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Original

Food habits and nutritional status of adolescents in Emilia-Romagna, Italy

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Abstract

Introduction: **The prevalence of childhood and adolescent obesity is increasing, with negative medical and psychosocial consequences.**

Aims: **This study examines the association between weight status and nutrient intake, sport and leisure habits of middle school students in Bologna (Italy).**

Methods: **Anthropometric data (height, weight) of 598 subjects (321 males and 277 females) 11-14 years old were collected. Questionnaires on nutrient intake, sport and leisure behaviour were administered.**

Results: **Protein, carbohydrate and total fat intakes of the adolescents were higher than the recommended ranges in all age groups and in both sexes. The proportion of energy from protein and total fat was higher than recommended, but the percentage from carbohydrate was lower. A significant proportion of the adolescents had a cholesterol intake above the Italian RDA and lower than recommended intakes for micronutrients. The prevalence of overweight and obesity is higher in males than in females at all ages (overweight: 35.2 *vs* 31.6 at 11 yrs.; 27.5 *vs* 20.2 at 12 yrs.; 18.6 *vs* 17.8 at 13 yrs.; 18.7 *vs* 10.9 at 14 yrs.; obesity: 5.5 *vs* 3.2 at 12 yrs.; 3.9 *vs* 1.1 at 13 yrs.; 5.3 *vs* 3.6 at 14 yrs.), except in subjects 11 years old (obesity: 7.4 *vs* 10.5). The overweight and obese adolescents consumed less carbohydrates and less fibre than their normal weight and underweight counterparts.**

Conclusion: **The results of the present study indicate an unbalanced diet of the Bologna adolescents, which could damage their health and quality of life.**

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HÁBITOS ALIMENTICIOS Y ESTADO NUTRICIONAL DE LOS ADOLESCENTES DE EMILIA-ROMAGNA, ITALIA

Resumen

Introducción: **La prevalencia de la obesidad de la infancia y la adolescencia sigue aumentando con sus consecuencias negativas médicas y psicológicas.**

Objetivos: **Este estudio explora la asociación entre el estado del peso y la ingesta de nutrientes, deporte y hábitos de ocio de estudiantes de grado medio en Bolonia (Italia).**

Métodos: **Se recogieron los datos antropométricos (talla, peso) de 598 individuos (321 chicos y 277 chicas) de 11-14 años. Se administraron cuestionarios de ingesta de nutrientes, deporte y hábitos de ocio.**

Resultados: **La ingesta de proteínas, hidratos de carbono y grasa total de los adolescentes fue superior a los rangos recomendados para todos los grupos de edad y ambos sexos. La proporción de energía procedente de las proteínas y la grasa total fue superior a la recomendada, pero el porcentaje procedente de hidratos de carbono fue inferior. Una proporción significativa de adolescentes tenía un consumo de colesterol por encima de las CDR de Italia e ingestas menores a las recomendadas de micronutrientes. La prevalencia de sobrepeso y obesidad es mayor en hombres que en mujeres de cualquier edad (sobrepeso: 35,2 frente a 31,6 a los 11 años; 27,5 frente a 20,2 a los 12 años; 18,6 frente a 17,8 a los 13 años; 18,7 frente a 10,9 a los 14 años; obesidad: 5,5 frente a 3,2 a los 12 años; 3,9 frente a 1,1 a los 13 años; 5,3 frente a 3,6 a los 14 años), excepto en los individuos de 11 años de edad (obesidad: 7,4 frente a 10,5). Los adolescentes con sobrepeso y obesos consumen menos hidratos de carbono y fibra que sus iguales con peso normal o inferior al normal.**

Conclusión: **Los resultados de este estudio indican una dieta desequilibrada en los adolescentes boloñeses lo que podría perjudicar su salud y calidad de vida.**

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Palabras clave: *Hábitos alimenticios. Estado nutritivo. Adolescentes.*

Introduction

The prevalence of obesity among adults, children and adolescents is increasing worldwide (Allison et al., 1999[1]; Bundred et al., 2001;[2] Graf et al., 2004)[3], with negative medical (Whitlock et al., 2005;[4] Baker et al., 2007;[5] McMahan et al., 2007;[6] Freedman et al., 2008;[7] Juonala et al., 2008;[8] McGill et al., 2008;[9] Viikaria et al., 2009)[10] and psychosocial consequences (Graf et al., 2004;[3] Cornette, 2008;[11] Fonseca et al., 2008)[12]. Medical problems include pre-diabetes and diabetes, cardiovascular, pulmonary, orthopaedic and gastrointestinal diseases, and psychological problems (Freedman et al., 1999,[13] 2008;[7] Must et al., 1992;[14] Clarke et al., 1986;[15] Johnson et al., 1975;[16] Morrison et al., 1979;[17] Sinha et al., 2002;[18] Pinhas-Hamiel et al., 1996;[19] Richards et al., 1985;[20] Juonala et al., 2008;[8] McGill et al., 2008[9] Viikaria et al., 2009)[10]. Type 2 diabetes is increasingly observed in overweight youth.

Research over the past 40 years suggests that overweight children are at increased risk of becoming obese adults (Abraham and Nordsieck, 1960,[21] 1970;[22] Guo et al., 2002)[23]. This relationship becomes stronger as the degree of overweight becomes more serious. According to Guo et al. (2002)[23], a child or adolescent with a high BMI has a high risk of being overweight or obese at 35 years of age, and this risk increases with age. The child's age is important in a risk assessment for adult obesity: the older the child, the more likely his or her overweight status will persist into adulthood (Tsiros et al., 2007)[24]. Yet, a younger age of onset of overweight is associated with an ultimately more severe obesity. Adolescence is a vulnerable period for the development of obesity, and adolescent weight tracks strongly into adulthood. Comparisons of overweight and normal weight schoolchildren have found a relative risk for adult obesity of 2.39 to 6.55% (Charney et al., 1976;[25] Stark et al., 1981;[26] Guo et al., 1999)[27]. Gender also interacts with age in predicting adult obesity (Stark et al., 1981;[26] Guillaume et al., 1997;[28] Mitchell et al., 1994)[29]. In a longitudinal study of white children from Ohio, overweight elementary school-aged girls were more likely to become obese adults by age 35 years than overweight elementary school-aged boys (mean 50% *vs* 30% compared with 18% for the general population) (Guo et al., 2002)[23]. Overweight adolescents in this study were more likely to remain overweight until age 35 years (≥ 60% obese), and there was no sex difference. Gender appears to modify the risk for overweight, with boys being at greater risk than girls if they are inactive (Guillaume et al., 1997)[28].

Although the general public understands the increase in overweight in terms of increased ingestion of fat and decreased physical activity, the question of whether overweight and obesity are caused by genetic or physiological differences is still a topic of research. In addition, the assessment of physical activity and leisure habits is one of the most difficult tasks in epidemiological research. There are ever greater opportunities for children to be sedentary in their leisure time; in particular, TV viewing and electronic gaming are positively related to overweight (Crespo et al., 2001,[30] Robinson 1999;[31] Stettler et al 2004;[32] te Velde et al., 2007)[33]. Time spent in sedentary behaviours is inversely associated with exercise among adolescents (Stettler et al 2004,[32] Marshall et al., 2004)[34], particularly among girls (Robinson, 1999)[31]; however, this issue is controversial (Biddle et al., 2004;[35] te Velde et al., 2007)[33].

The aim of this study was to investigate the incidence of weight disorders in a sample of Italian adolescents and to examine their association with nutrient intake, sport and leisure habits.

Materials and methods

We surveyed 598 subjects (321 males and 277 females) 11-14 years old to evaluate weight status, nutritional intake, sport and leisure habits. The anthropometric characters were height and weight, which also gave the BMI values. Weight status was defined according to the overweight and obesity cut-offs proposed by Cole et al. (2000)[36], and the underweight cut-off proposed by Cole et al. (2007)[37]. To determine the nutrient intake of each participant, we used a 24-hour dietary recall, a commonly used dietary assessment method (Briefel, 1994;[38] Kubena, 2000;[39] Jonnalagadda and Diwan, 2002)[40]. Interviewers were trained to collect the recalls, with specific instructions about obtaining detailed descriptions of the foods and fluids consumed and the portion sizes. To determine the adequacy of the dietary intakes, the reported nutrient intake data were compared to age- and gender-matched Italian RDAs (LARN, SINU,1998).

A questionnaire was used to assess the kind, frequency and number of hours of extra-curricular physical activity. Usual TV viewing and PC use were measured by the questions "About how many hours a day do you usually watch television and videos in your leisure time?" and "About how many hours a day do you usually use a computer in leisure time?".

ANOVA was used to evaluate the differences among groups. Statistical analyses were performed with STATISTICA software (Statistica for Windows: Statsoft 5.0, Vigonza, Padua, Italy 2000). The probability level was set at 0.05. Odds ratios (OR) of obesity were estimated by comparing obese with normal weight children. TV/PC viewing and extracurricular physical activity were divided into terziles (≤ 2 h/d; 3-4 h/d; > 4 h/d) for the estimation of ODs for obesity.

Results

The height, weight and BMI of the adolescents (table I) approach the 50th centile of the reference standard of the Italian population (Cacciari et al., 2006)[41]. Table II presents the reported macronutrient intakes of

Table I
Height, weight and BMI in males and females for age groups

	x	*S.D.*	*x*	*S.D*	*x*	*S.D.*	*x*	*S.D*
males	*11 y. (n = 53)*		*12 y. (n = 91)*		*13 y. (n = 102)*		*14 y. (n = 75)*	
Height (cm)	147.5	6.3	152.8	8.3	158.6	8.2	163.3	9.0
Weight (kg)	44.2	11.1	47.2	10.1	51.8	10.6	56.2	10.3
BMI	20.1	3.9	20.1	3.2	20.5	3.3	21.0	3.2
females	*11 y. (n = 38)*		*12 y. (n = 94)*		*13 y. (n = 90)*		*14 y. (n = 55)*	
Height (cm)	148.8	6.0	152.9	6.6	156.5	5.8	160.2	4.9
Weight (kg)	44.7	9.7	46.0	9.3	49.3	9.3	53.3	8.4
BMI	20.0	3.4	19.6	3.2	20.1	3.3	20.8	3.1

Table II
Macronutrient intake of the participants in the present study

	x	*S.D.*	*Recommended values*	*x*	*S.D*	*Recommended values*	*x*	*S.D.*	*Recommended values*	*x*	*S.D*	*Recommended values*
males	*11 y. (n = 53)*			*12 y. (n = 91)*			*13 y. (n = 102)*			*14 y. (n = 75)*		
Water (g)	1,650.2	462.0		1,6								
Protein (g)	87.1	22.6	55.1	89.3	27.0	59.2	87.1	28.3	64.8	79.0	26.0	68.9
Fat (g)	70.4	28.0	63.6-78	69.7	21.2	66.37-82.63	70.6	24.5	69.53-89.57	68.1	25.2	74.33-93.03
Carbohydrate (g)	257.7	85.6	317.5-352.1	260.2	79.8	331.6-370.6	254.3	71.6	348.0-396.1	260.4	72.4	368.7-413.6
% energy protein	18.3	4.0	10-12%	18.4	4.5	10-12%	18.1	4.5	10-12%	16.7	4.0	10-12%
% energy fat	32.0	8.2	30%	32.2	7.9	30%	32.5	6.9	30%	31.8	7.2	30%
% energy carbohydrate	49.7	8.8	55-65%	49.4	9.4	55-65%	49.4	8.6	55-65%	51.6	8.4	55-65%
Fiber (g)	6.9	4.3	22.1	7.5	3.9	23.6	6.9	3.7	25.9	7.5	4.2	28.1
Energy (kcal.)	1,949.0	512.2	1,949-2,276.5	1,961.7	436.2	2,038.5-2,409.5	1,946.3	478.9	2,158-2,583	1,913.0	494.7	2,252-2,739
females	*11 y. (n = 38)*			*12 y. (n = 94)*			*13 y. (n = 90)*			*14 y. (n = 55)*		
Water (g)	1,728.4	528.1		1,637.7	549.9		1,506.5	564.5		1,588.3	379.9	
Protein (g)	82.0	19.6	56.1	80.8	21.9	56.6	80.1	26.6	59.4	82.6	28.2	62.2
Fat (g)	71.6	25.5	55.5-68.2	66.9	20.9	57.9-72.5	71.8	24.1	60.5-74	63.6	23.8	62.6-76.5
Carbohydrate (g)	247.9	89.9	268-298.4	258.7	72.7	283.9-318.9	253.8	64.2	298.3-330.5	265.2	64.2	300.4-333.7
% energy protein	17.8	4.3	10-12%	17.3	4.1	10-12%	16.7	3.9	10-12%	17.3	4.3	10-12%
% energy fat	33.8	8.8	30%	31.8	7.5	30%	33.4	7.2	30%	29.8	7.5	30%
% energy carbohydrate	48.4	10.7	55-65%	51.0	8.8	55-65%	49.9	8.4	55-65%	53.0	8.9	55-65%
Fiber (g)	7.7	4.2	22.4	7.7	4.5	23.0	7.0	3.9	24.7	8.1	4.2	26.7
Energy (kcal.)	1,901.3	492.8	1,701.5-1,985	1,896.1	397.1	1,776.5-2,110.5	1,922.9	440.7	1,847-2,197	1,896.9	442.8	1,870-2,256.5

the adolescents. The mean energy intake is within the recommended energy requirement in the males but is slightly lower in the females. Protein and total fat intakes are higher than the recommended ranges in all age groups and both sexes, while carbohydrates are slightly lower. Contemporary dietary guidelines (LARN, SINU, 1998)[42] recommend that healthy children consume a diet that provides 10-12% energy from protein, 55-65% from carbohydrates and 30% from lipids. In the present sample, when we consider the single macronutrient energy as a percentage of total energy, the value is higher than the recommended range for protein and total fat but lower for carbohydrates. Cholesterol intake is above the Italian RDA in almost all age classes, except for 11-year-old boys, with lower than recommended values, and 13-year-old girls, with values similar to those recommended. The total dietary fibre intake does not reach the recommended level of 21-38 g/day (males) and 26 g/day (females) in any age group. Table III presents the reported vitamin and mineral intakes. Except in a few cases (iron in 12-13-year-old boys and in 14-year-old girls; vitamin C in 14-year-old boys and in 12-year-old girls), the micronutrient values are below the RDAs in all groups and in both sexes.

Table III
Vitamin and mineral intakes of the participants in the present study

	x	*S.D.*	*x*	*S.D*	*x*	*S.D.*	*x*	*S.D*
males	*11 y. (n = 53)*		*12 y. (n = 91)*		*13 y. (n = 102)*		*14 y. (n = 75)*	
Sodium (mg)	1,147.1	907.4	1,133.0	642.2	987.3	634.3	991.8	549.8
Potassium (mg)	2,022.2	1,603.1	2,322.6	2,078.5	2,159.5	1,667.1	2,023.5	1,239.4
Iron (mg)	11.2	11.1	13.7	14.7	12.4	11.9	10.2	8.4
Calcium (mg)	670.4	409.7	703.5	457.7	661.8	430.5	598.9	415.6
Phosphorus (mg)	1,067.5	517.0	1,143.7	624.9	1,083.9	551.4	978.1	460.8
Thiamin (mg)	0.8	0.3	0.9	0.3	0.7	0.3	0.8	0.3
Riboflavin (mg)	0.9	0.3	0.9	0.3	0.8	0.4	0.9	0.5
Niacin (mg)	11.0	6.1	10.2	5.1	10.4	6.3	10.8	6.9
Vitamin A (mg)	216.4	195.9	321.9	258.8	272.3	237.4	533.2	1,929.0
Vitamin C (mg)	46.7	48.0	41.9	44.3	44.6	41.8	54.4	53.7
Cholesterol (mg)	172.9	112.2	211.4	174.1	222.5	255.3	203.6	184.8
females	*11 y. (n = 38)*		*12 y. (n = 94)*		*13 y. (n = 90)*		*14 y. (n = 55)*	
Sodium (mg)	952.3	629.6	1,049.7	595.3	1,061.3	715.6	1,022.8	666.1
Potassium (mg)	2,090.5	1,400.0	2,089.2	1,455.4	2,042.4	1,641.3	2,313.7	2,010.9
Iron (mg)	10.8	9.0	11.5	9.7	11.4	11.6	13.1	13.7
Calcium (mg)	733.2	534.4	585.3	316.3	682.3	479.3	727.1	434.9
Phosphorus (mg)	1,049.8	505.7	1,000.3	407.9	1,005.7	560.1	1,095.9	588.5
Thiamin (mg)	0.7	0.3	0.8	0.3	0.7	0.4	0.7	0.3
Riboflavin (mg)	0.9	0.4	0.9	0.8	0.8	0.4	0.8	0.4
Niacin (mg)	9.3	5.8	10.4	6.1	8.6	5.8	9.3	5.2
Vitamin A (mg)	349.0	338.1	715.7	3,928.7	353.8	283.8	328.5	255.1
Vitamin C (mg)	47.5	41.9	55.4	53.1	48.8	43.0	49.8	47.9
Cholesterol (mg)	183.6	144.1	173.0	156.3	194.2	153.0	194.2	171.7

Table IV
Mean hours of physical activity/week and of TV/computer per day

males	*11 y. (n = 53)*			*12 y. (n = 91)*			*13 y. (n = 102)*			*14 y. (n = 75)*		
	N	*x*	*S.D.*	*N*	*x*	*S.D.*	*N*	*x*	*S.D.*	*N*	*x*	*S.D.*
Extracurricular physical activity	52	3.4	2.0	80	3.5	2.2	86	3.9	2.1	63	4.7	2.7
TV/PC viewing	53	2.9	1.4	91	2.9	1.6	102	3.1	1.4	75	2.8	1.2
females	*11 y. (n = 38)*			*12 y. (n = 94)*			*13 y. (n = 90)*			*14 y. (n = 55)*		
	N	*x*	*S.D.*	*N*	*x*	*S.D.*	*N*	*x*	*S.D.*	*N*	*x*	*S.D.*
Extracurricular physical activity	27	2.5	1.0	78	2.7	1.5	65	3.2	2.2	42	3.7	2.5
TV/PC viewing	38	2.4	1.2	94	2.3	1.4	90	2.6	1.2	55	3.0	1.3

The mean hours of physical activity/week increase with age from 11 to 14 years (table IV), passing from 3.4 to 4.7 hours in males and from 2.5 to 3.7 hours in females. The time spent in TV/computer per day (table IV) is quite stable with age, although there is a tendency to an increase in girls. Generally boys spend more hours in both sport and TV/computer activities per day than girls.

Table V shows the weight status trend with respect to age in both sexes. In males, the prevalence of underweight is quite stable (3.3-3.9%) from 11 to 13 years, while a lower percentage is observed at 14 years. Overweight subjects are more frequent at 11 years (35.2%) and decrease with age (18.7% at 14 years), while the percentage of obese subjects is quite stable with age. In females, the highest frequency of underweight subjects

Table V
Weight status of males and females for age classes

	11 years		*12 years*		*13 years*		*14 years*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
males								
underweight	2	3.7	3	3.3	4	3.9	1	1.3
normal weight	29	53.7	58	63.7	75	73.5	56	74.7
overweight	19	35.2	25	27.5	19	18.6	14	18.7
obese	4	7.4	5	5.5	4	3.9	4	5.3
females								
underweight	3	7.9	7	7.4	9	10.0	2	3.6
normal weight	19	50.0	65	69.1	64	71.1	45	81.8
overweight	12	31.6	19	20.2	16	17.8	6	10.9
obese	4	10.5	3	3.2	1	1.1	2	3.6

is at 13 years and the lowest is at 14 years. As in the males, overweight and obese subjects decrease with age.

When the subjects are considered on the basis of their weight status (table VI), the mean energy intake decreases from underweight to obese individuals, with significant differences between the extreme groups. The energy intake in obese subjects is below the recommended values. In males, the reduction of energy with increasing BMI is mainly accompanied by a reduction of carbohydrates (significant in males, obese and overweight *vs*. the other categories) and of fibre (significant between underweight and obese subjects) and by low quantities of proteins and lipids. If we consider the percentage of energy from the macronutrients, there is an increase of energy from fat and protein passing from the underweight to obese groups (significant, obese *vs*. underweight and normal weight subjects). In contrast, the energy from carbohydrates decreases (with significant differences between the extreme groups). Except for sodium, the other minerals tend to increase from the underweight to obese groups, while vitamin C tends to decrease.

In females, proteins, lipids and carbohydrates decrease with increasing BMI categories (with significant differences between the extreme groups for proteins and carbohydrates). The percentage of energy from fat increases from underweight to obese subjects, while the energy from carbohydrates decreases and the energy from protein is quite stable. The differences among groups are not significant. A tendency to decrease with increasing BMI is also observed for minerals (with significant differences between the extreme groups for sodium and phosphorus) and for the B-group vitamins. Vitamins A and C show a more irregular trend, while cholesterol decreases, with significant differences between underweight and obese subjects.

If we consider the relationship between lifestyle and weight status (table VII), we observe that an increase in hours spent watching TV/PC is associated with increasing BMI, with significant differences between obese subjects and subjects belonging to the other weight categories. In females, there are no appreciable differences in hours of TV/PC viewing among weight groups. In both the boys and girls, the most active subjects belong to the normal weight and overweight categories. The following results were obtained from the crude analysis comparing obese with normal weight children conducted with TV/PC viewing and hours of extracurricular physical activity variables categorized in terziles (table VIII): in males, ORs show an increasing trend for TV/PC viewing and the odds of obesity are reduced among children in the third terzile of physical activity; in females, there are no differences between the second and third terzile of TV/PC viewing, and no conclusive results are obtained for the physical activity categories.

Conclusions

For all groups, the reported total energy intake (based on a 24-hour recall dietary diary) corresponds to the recommended energy requirements. Macronutrients are above the recommended range, while micronutrients are generally below the recommended range.

Increasing attention to their physique by both boys and girls can be inferred, since overweight and obese subjects decrease with age. This is confirmed by a previous study on the body image of the same subjects (Argnani et al., 2008)[43]: dissatisfaction increases during growth. Boys are concerned with height and muscular development and girls consider excessive weight inappropriate. During growth, both sexes develop stereotypes of attractiveness.

The boys and girls report an energy intake that decreases with increasing BMI categories. These results

Table VI
Relationship between weight status and nutrient intake (significant differences in brachets)

	underweight (a)		*normal weight (b)*		*overweight (c)*		*obese (d)*	
	x	*S.D.*	*x*	*S.D*	*x*	*S.D.*	*x*	*S.D*
males	*(n = 10)*		*(n = 215)*		*(n = 77)*		*(n = 17)*	
Water (g)	1,656.3	517.6	1,591.2	443.6	1,557.3	499.7	1,594.4	453.7
Prtoein (g)	89.0	28.0	86.7	27.5	84.3	23.5	84.0	29.6
Fat (g)	68.9	35.9	70.9	23.7	66.7	25.1	61.7	20.8
Carbohydrate (g)	304.2 (c,d)	39.0	266.7 (c,d)	74.3	241.2 (a,b,d)	79.1	186.3 (a,b,c)	45.9
% energy protein	16.7 (d)	3.3	17.6 (d)	4.4	18.7	4.5	20.7 (a,b)	4.3
% energy fat	27.6 (d)	9.4	31.9	6.8	32.3	8.5	34.6 (a)	8.3
% energy carbohidrates	55.7 (c,d)	11.4	50.5 (d)	8.7	49.0 (a)	10.1	44.7 (a,b)	10.4
Fiber (g)	9.2 (d)	3.1	7.1	4.0	7.2	4.0	5.3 (a)	2.6
Energy (kcal)	2,130.5 (d)	473.9	1,990.4 (c,d)	469.1	1,845.9 (b)	471.4	1,593.1 (a,b)	336.7
Sodium (mg)	1,342.2	1,309.7	1,036.6	646.7	1,036.1	580.6	1,034.7	912.1
Potassium (mg)	1,601.9	475.5	2,177.1	1,734.1	2,133.5	1,598.7	2,514.0	2,330.4
Iron (mg)	8.4	2.9	12.3	12.4	12.0	10.6	14.5	17.2
Calcium (mg)	611.6	372.1	659.5	430.4	664.2	395.7	697.2	629.7
Phosphorus (mg)	970.7	374.9	1,083.1	566.2	1,076.4	475.7	1,103.1	794.9
Thiamin (mg)	0.8	0.3	0.8	0.3	0.7	0.3	0.7	0.4
Riboflavin (mg)	0.9	0.4	0.9 (d)	0.4	0.9	0.3	0.7 (b)	0.3
Niacin (mg)	12.3	8.2	10.5	6.1	10.8	5.9	11.7	7.6
Vitamin A (mg)	264.5	177.4	359.5	1,137.6	298.5	246.8	241.0	215.1
Vitamin C (mg)	48.7	37.0	47.5	47.9	44.5	45.4	37.6	36.6
Cholesterol (mg)	164.7	93.6	213.6	187.0	198.4	244.1	155.6	85.6
females	*(n = 21)*		*(n = 192)*		*(n = 53)*		*(n = 10)*	
Water (g)	1,757.7 (c)	496.6	1,632.0 (c)	533.6	1,375.0 (a,b,d)	447.1	1,757.5 (c)	325.4
Prtoein (g)	89.8 (c,d)	26.0	83.0 (c,d)	24.2	72.9 (a,b)	22.2	66.2 (a,b)	20.7
Fat (g)	71.1	21.4	69.6	23.6	63.4	22.7	63.2	20.6
Carbohydrate (g)	303.6 (b,c,d)	70.2	261.4 (a,c,d)	71.6	231.0 (a,b,d)	55.2	203.7 (a,b,c)	50.4
% energy protein	16.9	3.4	17.3	4.1	16.9	4.0	16.8	5.2
% energy fat	29.6	5.0	32.1	7.8	32.6	8.5	35.1	6.2
% energy carbohidrates	53.5	5.7	50.6	9.1	50.5	9.8	48.1	9.5
Fiber (g)	8.9 (c)	5.1	7.8	4.4	6.6 (a)	3.1	6.1	3.0
Energy (kcal)	1,135.8 (b,c,d)	481.0	1,941.3 (a,c,d)	429.6	1,729.4 (a,b)	335.5	1,593.0 (a,b)	354.0
Sodium (mg)	958.9 (d)	449.9	1,092.4 (d)	688.5	962.8 (d)	547.9	426.4 (a,b,c)	374.0
Potassium (mg)	2,365.9	1,627.5	2,225.4	1,734.8	1,761.2	1,159.7	1,199.8	597.8
Iron (mg)	14.0 (d)	12.0	12.3	11.7	9.2	8.2	5.4 (a)	2.8
Calcium (mg)	686.3	467.3	690.1	435.9	597.0	413.0	419.2	232.3
Phosphorus (mg)	1,125.2 (d)	594.6	1,067.0 (c,d)	515.9	903.6 (b)	421.1	628.6 (1,2)	329.1
Thiamin (mg)	0.9 (c,d)	0.3	0.8 (c)	0.3	0.6 (a,b)	0.3	0.6 (a)	0.3
Riboflavin (mg)	0.9	0.3	0.9	0.7	0.8	0.4	0.6	0.4
Niacin (mg)	10.3	5.0	9.8	6.1	8.3	4.8	6.9	4.5
Vitamin A (mg)	305.6	200.4	543.6	2,754.3	312.7	309.1	227.7	159.8
Vitamin C (mg)	55.9	44.9	51.5	49.8	43.7	34.7	71.5	54.6
Cholesterol (mg)	216.6 (d)	171.9	186.8	157.5	179.4	153.2	88.2 (a)	50.6

confirm other studies showing that overweight persons report a lower energy intake than their lean counterparts (Miller et al., 1990)[44]. A possible explanation may be related to lower metabolism in the obese subjects or to the possible under-reporting of energy intake. Several authors have described the association between total energy intake and overweight (Rocandio et al., 2001;[45] Maffeis et al., 1996;[46] Gazzaniga et al., 1993)[47]. Rocandio et al. (2001)[45] showed that overweight children consume less energy (kJ day^{-1}) than non-overweight children, and suggested that the positive energy balance causing overweight is due to low energy output.

The 24-hour dietary recall used in the present study is a common assessment method to obtain dietary and nutrient intake information; it has been used in several national surveys, such as the USDA Continuing Survey of Food Intake of Individuals and NHANES (Briefel, 1994)[38]. Nevertheless, the accuracy of estimates of energy and nutrient intake based on 24-hour dietary recall interviews depends on the reliability of the complete recall of foods and beverages consumed, correct estimations of portion sizes and accurate recall of the types of food, ingredients or other relevant characteristics (Bingham 1991)[48].

Table VII
Relationship between weight status hours of extracurricular physical actividy and TV/PC viewing

	underweight			*normal weight*			*overweight*			*obese*		
	N	*x*	*S.D.*	*N*	*x*	*S.D.*	*N*	*x*	*S.D.*	*N*	*x*	*S.D.*
males												
Extracurricular physical activity	10	2.7	1.4	221	2.9	1.4	77	3.0	1.4	17	3.9	1.5
TV/PC viewing	8	2.7	1.1	195	4.1	2.4	66	3.8	2.1	14	3.3	0.8
females												
Extracurricular physical activity	20	2.2	1.3	194	2.6	1.3	53	2.6	1.4	10	2.6	1.4
TV/PC viewing	18	2.8	1.8	149	3.0	1.8	39	3.2	2.6	7	2.1	1.8

Some authors (Poppitt et al., 1998;[49] Johnson et al., 1998;[50] Johansson et al., 1998;[51] De Vries et al., 1994;[52] Jonnalagadda et al., 2000)[53] indicate a 10-20% error of under- or over-estimation of energy intake, influenced by the gender, weight status, age and socio-economic status of the individual. It has been observed that overweight individuals typically under-report their intake and underweight individuals over-report their intake (Poppitt et al., 1998;[49] Johansson et al., 1998;[51] Johnson et al., 1998;[50] Jonnalagadda and Diwan, 2002)[40]. Dietary under-reporting has been shown to be particularly prevalent in obese subjects (Johansson et al., 1998;[51] Macdiarmid and Blundell, 1997;[54] Ortega et al., 1995)[55]. Ortega et al. (1995)[55] recorded 9.1% of under-reporting for overweight adolescents, whereas Bandini et al. (1990)[56] found 30% of under-reporting in overweight adolescents. The discrepancy between the weight status of the considered subjects and their energy intake could be related to this factor.

In agreement with Ortega et al. (1995)[55], our survey shows differences in dietary composition among groups. The overweight and obese adolescents consume less carbohydrates than their normal weight and underweight counterparts. The differences between the means, when expressed as percentage of energy intake, are statistically significant only for males, but overweight adolescents have a significantly lower carbohydrate intake when expressed in total grams. Our results are consistent with those of Hassapidou et al. (2006)[57] and Gazzaniga and Burns (1993)[47] on U.S. preadolescents, those of Ortega et al. (1995)[55] on Spanish adolescents, and those of Villa et al. (2007)[58] on Estonian children. They found that overweight subjects consumed less energy as carbohydrates, and there was also an inverse relationship between total

Table VIII
Frequency, prevalence and crude odds ratios for obesity by TV/PC viewing and physical activity

Characteristic	*Frequency (obese/normal weight)*	*Prevalence (%)*	*OR*
males			
TV/PC viewing			
> 4 h/d	6/37	16.2	6.3
3-4 h/d	8/84	9.5	3.4
≤ 2	3/100	3.0	1.0
Extracurricular physical activity			
> 4 h/d	1/71	1.4	0.3
3-4 h/d	10/64	15.6	3.1
≤ 2	3/60	5.0	1.0
females			
TV/PC viewing			
> 4 h/d	1/18	5.6	1.3
3-4 h/d	5/86	5.8	1.3
≤ 2	4/90	4.4	1.0
Extracurricular physical activity			
> 4 h/d	1/19	5.3	0.6
3-4 h/d	0/65	0.0	0.0
≤ 2	6/65	9.2	1.0

BMI and energy intake as carbohydrates. Moreover, they showed that lean boys consumed significantly more fibre than overweight boys. This tendency was also observed in our study, with significant differences between the extreme weight categories. In spite of the tendency to a decrease with increasing BMI categories, no significant difference was found between fat and protein intakes in males, while proteins showed a significant decreasing trend in females. When expressed as percentage of energy intake, the fat and protein intake of males increases from the underweight to obese groups (significant between the extreme BMI subjects). In females, the percentage of energy from fat shows an increasing trend, while the energy from proteins is about the same in all the weight status categories.

According to some authors, the macronutrient composition of children's diets, with higher fat and lower carbohydrate intakes, may play a role in adiposity, independently of the influence of total energy intake, gender, physical fitness and parental BMI (Rocandio et al., 2001;[45] Tucker et al., 1997;[59] Maffeis et al., 1996,[46] Gazzaniga nd Burns, 1993)[47]. Similar results have come from animal studies: particularly high dietary fat consumption causes obesity, even without excessive energy intake (Oscai et al., 1987;[60] Jen, 1988)[61].

A significant proportion of our adolescents did not meet the recommended intakes for micronutrients, as previously reported. In females, the values decrease with increasing BMI. Differences between underweight and obese subjects are significant for sodium, iron, phosphorus and thiamine, while the minerals tend to increase in males.

Lack of physical activity and a sedentary lifestyle are thought to have a role at least as important as diet in the aetiology of obesity. We found no significant differences in the physical activity of subjects with different weight status, even if the odds of obesity are reduced in adolescents in the third terzile of physical activity. It should be pointed out, however, that physical activity was not measured directly, but calculated according to answers given by the adolescents. The possibility that the overweight and obese subjects overestimated the time they spent in sports must be considered. The male adolescents in the present study show an increased number of hours spent in TV/PC viewing with increasing BMI categories; the differences are significant between the obese subjects and their peers of the other weight categories. This is confirmed by the increase in ORs of obesity with increasing TV/PC viewing**.**

The results of the present study indicate an unbalanced diet in the sample of Italian adolescents, which could damage their health and quality of life. To prevent obesity and to avoid the disorders associated with this condition, it appears necessary not only to regulate energy intake but also to control the composition of the diet.

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