesity are dietary factors. When energy intake is in excess of energy expenditure and hence requirements, energy stored will increase and hence there will be an increase in body fat potentially leading to obesity. But it would appear that an imbalance in energy intake is not the only factor in the etiology of obesity. The composition of the diet also seems to be a determinant [6]. Many studies suggested that a diet higher in fat and lower in carbohydrates, independent of total energy intake, may contribute to obesity [6–8]. In addition effect of distribution of energy over the day on development of obesity has been studied. Many studies indicated that obesity was related to lower intake at breakfast [9] and higher intake at lunch and/or dinner [10, 11].

The aim of this study is to investigate the prevalence of overweight and obesity in an adolescent group representative of an urban population in Tehran, the capital of Islamic Republic of Iran, and to determine possible association with energy and nutrient intakes and distribution of energy over the day in two groups of normal and overweight/obese adolescents.

Methods

Study population

Tehran lipid and glucose study (TLGS) is a study to determine the risk factors for atherosclerosis among Tehran urban population and to develop population-based measures to change the life-style of the population and to prevent the rising trend of diabetes mellitus and dyslipidemia. The design of this study encompass two major components: phase 1 is a cross sectional prevalence study of CVD and associated risk factors and phase 2 is a prospective follow up study for 20 years. A multistage stratified cluster random sampling technique was used to select 17 000 people aged 3 to 69 years from Tehran urban district-13. So far about 11 000 subjects were studied. A subsidiary population aged 10–19 years old consisting of 421 subjects (177 boy and 244 girl) was randomly selected for dietary assessments.

Anthropometric Study

Weight and height were determined, without shoes, using a digital electronic weighing scale (Seca 707; range 0.1–150 kg) and tape meter stadiometer, respectively. From the anthropometric data the body mass index was calculated (BMI, weight/height^2, kg/m^2).

Overweight and obesity was defined according to recommended BMI cut-off values for adolescents [12]. Subjects were divided into two groups: (1) overweight and obese (O) and, (2) normal weight (NW) subjects.
Basal Metabolism Rate (BMR) was estimated using Harris and Benedict equation which take into account age, sex, weight and height [13]. Underreporters were identified using the cut-off value of energy intake/BMR < 1.27 [14].

Dietary assessment

Energy intake, percent of energy intake derived from protein, fat and carbohydrate, and percent of energy intake from each meal and snack were assessed by means of two 24-hour dietary recall. The 24-hour dietary recall describes the reported intakes from midnight to midnight, meal after meal. The first recall was performed at subjects, home and the second at a clinic visit in the diet unit of TLGS. These two days were among the usual days for subjects. Mothers were asked about type and quantity of meals when subjects were unable to recall.

Standard reference tables were used to convert household portions to grams for computerization. Following coding of diaries, the dietary recall form was linked to a nutrient database (Nutritionist III) and nutrient intakes calculated from quantity of food consumed.

Statistical Analysis

Statistical analyses were done with an IBM computer using the SPSS 9.05 statistical software package (SPSS Inc., Chicago, IL), and data were presented as mean and standard deviation. Data were adjusted for age when indicated. All analyses were performed separately for boys and girls. The degree of significance of differences between means was calculated using Student's *t*-test. Pearson correlation coefficients between dietary and anthropometric data were also calculated. Two tailed tests were used, and p-values of less than 0.05 were considered to be significant.

Results

The subjects of this study were 177 (42%) boys and 244 (58%) girls between ages 10 and 19. Prevalence of overweight and obesity was 10.7% and 5.1% in boys and 18.4% and 2.8% in girls, respectively. Significant differences

were seen between O and NW subjects with respect to body weight and BMI in both sexes. Overweight/obese girls were significantly taller than NW peers (Table I).

Overweight/obese boys had an apparently higher energy intake than their normal weight counterparts. Although the amount of protein and fat consumed was higher in O than NW boys, the contribution of each of macronutrients to total energy intake was similar in both sexes (Table II).

Comparison of percentage of energy provided by each meal and snack between O and NW subjects in each gender is shown in Table 3. Overweight/obese adolescents ate less at breakfast and more at lunch than leaner peers, but such difference was only significant in girls. In addition, O girls consumed more between dinner and bedtime than their NW counterparts (Table III).

Correlation between BMI and dietary factors, after adjustment for age, showed that in boys BMI was positively related to total energy intake ($r = 0.23$, $p < 0.01$), percentage of energy provided by lunch ($r = 0.16$, $p < 0.05$), and negatively related to percent of energy provided by the snack between lunch and dinner ($r = –0.16$, $p < 0.05$). In girls BMI was positively related to percentage of energy provided by lunch ($r = 0.22$, $p < 0.01$), percentage of energy provided by afterdinner snack ($r = 0.18$, $p < 0.01$), and negatively with breakfast energy percentage ($r = –0.18$, $p < 0.01$).

Nine percent of NW and 11% of O boys underreported their energy intake. In girls 14% of NW and 29% of O subjects underreported their energy intake ($p < 0.05$). Underreporting was more prevalent in girls than in boys (17% vs. 9%, $p < 0.05$).

Table I: Anthropometric data of study population

	Boys		Girls	
	Overweight/Obese	Normal	Overweight/Obese	Normal
Number	28	149	52	192
Age (years)	13.9 ± 2.2	14.3 ± 2.7	15.0 ± 2.6	14.2 ± 2.8
Height (cm)	163 ± 12	160 ± 16	158 ± 8*	154 ± 11
Weight (kg)	70 ± 16*	48 ± 14	66 ± 12*	45 ± 11
BMI (kg/m^2)	26.1 ± 3.8*	18.3 ± 2.8	26.3 ± 3.0*	18.7 ± 3.0

BMI, body mass index
* $p < 0.001$ compared with normal weight group.

Table II: Differences in the intake of energy and nutrients between overweight/obese and normal weight subjects

	Boys		Girls	
	Overweight/Obese	Normal	Overweight/Obese	Normal
Energy intake (kcal)	3032 ± 720*	2636 ± 722	2191 ± 723	2150 ± 558
Protein (gr)	82 ± 20†	73 ± 19	61 ± 22	65 ± 53
Protein (%)	10.8 ± 1.6	11.1 ± 1.6	11.2 ± 2.5	11.3 ± 1.7
Carbohydrate (gr)	436 ± 102	396 ± 115	317 ± 108	312 ± 82
Carbohydrate (%)	57.6 ± 5.1	59.5 ± 6.6	57.6 ± 8.0	57.7 ± 7.5
Fat (gr)	107 ± 35*	88 ± 34	79 ± 37	76 ± 31
Fat (%)	31.5 ± 5.4	29.3 ± 7.0	31.0 ± 8.1	31.2 ± 7.3

* $p < 0.01$, † $p < 0.05$ compared with normal weight group.

Table III: Percentage of energy provided by each meal and snack in overweight/obese and normal weight subjects.

	Boys		Girls	
	Overweight/Obese	Normal	Overweight/Obese	Normal
Breakfast (%)	12.9 ± 6.9	14.7 ± 6.7	10.0 ± 7.1*	13.0 ± 7.6
Between breakfast and lunch (%)	4.2 ± 5.4	4.7 ± 6.8	6.5 ± 7.0	6.8 ± 7.3
Lunch (%)	39.5 ± 8.5	37.4 ± 9.6	42.7 ± 12.0†	37.9 ± 11.5
Between lunch and dinner (%)	9.6 ± 5.7	10.4 ± 7.9	10.1 ± 7.1	11.3 ± 7.7
Dinner (%)	31.8 ± 9.5	30.5 ± 9.9	28.1 ± 10.3	29.3 ± 10.1
Between dinner and bedtime (%)	2.2 ± 2.1	19.9 ± 2.1	2.5 ± 2.6*	1.7 ± 2.4

* $p < 0.05$, † $p < 0.01$ compared with normal weight group.

Discussion

Prevalence of overweight and obesity in adolescents in our study was relatively equal to that reported in white American peers (National Health and Nutrition Examination Survey III) [15]. However, this prevalence was greater than other studies previously reported in Iran. This may be due to different BMI cut-off references or actually increased prevalence of overweight and obesity.

In this study no differences were found between NW and O girls with respect to energy intake. In boys energy intake was significantly higher in O than NW groups. Many studies show that energy intake was positively associated with overweight as expressed by the BMI in both males and females [16, 17]. On the other hand some studies reported no difference in energy intake between obese and normal weight subjects [7, 18, 19] or even lower energy intake in obese than normal subjects [8, 20]. These studies stated that this finding may be due to underreporting of energy intake that was observed more frequently in obese than normal weight peers [8, 20]. In addition blunt physical activity in obese may result in a positive energy balance in this group [20]. However, it must be kept in mind that the methods available for energy intake measurements are imprecise, and may easily overlook the minor excess of energy intake over a long period of time, required to result in obesity. In this study obese boys had higher energy intake than NW boys. Such finding was not seen in girls. Underreporting was more prevalent in O than in NW girls but this difference was not observed in O and NW boys. This phenomenon could explain lack of association between energy intake and BMI in girls. This is in agreement with many other studies that showed underreporting that is more prevalent in women than in men [14, 21, 22] and more frequent and severe among obese persons than lean persons [14, 23–25].

Protein, carbohydrate and fat intakes expressed as percentage of total energy intake were not different in O and NW group in both sexes. Although in O boys percentage of energy intake derived from carbohydrate was lower and percent of energy intake derived from fat was higher than normal, this difference was not statistically significant. Several studies showed that dietary composition (high fat energy percentage and low carbohydrate energy percentage), independent from total energy intake contributes to obesity in adolescents [7, 8, 16].

Study of the distribution of energy in meals and snacks over the day showed that energy provided by breakfast was lower and energy provided by lunch and after dinner snack was higher in O than NW groups, but such difference was only significant in girls. In both sexes BMI was positively related with lunch energy percentage. In girls BMI was negatively related with breakfast energy percentage. In one study that compared breakfast habits of obese and normalweight schoolchildren, invastigators showed that obese subjects not only omitted breakfast more commonly than normal subjects but also took smaller quantities of energy at breakfast [9]. Several studies have indicated that the omission of breakfast, or the consumption of an insufficient breakfast, could contribute towards dietary imbalances and less satisfactory food habits over the rest of the day [26–28]. Results from the U.S.D.A. Nationwide Food Consumption Survey also indicate that breakfast eating increases the quality of the total diet [29]. Children with a high BMI reported a lower intake at breakfast and of afternoon snacks, but a higher intake at lunch and dinner, compared to children with a lower BMI [10]. In an other study, the percentage distribution of the intake of energy among the different meals, particularly at dinner, contributed to explain inter-individual variance of fatness in children of both sexes [30].

In summary, in this study high prevalence of overweight and obesity among adolescents was seen. In boys some relationship between total energy intake, distribution of energy over the day and BMI was seen. In girls BMI was only related with distribution of energy over the day. We have failed to find a relationship between diet composition and body size as measured by BMI.

An important reason to treat obese children is to reduce the risk for future cardiovascular disease. Currently, there are no clear or easy strategies that are effective in clinical treatment of obesity in children or adults. The best management is prevention. In order to prevent obesity, it appears necessary not only to regulate energy intake, but also to control the composition of the diet, have an adequate breakfast, and provide better distribution of total calorie intake across the day, avoiding its concentration into one or two meals. Given that it is during infancy and childhood that feeding habits are developed, it is important to ensure that correct habits are acquired and special attention should be given to improving the dietary habits in this time.

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References

1. Falkner, B. and Michel, S. (1999) Obesity and other risk factors in children. Ethn. Dis. 9, 284–289.
2. Caprio, S. and Tamborlane, W.V. (1999) Metabolic impact of obesity in childhood. Endocrinol. Metab. Clin. North. Am. 28, 731–747.
3. Himes, J.H. and Dietz, W.H. (1994) Guidelines for overweight in adolescent preventive services: recommendations from an expert committee. The Expert Committee on Clinical Guidelines for Overweight in Adolescent Preventive Services. Am. J. Clin. Nutr. 59, 307–316.
4. Rocchini, A.P. (1992) Adolescent obesity and cardiovascular risk. Pediatr. Ann. 21, 235–240.
5. Dietz, W.H. (1998) Childhood weight affects adult morbidity and mortality. J. Nutr. 128, 411S–414S.
6. Miller, W.C., Lindeman, A.K., Wallace, J. and Niederpruem, M. (1990) Diet composition, energy intake, and exercise in relation to body fat in men and women. Am. J. Clin. Nutr. 52, 426–430.
7. Ortega, R.M., Requejo, A.M., Andres, P., Lopez-Sobaler, A.M., Redondo, R. and Gonzalez-Fernandez, M. (1995) Relationship between diet composition and body mass index in a group of Spanish adolescents. Br. J. Nutr. 74, 765–773.
8. Garaulet, M., Martinez, A., Victoria, F., Perez-Llamas, F., Ortega, R.M. and Zamora, S. (2000) Difference in dietary intake and activity level between normal-weight and overweight or obese adolescents. J. Pediatr. Gastroenterol. Nutr. 30, 253–258.
9. Ortega, R.M., Requejo, A.M., Lopez-Sobaler, A.M., Quintas, M.E., Andres, P., Redondo, M.R., Navia, B., Lopez-Bonilla, M.D. and Rivas, T. (1998) Difference in the breakfast habits of overweight/obese and normalweight schoolchildren. Int. J. Vitam. Nutr. Res. 68, 125–132.
10. Bellisle, F., Rolland-Cachera, M.F., Deheeger, M. and Guilloud-Bataille, M. (1988) Obesity and food intake in children: evidence for a role of metabolic and/or behavioral daily rythms. Appetite. 11, 111–118.
11. Silverstein, L.J. (1995) The relationship of breakfast eating to body weight. Obesity Research 3 (suppl 3), 97.
12. Must, A., Dallal, G.E. and Dietz, W.H. (1991) Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ht2) and triceps skinfold thickness. Am. J. Clin. Nutr. 53, 839–846.
13. Johnson, R.K. (2000) Energy. In: Krause's Food, Nutrition, & Diet Therapy. (Mahan, L.K., Escott-Stump, S., eds.) p. 26, W.B. Saunders, Philadelphia.
14. Hirvonen, T., Mannisto, S., Roos, E. and Pietinen, P. (1997) Increasing prevalence of underreporting does not necessarily distort dietary surveys. Eur. J. Clin. Nutr. 51, 297–301.
15. Troiano, R.P. and Flegal, K.M. (1998) Overweight children and adolescents: Description, epidemiology and demographics. Pediatrics 101, 497.
16. Nelson, L.H. and Tucker, L.A. (1996) Diet composition related to body fat in a multivariate study of 203 men. J. Am. Diet. Assoc. 96, 771–977.
17. Fricker, J., Fumeron, F., Clair, D. and Apfelbaum, M. (1989) A positive correlation between energy intake and body mass index in a population of 1312 overweight subjects. Int. J. obes. 13, 673–81.
18. Miller, W.C., Lindeman, A.K., Wallace, J. and Niederpruem, M. (1990) Diet composition, energy intake, and exercise in relation to body fat in men and women. Am. J. Clin. Nutr. 52, 426–430.
19. Guillaume, M., Lapidus, L. and Lambert, A. (1998) Obesity and nutrition in children. The Belgian Luxembourg Child Study IV. Eur. J. Clin. Nutr. 52, 323–328.
20. Maffeis, C., Pinelli, L. and Schutz, Y. (1996) Fat intake and adiposity in 8 to 11-year-old obese children. Int. J. Obes. Relat. Metab. Disord. 20, 170–174.
21. Johnson, R.K., Goran, M.I. and Poehlman, E.T. (1994) Correlates of over- and underreporting of energy intake in healthy older men and women. Am. J. Clin. Nutr. 59, 1286–1290.
22. Price, G.M., Paul, A.A., Cole, T.J. and Wadsworth, M.E. (1997) Characteristics of the low-energy reporters in a longitudinal national dietary survey. Br. J. Nutr. 77, 833–851.
23. Prentice, A.M., Black, A.E., Coward, W.A., Davies, H.L., Goldberg, G.R., Murgatroyd, P.R., Ashford, J., Sawyer, M. and Whitehead, R.G. (1986) High levels of energy expenditure in obese women. Br. Med. J. (Clin. Res. Ed.). 292, 983–987.
24. Lichtman, S.W., Pisarska, K., Berman, E.R., Pestone, M., Dowling, H., Offenbacher, E., Weisel, H., Heshka, S., Matthews, D.E. and Heymsfield, S.B. (1992) Discrepancy between self-reported and actual caloric intake and exercise in obese subjects. N. Engl. J. Med. 327, 1893–1898.
25. Samaras, K., Kelly, P.J. and Campbell, L.V. (1999) Dietary underreporting is prevalent in middle-aged British women and is not related to adiposity (percentage body fat). Int. J. Obes. Relat. Metab. Disord. 23, 881–888.
26. Schlundt, D.G., Hill, J.O., Sbrocco, T., Pope-Cordle, J. and Sharp, T. (1992) The role of breakfast in the treatment of obesity: a randomized clinical trial. Am. J. Clin. Nutr. 55, 645–651.
27. Hanes, S., Vermeersch, J. and Gale, S. (1984) The National Evaluation of School Nutrition Programs: program impact on dietary intake. Am. J. Clin. Nutr. 40 (2 Suppl), 390–413.
28. Morgan, K.J., Zabik, M.E. and Leveille, G.A. (1981) The role of breakfast in nutrient intake of 5- to 12-year-old children. Am. J. Clin. Nutr. 34, 1418–1427.
29. Morgan, K.J., Zabik, M.E. and Stampley, G.L. (1986) The role of breakfast in diet adequacy of the U.S. adult population. J. Am. Coll. Nutr. 5, 551–563.
30. Maffeis, C., Provera, S., Filippi, L., Sidoti, G., Schena, S., Pinelli, L. and Tato, L. (2000) Distribution of food intake as a risk factor for childhood obesity. Int. J. Obes. Relat. Metab. Disord. 24, 75–80.

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