

Body composition and dietary intake of adolescents from public schools in Blumenau (Brazil)

Composição corporal e consumo alimentar de adolescentes da rede pública de ensino de Blumenau (Brasil).

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Abstract – The objective of this study was to characterize the body composition and dietary intake of adolescents from public schools in Blumenau, Santa Catarina. A total of 268 students aged 12 to 16 years were selected by random non-probability sampling. Anthropometric measures including weight, height, waist circumference, and skinfold thickness were collected using pre-established protocols to estimate nutritional status and body composition. Dietary intake was evaluated using a food frequency questionnaire. Descriptive analysis, frequency analysis, and the Student t-test were used ($p < 0.05$). The results showed that 57% of the subjects were eutrophic; of these 38% presented adequate fat percentage. The diet of the adolescents was characterized by high energy intake (>2493.5 kcal), with the distribution of macronutrients being in accordance with current recommendations. However, 84% of the adolescents consumed excess saturated fatty acids ($>10\%$) and 46% consumed excess cholesterol (>300). Comparison of dietary intake between genders showed a significant difference for protein ($t=2.234$, $p < 0.026$), vitamin C ($t=2.128$; $p < 0.034$), iron ($t=2.654$; $p < 0.008$), and calcium ($t=2.239$; $p < 0.026$). In conclusion, the results indicate the need to better understand and evaluate food intake in adolescents in order to develop intervention strategies.

Key words: Adolescents; Body composition; Food Consumption; Nutritional Status.

Resumo – Caracterizar a composição corporal e o consumo alimentar, em adolescentes da rede pública da cidade de Blumenau, SC. Foi realizado cálculo amostral, selecionou-se aleatoriamente e não probabilística 268 indivíduos entre 12 a 16 anos da Cidade de Blumenau, SC. As medidas antropométricas coletadas foram: massa corporal, estatura, perímetro da cintura, dobras cutâneas, a fim de estimar o estado nutricional e a composição corporal. O consumo alimentar foi obtido pelo Questionário de Frequência de Consumo Alimentar. Foi utilizada análise descritiva, de frequência e teste t de Student, com $p < 0,05$. A amostra apresentou 57% de indivíduos eutróficos, desses, 38% apresentaram percentual de gordura adequado. A dieta caracterizou-se por um consumo energético elevado ($>2493,5$ kcal) com distribuição de macronutrientes de acordo com as recomendações, porém, 84% dos adolescentes consumiam ácidos graxos saturados em excesso ($>10\%$) e, 46% consumo excessivo de colesterol ($>300\text{mg/dia}$). Referente às recomendações dos micronutrientes, somente o cálcio para as meninas se mostrou abaixo dos valores sugeridos. Comparando o consumo alimentar entre os sexos, verificou-se diferença para: proteína ($t = 2, 234$; $p < 0, 026$); vitamina C ($t=2, 128$; $p < 0, 034$); ferro ($t=2, 654$; $p < 0, 008$); cálcio ($t=2, 239$; $p < 0, 026$). Os achados evidenciam a necessidade de conhecer e avaliar o tipo de alimentação feita pelos adolescentes, a fim de elaborar estratégias de intervenção.

Palavras-chave: Adolescência; Composição corporal; Consumo de alimentos; Estado nutricional.

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INTRODUCTION

Adolescence is marked by the last period of increased growth, which is a period of high nutritional demand¹. Thus, food quantity and quality must be adequate to meet the specific nutritional needs during this period of life.

However, regarding the context of full change and development, food consumption in this period is strongly influenced by several factors such as socio-cultural and socioeconomic aspects, body image, media influence, eating habits, food availability, facility of preparation and increasing energy needs².

Studies have shown that the eating habits of adolescents eventually meet energy requirements, especially with foods with high contents of saturated fat, simple sugars and sodium^{2,3}, which may be associated with increased obesity in children and adolescents, a fact particularly disturbing, especially at this stage of life, since obesity is a risk factor for obesity in adulthood⁴. According to World Health Organization⁵, one of the key factors considered as determinants of sudden increase in cases of overweight are eating habits and sedentary lifestyle.

Studies evaluating body composition in adolescents, especially linking nutritional status with lifestyle and daily energy expenditure, have contributed to the diagnosis of cases of overweight and early obesity and collaborated with indicators for assessing risk factors for cardiovascular disease in childhood and adolescence⁶.

Understanding the relevance of this theme, since dietary intake can result in anthropometric changes, this study aimed to characterize and compare body composition and food intake in adolescents of both sexes from public schools in the city of Blumenau, Santa Catarina, Brazil.

METHODOLOGICAL PROCEDURES

Population and sample

This is a descriptive cross sectional study with non-probability sampling, obtained from a population of 10,933 adolescents aged 12 to 16 years of both genders enrolled in municipal schools in the city of Blumenau.

The sample calculation used data on the number of students (10,933) by gender and age group (12-16 years) enrolled in public schools in the city of Blumenau, in 2008, provided by the Municipal Department of Education. Based on these data, the sample was calculated according to: total number of boys and girls, confidence interval of 95% sam-

pling error of 5% and prevalence of 23%, since the overweight prevalence found in studies with Brazilian adolescents of both sexes from various regions of the country ranged from 4.7% to 22.9%^{7,8}.

The selection of schools took place in two steps. In the first step, all schools were listed and grouped in areas of the city of Blumenau. Thus, eleven schools from different districts were selected by adopting a non-probabilistic systematic strategy, considering the different realities of the locality, which ensured the sample representativeness.

In the second step, students from each school were randomly selected and invited to participate in the study, being eligible all students aged 12 to 16 years whose parents or guardians have consented in their participation. Thus, the final sample consisted of 268 adolescents, representative of the seventh and eighth grades of basic education.

This study was approved by the Ethics Research Committee of the University of Blumenau under number 169/08, according to resolution 196/96 of the National Health Council involving humans and in accordance with the Declaration of Helsinki 1995.

Instruments and procedures

The evaluations were conducted in the first half of 2009 at the pre-selected school during the morning period (8:00 to 12:00 am). Initially, the adolescents were informed about the study. Those who agreed to participate received the "free and informed consent form" to be filled by parents or guardians.

All anthropometric measurements were performed by a single researcher in order not to compromise the validity of anthropometric data. The body composition of adolescents was assessed using the Body Mass Index (BMI), calculated by dividing weight in kilograms (kg) by squared height in meters (m²), using values proposed by WHO⁵ as classification criterion. To measure the weight, calibrated portable digital scale label Plenna was used, with accuracy of 100 grams (g) and capacity of 150 kilograms, assuming minimal variation between two measures of 100g, with adolescents barefoot and wearing light clothing. Height was measured using a portable two-meter stadiometer label Seca, calibrated by 0.1 centimeters (cm), attached to the wall with adolescents barefoot, standing with their backs to the wall and head in the Frankfort plane, assuming the maximum variation of 0.5 cm between two measurements. Sexual maturity was not evaluated, since it was not object to this research.

The triceps and calf skinfolds (right side) were also measured. Skinfold caliper label Cescorf® with an accuracy of 10mm was used. Measurements were performed according to the Tritschler protocol⁹, in duplicate. The body fat percentage was calculated using the formula of Slaughter et al.¹⁰ and by adopting the values for age and sex and their cutoff points proposed by Deurenberg et al.¹¹ as classification criterion.

Waist circumference (WC) was measured for the assessment of central adiposity. This measure was taken at the midpoint between the last rib and the iliac crest, using a flexible anthropometric tape model Gulick brand Mabis with scale of 0.1 cm⁹. The WC was measured in duplicate and a third measurement was performed when differences above 0.1 cm between measurements were observed. The average of two measurements was used in the analysis. Values above 71.5 cm were regarded as high for boys and for girls, above 70.6¹². However, the waist-to-height ratio (WHR) was calculated using the cutoffs points of 0.5 proposed by some authors¹³ as reference.

The habitual food intake of adolescents was assessed by applying the Food Frequency Questionnaire (FFQ) developed and validated for the Brazilian population¹⁴. This is a semi-quantitative food frequency questionnaire containing 81 food items, three quantity choices and eight consumption choices: more than 3 times a day, 2-3 times a day, once daily, 5 to 6 times per weeks 2 to 4 times per week, 1 time per week, 1-3 times per month, never or almost never.

The energy intake calculation and diet composition of the participants were performed using a spreadsheet developed in Microsoft Excel program that initially transforms frequencies into daily frequencies (using the average frequency interval); these were multiplied by the amounts of portions and, finally, the daily amounts were converted into nutrients. The calculation of nutrients was performed through a food composition database from the Nutrition Support Program, developed by the Faculty of Medicine of São Paulo¹⁵. To maintain the quality of data, cases with energy intake greater than 6000 kcal or less than 500 kcal were excluded.

For analysis of the nutritional adequacy referring to Total Energy Value (TEV) of the diet, the American recommendation Dietary Reference Intakes (IOM) was used as reference¹⁶, which considers the following ranges of macronutrient participation acceptable for ages 4 to 18: 45-65% from carbohydrates, 25-35% from lipids, 10-30% from

protein and 2493.5 kcal from energy. To analyze the content and quality of fats, the recommendations of the American Academy of Pediatrics Committee of Nutrition¹⁷ have been adopted: saturated fatty acids <10% of total fat, polyunsaturated fatty acids > 10% and cholesterol < 300 mg / day. Concerning the qualitative analysis of the prevalence of inadequate vitamin C and iron intake, the Estimated Average Requirement, EAR was used, which estimates the inadequacy prevalence of some nutrient by a particular group and is recommended by the Institute of Medicine^{18,19}. For calcium intake, the Adequate Intake (AI) was used²⁰, since there is no EAR established for this nutrient.

Statistical analysis

To characterize the sample and presentation of data, descriptive statistics was used (mean, standard deviation) and comparison between genders was performed by t-tests for independent samples. For statistical analysis, a confidence interval of 95% was adopted, with alpha level set at $p < 0.05$. Analyses were performed using the SPSS 13.0 software (Chicago, IL).

RESULTS

The population studied makes up the total sample, consisting of 132 boys (49.2%) and 136 girls (50.7%) with average ages of 14.3 ± 0.9 and 14.4 ± 0.8 years, respectively. During the development of assessments, 10 boys and 9 girls were excluded for not meeting the pre-established criteria, showing underestimated and overestimated food consumption values.

The characterization of the study sample stratified by sex, using anthropometric measures, is presented in Table 1.

Table 2 describes the frequencies and proportions of adolescents for each nutritional status, redistributed into categories of body fat percentage.

The food intake description by adolescents is shown in Table 3. High energy consumption in both sexes was observed. However, the high standard deviation values indicate that there is a wide variation between individuals. Regarding, difference between sexes was observed, which was statistically significant for protein, calcium, iron and vitamin C intake.

As for the food consumption adequacy of adolescents (Table 4) regarding the consumption of macronutrients, adequate intake for both sexes was found. Regarding the quality of the lipid in the diet of adolescents, cholesterol intake was higher

Table 1. Description of anthropometric measures of adolescents stratified by sex

Variables	Males		Females		t	p
	\bar{X}	SD	\bar{X}	SD		
BM (Kg)	54.4	11.6	52.7	10.6	1.260	0.209
Height (cm)	163.3	9.3	159.0	5.7	2.205	0.028*
BMI (kg/m ²)	20.2	3.4	20.8	3.7	0.979	0.328
% BF	17.1	8.0	23.4	6.9	6.80	0.000*
WHR	0.4	0.3	0.4	0.04	0.904	0.367
WC (cm)	68.0	8.4	66.6	8.2	1.320	0.188

\bar{X} = Average, SD = Standard deviation; BM: Body mass, BMI = Body mass index,% BF = Body fat percentage; WHR = Waist-to-height ratio, WC = Waist circumference . * p <0.05

Table 2. Distribution of adolescents according to nutritional status redistributed into body fat percentage.

(BMI)	(%BF)	Males		Females	
		n	%	n	%
Underweight	Below adequate	9	20	7	18.9
	Adequate	35	77.8	30	81.1
	Above adequate	1	2.2	-	-
Eutrophic	Below adequate	5	6.9	2	2.4
	Adequate	47	65.3	55	67.1
	Above adequate	20	27.8	25	30.5
Overweight	Below adequate	-	-	1	8.3
	Adequate	-	-	1	8.3
	Above adequate	12	100	10	83.3
Obesity	Below adequate	-	-	-	-
	Adequate	1	33.3	-	-
	Above adequate	2	66.7	5	100

n: number of individuals; %: percentage of individuals
Body Mass Index (BMI), body fat percentage (% BF)

Table 3: Description of dietary energy and nutrient intake.

Nutrient	Males		Females		t	p
	\bar{X}	SD	\bar{X}	SD		
Energy (kcal)	3235.6	2815.3	2716.3	1326.4	1.941	0.053
Carbohydrate (g)	426.3	265.9	373.2	176.51	1.930	0.055
Protein (g)	115.2	94.1	94.9	48.5	2.234	0.026*
Lipids (g)	121.3	163.5	97.3	56.1	1.614	0.108
Calcium (mg)	1427.3	1025.2	1187.0	706.9	2.239	0.026*
Iron (mg)	32.0	18.8	26.0	18.2	2.654	0.008*
Vitamin C (mg)	463.6	429.3	369.5	281.1	2.128	0.034*
SFA (g)	45.2	25.4	40.8	22.9	1.476	0.141
PUFA (g)	15.4	12.1	13.4	9.9	1.466	0.144
Cholesterol (mg)	393.9	321.9	347.4	286.9	1.248	0.213

\bar{X} = average, SD: standard deviation.

* P <0.05; SFA = saturated fatty acids; PUFA = polyunsaturated fatty acid; MFA = monounsaturated fatty acids.

than appropriate for males. However, the intake of polyunsaturated fatty acids was ineffective in both sexes. It is noteworthy that the major contributor to total fat intake of adolescents was the saturated fatty acid, which consumption exceeded recom-

mended values for the vast majority of adolescents. Referring to micronutrients, calcium was the only nutrient that showed insufficient intake, being more pronounced in females.

Table 4. Percentage of adolescents according to adequate food consumption (Dietary Reference Intakes).

Nutrient	Males (%)			Females (%)		
	Insufficient	Adequate	High	Insufficient	Adequate	High
Carbohydrate(g)	12.1	75.8	12.1	6.6	81.6	11.8
Protein (g)	1.5	98.5	-	2.9	97.1	-
Lipids (g)	16.7	52.3	31.1	19.1	50	30.9
Calcium (mg)	55.3	44.7	-	61.8	38.2	-
Iron (mg)	6.8	71.2	21.9	19.1	63.9	16.9
Vitamin C (mg)	10.6	89.3	-	5.1	94.8	-
SFA (g)	-	18.2	81.8	-	13.2	86.8
PUFA (g)	100	-	-	97.1	2.9	-
Cholesterol (mg)	-	47.7	52.3	-	59.6	40.4

DISCUSSION

Considering variables BMI, WC; WHR and % BF, most adolescents had nutritional levels within normality standards^{12,13}. Nevertheless, overweight and obesity were identified in 11.9% of adolescents, which is a proportion relatively lower than that reported in another study²¹. In contrast, a study involving 354 students aged 17 to 19 years from the state of Bahia, pointed overweight and obesity of 4.0% among adolescents studied²². In another study in Curitiba, it was found that 17% of boys and 21% of girls have undesirable nutritional status^{6,23}.

Studies on overweight and obesity in children and adolescents use different classification criteria. This fact prevents a reliable assessment of this prevalence in lower age groups. Notwithstanding, most studies have shown increasing overweight and obesity trend. According to research conducted by the Ministry of Health²³, obesity has increased in Brazil, showing that 13% of Brazilian adults are obese and in the younger population (ages 12 to 17 years), obesity has already reached 10.9%.

In line with this and other studies^{4,6,13}, the nutritional status classification occurs by means of BMI. For the general population, this is a fast, easy and inexpensive method; however, it does not describe the variation that occurs in the body composition of individuals, and admitting its inadequacy as a quantitative marker of body fat is a consensus^{4,7}. According to results of this study, there is a high number of boys and girls showing fat percentage above adequate levels and those classified as underweight, who have adequate fat percentage as ratified by Filozof²⁴.

In relation to a desirable nutritional status and because the average BMI of the population is within the normality range, it is expected that the

energy consumption of adolescents is adequate for maintaining a healthy weight. It was observed that the average energy consumption of boys and girls met 129.7% and 108.9% of the recommendation, respectively. According to Saito and Ruffo²⁵, at every age group, male individuals consume increasing amounts of food, which provide more calories than female individuals. The average energy consumption values found for adolescents in this study are in agreement with those found in a study conducted with 390 adolescents in the state of São Paulo, in which the authors observed an average energy consumption of 3.716 kcal for males and 3.585 kcal for females²⁶. On the other hand, Garcia et al.²⁷ found average energy consumption far under requirements, in which the average energy consumption for males was 2026.0 kcal and 1842.7 kcal for females, with no significant difference between sexes.

However, although adolescents tended to present high energy consumption, the contribution of macronutrients to the total caloric content was in accordance with the recommendations for most of them. Regarding the consumption of carbohydrates, the study by Caramel et al.³ with a sample of 390 students from 10 to 17 years of age also found adequate carbohydrate intake. However, in this study, the source of carbohydrate was inadequate, and revealed a high consumption of sweets among the respondents, with an average of 3.8 servings / day, representing 78.2% of adolescents who exceeded the maximum recommended intake of 2 servings / day. Another study showed that the consumption of soft drinks was 10.3 and 8.6% the total caloric content of the diet of obese boys and girls, respectively²⁸.

Also with respect to sources of macronutrients, for lipids, the participation of cholesterol is signifi-

cant, especially saturated fat in the diet of adolescents, while the contribution of polyunsaturated fatty acid is insufficient to the lipid of the diet.

Campos et al.²⁹ evaluated 260 boys and 237 girls aged 10-18 years in the city of Curitiba, Brazil and found in 54% of boys and 48.6% of girls, lipid consumption above 30% of total caloric intake. As for saturated fats, 79.1% of boys and 83.2% of girls consumed more than 10% saturated fat. Regarding cholesterol, 57.1% of boys and 41.8% of girls had a usual intake above 300 mg / day for boys and girls, respectively.

It is worth reporting that excessive consumption of lipids as saturated fat is the main factor for high plasma LDL cholesterol concentrations and contributes for the development of dyslipidemia, which prevalence in childhood and adolescence ranges from 24 and 33%, with progressive increase over the years, and decrease in some countries, especially in those that have established prevention programs³⁰.

Regarding the consumption of micronutrients, iron and vitamin C were adequate among adolescents, but are divergent from results found in other studies, indicating deficiency in vitamin C and iron intake²⁶. However, it is important to highlight an important consideration with regard to the bioavailability of these micronutrients. The absorption of non-heme iron is determined by several factors; however, vitamin C is an abundant compound in food, but very volatile and oxidizable. Therefore, individuals reported adequate consumption of vitamin C and iron; however, due to the factors mentioned above, these may not be reliably meeting requirements.

The inadequate calcium intake found in this study is consistent with data found in other researches²⁷. In the study conducted by Toral et al.²⁶, the average calcium intake was lower than that found in this study, which were 579.86 mg for females and 819.68 mg for males. The authors explain that this deficit, in large part is due to the low consumption of foods rich in calcium, milk, dairy products and dark-green vegetables.

This work has some limitation that should be considered, such as the individual's ability to provide accurate and precise information and intrinsic limitations of the type of questionnaire used.

CONCLUSION

In general, this research demonstrated that most adolescents have nutritional status within standar-

ds recommended in literature. However, the cutoffs for BMI and % BF should be carefully analyzed because these categorizations may mask the true characteristics of subjects.

The diet of adolescents was characterized by high energy intake with distribution of macronutrients in accordance with recommendations. Vitamin C and iron consumption are adequate, but there is insufficient calcium intake. There is also excessive intake of saturated fatty acids. This reality highlights the importance of promoting nutritional education among young people to ensure an adequate intake of nutrients in order to avoid nutrition-related health problems.

Thus, the contribution of this study, in view of the reality rarely explored in the city of Blumenau, SC, points to the need for more comprehensive studies, considering the need to implement inter-sector projects and programs with clearly defined targets by governments and social organizations in the pursuit of slowing down the increasing prevalence of overweight / obesity and in the implementation of a healthier lifestyle for the entire population.

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