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Nutritional status of vegetarian and omnivorous adolescent girls

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Abstract

This study compared the dietary and anthropometric profile of 24 ovo-lacto-vegetarian and 36 omnivorous female adolescents, between 15 and 18 years old. Weight, height and skinfolds were measured. Food frequency questionnaires and a three day food record were used for dietary assessment. Vegetarians presented subscapular, suprailiac and midaxillary skinfolds statistically higher than omnivores, but the percent body fat was not different. The vegetarian diet provided smaller amounts of energy than that of the omnivores ($p < 0.05$) and only 17% of the vegetarians was able to reach the recommended allowance for protein. Regarding calcium, 83% of the vegetarians and 69% of the omnivores ate less than 2/3 of the recommended allowances and a significantly higher percentage of vegetarians presented low ingestion of iron, riboflavin, and niacin than omnivores ($p < 0.05$). It was concluded that the intake of vegetarians was lower in fat and cholesterol, and less adequate in micronutrients than the omnivores ones.

Keywords: Adolescents; Anthropometric evaluation; Vegetarianism; Dietary assessment; Nutritional status

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1. Introduction

Vegetarian diets have been studied, mainly as to their potential benefits in preventing chronic diseases, such as obesity, hypertension, coronary disease, diabetes mellitus, breast and colon cancer among others [1,2,3,4,5]. However, the implications of the different types of eating patterns are difficult to interpret, because in addition to diet, other factors related to lifestyle, also have an influence on nutritional status [6].

Seventh-Day Adventists are an excellent population in which to study the health effects of vegetarianism, because the Church actively promotes the adoption of a lacto-ovo-vegetarian diet; it is not a requirement for membership and approximately 40% to 50% of them are vegetarians [7,8]. At the same time, potential confounding factors, such as cigarette smoking and alcohol intake are avoided as these are proscribed by the Church [9]. In accordance with Fonnebo [10], due to all the aforesaid causes, morbidity and mortality among those devoted to this religion are 50% lower than in the general population. Nevertheless, this has only been verified when the individuals follow Church's rules, including the vegetarian diet, from adolescence.

However, the counterpart to the positive implications that adopting vegetarianism can bring during periods of fast growth, such as adolescence, is that vegetarians are at increased risk for insufficient intakes of energy and some nutrients [11]. Besides, the high content of anti-nutritional factors of the vegetarian diet, such as phytates and oxalates, is related to the low bioavailability of minerals of this diet [12,13]. This is seen in the inadequate dietary and anthropometric profiles detected among vegetarian children and adolescents [14,15,16]. According to Soares [17] and Messina & Messina [18], the nutritional implications of the vegetarian eating pattern, at different physiologic phases of individuals and populations deserve more studies. Therefore, the purpose of this research was to compare the nutritional status of vegetarian and omnivorous Seventh-Day Adventist adolescent girls.

2. Methods

2.1. Subjects

The study was done with 60 female adolescents, 24 vegetarian and 36 omnivorous, Seventh-Day Adventists, between 15 to 18 years old, who studied at the Adventist Institute of Learning of São Paulo city, Brazil. They were recruited using posters fixed in the campus noticeboards and through word spread in the class rooms. None of the adolescents was on a special diet to lose weight. This research was conducted with the approval of the Federal University of Rio de Janeiro, and with the individual consent of each voluntary adolescent's parents before participating of any assessment. The data were collected between April and November 1997.

The adolescents who followed a vegetarian diet for at least one year were classified as vegetarians. The vegetarian diet included milk, dairy products and eggs. Poultry and fish were consumed less often than once every fifteen days. The omnivorous adolescents ate

meat, including poultry and fish, at least once a week. These criteria have been previously described by other authors [19,20,21,22,23,24,25].

2.2. Sexual maturation

In order to judge the stage of sexual maturation, each adolescent self-evaluated the development of her secondary sexual characteristics through the illustrations proposed by Tanner [26] for breast development and by Van Wieringen *et al*. [27] for pubic hair growth.

2.3. Anthropometric assessment

Anthropometric measurements included: height, weight, skinfold thicknesses, all measured by the same anthropometrist. Height was measured using a Harpenden stadiometer with adolescents in a orthostatic position and barefooted. They were not wearing any arches, tiaras or hairpins and their height was recorded to the nearest 0.1 cm. Body weight was measured with the adolescents in an upright position, wearing lycra shorts and top, barefooted. A digital Personal Line scale, model PL 150, with a 100g precision and a capacity of up to 150 kg was used and the weight was recorded to the nearest 0.1 kg. Skinfold thicknesses were measured in nine anatomic sites: biceps, triceps, suprailiac, subscapular, midaxillary, vertical abdominal, medial calf, chest, and mid thigh, according to the technique described by Pollock & Wilmore [28], using a Lange skinfold caliper. Three measurements were made for each skinfold, and the mean was used as a final result, expressed in millimeters.

The percentage of body fat was estimated according to Durnin & Rahaman [29] for adolescents under 16 years old, and Durnin & Womersley [30] for those between 16 and 18 years old. The body mass index—BMI (weight in kg/height in m^2) was calculated.

The nutritional diagnostic criteria proposed by the World Health Organization [31] were used, which state that adolescents between the 5th and 85th percentile of BMI-for-age are at normal weight, those who are below this cut-off value are thinness, those above the 85th percentile are at risk of overweight, and adolescents above this cut-off value and $\geq$90th percentile for both triceps and subscapular skinfolds are obese. The height/age (H/A) index was assessed in accordance with the National Center for Health Statistics guidelines—NCHS [32], as established by the WHO [31].

2.4. Physical activity

Physical activity was surveyed through questions that included the time spent in daily activities, and timing and frequency of the physical exercises done. Those adolescents who carried out a physical activity at least three times a week, for minimum of 30 minutes accumulated throughout the day, as recommended by the American College of Sports Medicine [33], were classified as physically active. The different types of physical activities were grouped by intensity into three categories: light, moderate and intense, according to FAO/WHO/UNU [34].

2.5. Dietary assessment

For qualitative dietary assessment, subjects were requested to answer a food frequency questionnaire (FFQ). Categories for frequency response to each item on this questionnaire were: daily, 4 to 6 times, 2 to 3 times and once a week. For quantitative assessment, a three-day food record was used, including one weekend day. All records were filled in by the adolescents and checked at the time they were handed in, in order to make sure that the information about the different foods had been properly described, according to previous studies [14,24,35]. The household measures were converted into grams, using the Soares *et al*. [36] and Pinheiro *et al*. [37] tables.

The nutritional composition of the diets was analyzed using the Nutrition Support Program of the Center for Informatics in Health of the Escola Paulista de Medicina, São Paulo, Brazil—version 2.0/CIS-EPM [38]. The composition of the foods and preparations frequently consumed by Seventh-Day Adventists which were not contained in the software was obtained from information given by the food industry. The average of the three records was used to compare food ingestion between vegetarians and omnivores. The consumption of energy, animal protein, iron, thiamin, riboflavin, niacin and ascorbic acid was compared with the Recommended Dietary Allowances [39]. As far as total proteins are concerned, the values corrected by protein digestibility of the Brazilian diet were used, as suggested by Vannucchi *et al*., referred to the FAO/WHO/UNU [34]. The macronutrients, expressed as a percentage of the total energy ingestion, were compared to the values established by the World Health Organization [40]. Calcium ingestion was compared to the values recommended by the Institute of Medicine [41]. The nutritional interviews and analyses were conducted by a registered dietician.

Because group mean intakes sometimes obscure unacceptably low or high intakes, the consumption of nutrients was distributed in three defined categories: inferior to 2/3 (very inadequate ingestion), from 2/3 to 3/3 (inadequate ingestion) and at or above the dietary recommendations (adequate ingestion) [42]. The daily energy expenditure was individually estimated, using equations proposed by FAO/OMS/UNU [34] and multiplied by an activity coefficient in accordance with the NRC/RDA [39].

2.6. Statistical analysis

Statistical analyses were carried out using the TRUE EPISTAT software, version 2.0. In order to compare the anthropometric variables between omnivorous and vegetarian adolescents, the parametric Student's t test was used. In relation to dietary variables, the non parametric Mann-Whitney test was used (U statistics), given the great variability of the data. Fisher's exact test was used to determine whether there were any differences between diet patterns for the percentages of subjects in each defined category of nutrient intake. The results have been expressed in means and standard deviation. All tests were considered significant at $p < 0.05$.

Table 1
Anthropometric parameters of vegetarian and omnivorous adolescents (mean and standard deviation)

	Vegetarians (n = 24)	Omnivores (n = 36)	*p*-value
Height (m)	1.60 ± 0.05	1.60 ± 0.05	0.262
Weight (kg)	57.68 ± 7.88	57.00 ± 8.83	0.377
Body mass index (kg/m^2)	23.93 ± 3.04	21.90 ± 2.85	0.227
Skinfold thicknesses (mm):			
Triceps	22.21 ± 7.45	21.30 ± 6.81	0.314
Subscapular	17.73 ± 7.70	13.80 ± 4.80	0.009
Suprailiac	24.18 ± 9.51	20.00 ± 8.42	0.040
Chest	9.59 ± 5.02	8.10 ± 2.75	0.065
Midaxillary	13.91 ± 7.04	10.70 ± 4.72	0.020
Vertical abdominal	21.20 ± 10.48	19.20 ± 6.78	0.185
Mid thigh	32.13 ± 7.16	30.50 ± 7.57	0.202
Calf	19.67 ± 5.84	18.60 ± 5.83	0.238
Biceps	10.16 ± 3.85	9.50 ± 3.55	0.261
Sum of 9 Skinfolds	170.79 ± 55.28	151.60 ± 44.67	0.073
% Body fat	31.08 ± 4.78	29.78 ± 4.10	0.132

3. Results

Among vegetarian adolescents, 11 (45.9%) had followed a lacto-ovo-vegetarian diet for their entire lives, 8 (33.3%) had adopted a vegetarian diet for at least 1 year, and 5 (20.8%) had poultry or fish less than once every fifteen days. All of them had already reached menarche and stages M4 and P4 of breast and pubic hair development, respectively. The mean age for menarche was 12.42 years ± 1.32 years among vegetarians and 12.07 ± 1.14 years among omnivorous (difference not statistically significant).

Table 1 shows that vegetarian adolescents presented higher average values than the omnivores in all anthropometric parameters assessed, except height. Subscapular, suprailiac and midaxillary skinfold thicknesses were statistically higher.

It has been verified that 6 (20.8%) of the vegetarians and 6 (16.7%) of the omnivores were overweight; however one of the overweight vegetarians was obese. Yet, 19 (79.2%) of vegetarians and 30 (83.3%) of omnivores were within of normal range of BMI, and none of the adolescents was thinness.

Only one vegetarian was below the 3rd percentile of the NCHS guidelines for H/A, while all the omnivores had adequate stature.

Regarding regular physical activity, the total time spent weekly on physical exercise was on average 3.42 ± 1.94 hours, and 4.39 ± 1.75 hours by vegetarians and omnivorous, respectively; the difference is not statistically significant. It has become evident that only 44.4% of the vegetarian and 31.8% of the omnivorous adolescents exercised with adequate frequency and duration of training. Besides, 57.1% of the vegetarians and all of the omnivores carried out moderate intensity activities.

Table 2 shows that, compared to the omnivores, a larger percentage of vegetarians consumed lettuce, beans, rice, whole wheat bread and banana daily, however a smaller percentage reported having cheese, chocolate, sweets and natural juices in their diets.

The three-day food record revealed that vegetarians consumed significantly lower

Table 2
Food intake patterns of vegetarian and omnivorous adolescents

Type of food	Percentage consuming the food item							
	Vegetarians (n = 24)				Omnivores (n = 32)			
	Daily	4 to 6/week	2 to 3/week	1/week	Daily	4 to 6/week	2 to 3/week	1/week
Meat	0	0	0	0	12	6	34	29
Poultry	0	0	0	0	0	12	41	41
Milk	48	0	20	14	56	6	12	0
Cheese	0	0	36	7	12	19	19	29
Eggs	0	0	8	12	3	0	12	25
Lettuce	72	16	0	7	28	28	19	12
Black beans	56	8	8	0	52	24	19	3
Banana	64	16	0	0	20	24	28	6
Whole rice	40	0	8	7	0	0	12	6
Whole bread	72	0	24	0	20	32	19	12
Margarine	0	0	8	0	20	28	34	6
Soft drinks	0	0	16	35	20	19	19	29
Natural juices	28	0	40	28	49	19	24	0
Gluten	0	0	56	44	0	0	12	18
Sweets	16	20	0	0	60	25	12	0
Chocolate	16	0	28	7	28	6	24	12

amounts of energy, protein, fat, and cholesterol than omnivores. As to the energy contributions of the percentage of macronutrients, the vegetarians' diet was characterized by a statistically smaller content of protein and fat and a higher content of carbohydrate than that of the omnivores (Table 3).

It has been verified that the energy consumption of 71% of the vegetarians and 66% of the omnivorous was below their calculated individual requirements. Regarding animal protein ingestion, it can be observed that all vegetarians had less than 67% of the recommendations (Fig. 1). In addition, 33% of the vegetarians had very inadequate diets, even considering total proteins. As far as the omnivores are concerned, 28% had a very low intake of animal protein and only 6% of total proteins. It must be emphasized that a significantly higher percentage of vegetarians consumed very low amounts of total proteins ($p < 0.05$) and animal proteins ($p < 0.0001$) than omnivores.

Table 3 shows that vegetarians ingested smaller amounts of iron and niacin than omnivores. On Fig. 2, it is shown that none of the vegetarians and only 3% of the omnivorous had diets providing adequate amount of calcium, and 83% of the first and 69% of the later ingested less than 2/3 of the dietary recommendations. Regarding iron, 96% of the vegetarians and 88% of the omnivorous ($p < 0.05$) ingested amounts below the recommended allowances (Fig. 2).

4. Discussion

As shown by Tojo *et al*. [43], in adolescence chronological age is less relevant to, and physiological age is more representative of the adolescents' development. All participants of

Table 3
Daily intake of energy, dietary fiber and nutrients by adolescents (mean and standard deviation), according to eating pattern

	Vegetarians (n = 24)	Omnivores (n = 32)	*p*-value
Energy (kcal)	1,721 ± 457	2,115 ± 601	0.021
Protein (g)	51.3 ± 18.2	74.4 ± 22.5	<0.0001
Total protein (% total energy)	11.8 ± 2.2	14.5 ± 3.1	<0.001
Total protein ($g \cdot kg^{-1}$)	0.93 ± 0.33	1.39 ± 0.45	<0.0001
Animal protein (g)	12.0 ± 6.6	42.8 ± 19.2	<0.0001
Animal protein ($g \cdot kg^{-1}$)	0.22 ± 0.12	0.80 ± 0.37	<0.0001
Carbohydrate (g)	274.6 ± 71.0	293.5 ± 91.1	0.306
Carbohydrate (% total energy)	65.9 ± 5.2	55.9 ± 7.4	<0.0001
Total Fat (g)	45.8 ± 16.2	71.4 ± 27.1	<0.0001
Total Fat (% total energy)	22.3 ± 5.0	29.7 ± 5.6	<0.0001
Cholesterol (mg)	66.4 ± 42.4	192.1 ± 93.4	<0.01
Dietary fiber (g)	22.3 ± 9.1	19.3 ± 6.6	0.095
Thiamin (mg)	0.87 ± 0.73	0.87 ± 0.52	0.410
Thiamin ($mg \cdot 1000\ kcal^{-1}$)*	0.42 ± 0.25	0.40 ± 0.23	0.470
Riboflavin (mg)	0.95 ± 0.60	1.06 ± 0.48	0.256
Riboflavin ($mg \cdot 1000\ kcal^{-1}$)*	0.44 ± 0.23	0.48 ± 0.15	0.121
Niacin (mg)	8.21 ± 5.82	12.25 ± 7.46	<0.001
Niacin ($mg \cdot 1000\ kcal^{-1}$)*	3.84 ± 2.08	5.65 ± 2.31	0.020
Ascorbic acid (mg)	113.2 ± 78.7	83.0 ± 71.8	0.080
Calcium (mg)	664.4 ± 292.9	716.8 ± 275.4	0.143
Iron (mg)	7.62 ± 3.23	10.53 ± 3.21	<0.01

* Average daily amount of vitamins consumed per 1000 kcal of energy.

the present study were considered to be post-pubescent, because they were already in advanced stages of the sexual maturation process, confirmed by the occurrence of menarche. Therefore, they were in the lineal growth final phase. Vegetarians and omnivorous reported the occurrence of the menarche at similar ages, as also observed by Persky *et al.* [14], however differing from Sanchez, Kissinger & Phillips [44] and Kissinger & Sanchez [45], who described that menarche occurred later among vegetarians. In addition, the menarche mean age of the adolescents of the present study were lower than the Brazilian average of 13 years and 2 months, obtained by the National Research on Health and Nutrition/INAN [46].

Differences in stature between vegetarians and omnivores were not seen, yet the adolescents assessed were shorter than the North American adolescents of the same age range and eating pattern, studied by Sabaté *et al.* [47]. These authors revealed that as of the age of 15, vegetarian Seventh-Day Adventists girls were 2.1 cm taller than omnivorous girls on average. Sabaté *et al.* [19] have verified that the vegetarian diet could interfere with the stature gain of pre-adolescents only, probably due to the delay of the beginning of puberty. However, in accordance with the same authors, the stature of vegetarians is not impaired, because they continued growing until the end of adolescence and they can reach a final heights that are similar those of omnivorous girls.

In the present research, only one vegetarian was below the 3rd percentile of the height/age

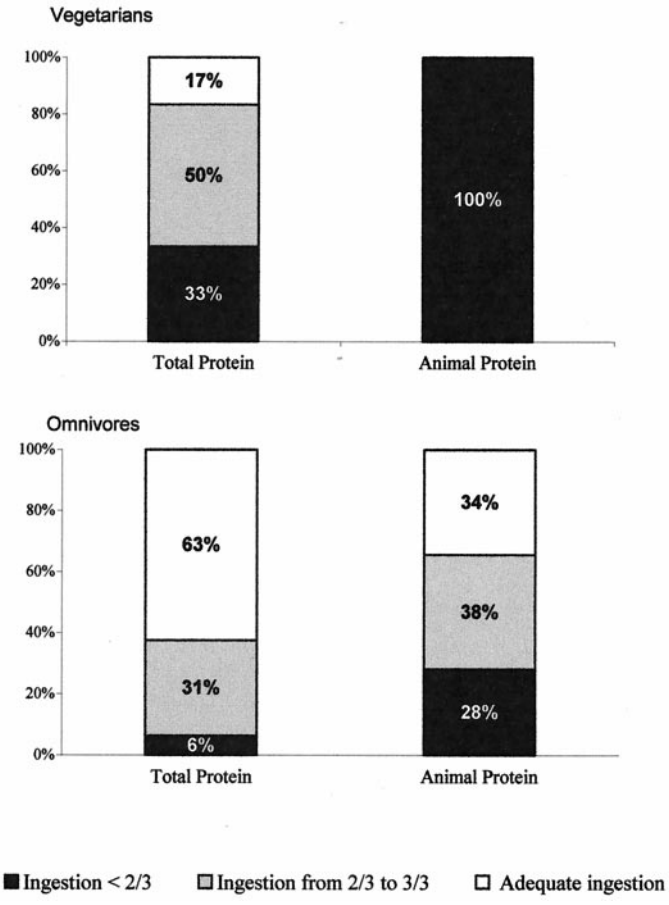

Fig. 1. Percentage of vegetarians and omnivorous adolescents according to recommendations for protein in $g \cdot kg^{-1} \cdot day^{-1}$ (FAO/OMS/UNU, 1985).

of NCHS guidelines, thus corroborating the findings of Tayter & Stanek [48], who observed vegetarian and omnivorous adolescents with adequate statures in accordance with this same referential. These results ratify those of Sabaté *et al*. [19], as they refer to the lifestyle adopted by Adventists, which assures proper lineal growth.

In general, considering skinfolds thickness it has been verified that vegetarians present more adiposity than omnivores, and the subscapular, suprailiac and midaxillary skinfolds were statistically higher in the former. Regarding BMI, the similar values found for vegetarians are in disagreement with those of Taber & Cook [49] and Janelle & Barr [50], who found that vegetarians had lower values than non-vegetarians. Nevertheless, our results are in accordance with those of Dwyer *et al*. [51], who state that a vegetarian diet cannot automatically be associated with leanness.

In this way, the growing interest in prevention of overweight in adolescence [52] must be extended also to vegetarians, because adolescents with high BMI have great chances of becoming overweight adults, and they have a high risk of developing chronic diseases.

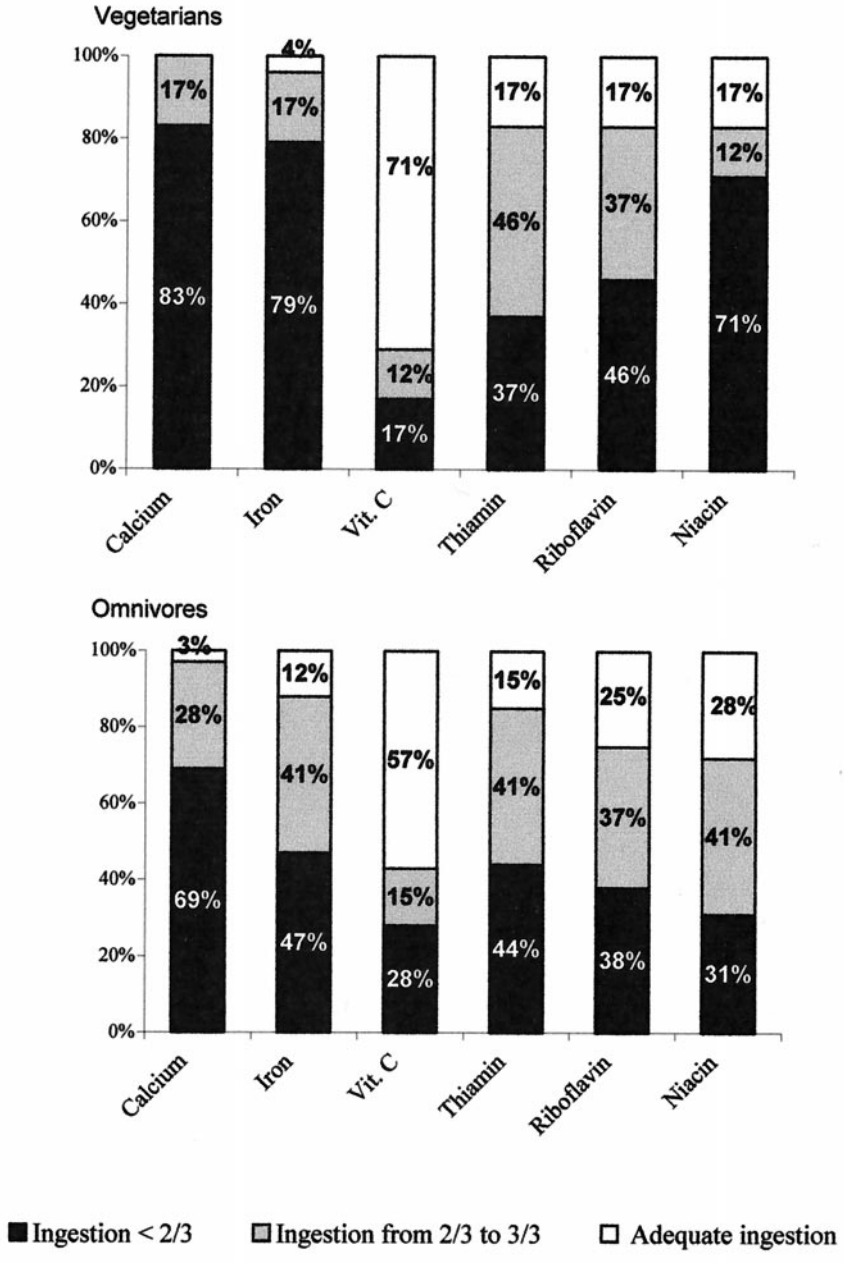

Fig. 2. Percentage of vegetarians and omnivorous adolescents according to recommendations for micronutrients (NRC/RDA, 1989; IOM/DRI, 1997; IOM/DRI, 1998).

However, BMI cannot fully express the body composition [53]. Thus, the percent body fat estimation has shown that some adolescents, even those considered within the normal range of BMI, could have already presented high level of body fatness. Tayter & Stanek [48] found a larger percentage of vegetarians than of omnivores (30% versus 10%) obese by the

weight/stature indicator. These authors discuss the importance of exploring in more detail physical activity as well, in an attempt to understand the reasons that lead vegetarians, who generally eat low energy density diets, to be overweight.

In the present study, a small number of adolescents performed regular physical exercise. The omnivorous individuals who had carried out some kind of physical exercise, performed moderate intensity activities. These activities are much more likely to be conducted over a longer period of time than high intensity activities, allowing for a daily energy expenditure which is proper to the maintenance of body weight [54]. Therefore, this factor can be contribute to the lower adiposity observed in omnivorous. Nevertheless, the questionnaire applied aimed only to characterize the regular pattern of physical activity, and not to investigate in depth daily energy expenditure and its relationship with the nutritional status of the adolescents.

Among ovo-lacto-vegetarian adolescents, there is a high risk of nutritional inadequacy, mainly in the girls [11,55].

Messina & Messina [18] showed that generally no differences are found in the energy consumption of adolescents with different eating patterns. In the present research, however, vegetarians' energy ingestion was statistically lower than that of omnivorous, as larger percentage of vegetarians did not reach 2/3 of their requirements, similarly to verified by others authors [35,48,56,57]. The low energy supply of vegetarians' diet is related to the predominance of vegetables, which usually contain large amounts of dietary fiber and a low lipid contents, which means low energy density [5,58]. As a matter of fact, a larger percentage of vegetarians ate fruit and vegetables daily, while fewer ate sweets, margarine, soft drinks and chocolate, characterized by the high energy value, similar to the findings of Neumark-Sztainer *et al*. [59]. Furthermore, it is believed that the underreporting food intake could be a plausible explanation for the lower energy intakes, particularly with the vegetarians subjects who may have been trying to give an impression of following a healthier diet [57].

Krondl [60] found that energy intakes are closely correlated with dietary quality of protein and micronutrients. We observed total and animal proteins ingestion to be extremely low among vegetarians, while 63% of omnivores met the protein recommended allowances.

The percentage of total energy intake from macronutrients and the intake of cholesterol was different between vegetarians and omnivores. Nevertheless, both groups were within the normal range established by WHO [40]. The dietary profile of vegetarians in the present study was more adequate than that described by Harman & Parnell [9] and Shultz & Leklem [61], since these authors observed that vegetarians exceeded 30% of total energy intake as fat. In relation to dietary fiber, previous researches show that vegetarians have an extremely low consumption, only reaching 2.2 g a day [14,48,56,62].

The ingestion of thiamin, riboflavin and ascorbic acid was similar in both groups studied, but most vegetarians consumed statistically lower amounts of niacin than omnivores, in contrast with the findings of Persky *et al*. [14], who stated that vegetarian and omnivorous adolescents consume similar amounts of niacin, but different amount of thiamin and riboflavin.

Regarding calcium, none of the vegetarians reached dietary reference intakes [41], emphasizing that most of them (83%) effectively ingested very low amounts ($<$2/3 of the

recommendations). Nevertheless, omnivores' consumption was not much different, since 69% of them also had very inadequate diets. This can be explained by the low percentage of adolescents who consumed calcium rich foods, such as cheese, for example, daily. It is worth emphasizing that vegetarians as well as omnivores can be subject to a lack of calcium, because in addition to the low ingestion of this nutrient, there is an interference by one or more of the factors which are negatively associated with its bioavailability [63]. Phytates, oxalates and other antinutritional factors, found in vegetables, impair intestinal absorption of calcium, while the high ingestion of sulfur amino acids, mainly present in meats, increases its urinary excretion [63].

It was observed that a statistically higher percentage of vegetarians had diets which did not contain the recommended dietary allowances of iron. Similar results were obtained by Abdulla *et al*. [64] and Harman & Parnell [9]. In addition to the low iron ingestion, two other factors are matters of concern in the vegetarian diet: the first one has to do with the absence of heme iron—which has a high bioavailability; and the second one is that Adventists do not consume fruit after their main meals. They believe that salty food must not be eaten together with sweet foods [65], thus neglecting an important source of vitamin C, which would help in the absorption of non-heme iron in the diet. In accordance with Alexander *et al*. [22] the coexistence of these factors that increases the chances of iron deficiency. However, the prevalence of iron deficiency anemia apparently is not different between vegetarians and non-vegetarians [35,66].

In conclusion, this study suggests that dietary inadequacies were present among vegetarian and omnivorous adolescent girls. Although the vegetarian diets were lower in fat and cholesterol than the omnivorous ones, which is associated with a reduced risk of coronary and vascular diseases, particular attention must be given to the vegetarian consumption of iron, protein, riboflavin and niacin. Information on ways to optimize intake and absorption needs to be disseminated to vegetarians in aiming at preventing the onset and the aggravation of nutritional problems and to allow a better life quality.

References

[1] Key T, Thorogood M, Appleby PN, Burr ML. Dietary and mortality in 11000 vegetarian and health conscious people: results of a 17 year follow up. British Medical Journal 1996;313:775–9.

[2] American Dietetic Association. Position of the American Dietetic Association: Vegetarian diet. Journal of The American Dietetic Association 1997;97:1317–9.

[3] Sabaté J. Nut consumption, vegetarian diets, ischemic heart disease risk, and all-causes mortality: evidence from epidemiologic studies. American Journal of Clinical Nutrition 1999;70(Suppl.):500S–3S.

[4] Vuoristo M, Miettinem TA. Absorption, metabolism, and serum concentrations of cholesterol in vegetarians: effects of cholesterol feedings. American Journal of Clinical Nutrition 1994;59:1325–31.

[5] Lampe JW. Health effects of vegetables and fruit: assessing mechanisms of action in human experimental studies. American Journal of Clinical Nutrition 1999;70(Suppl.):475S–90S.

[6] Dwyer JT. Vegetarian eating patterns: science, values, and food choices—where do we go from here? American Journal of Clinical Nutrition 1994;59(Suppl.):1255S–62S.

[7] Santos NMM. Avalição do estado de nutrição em ferro de estudantes universitários vegetarianos do Instituto Adventista de Ensino de São Paulo. Unpublished M.Sc. Dissertation, Universidade de São Paulo, 1996; 137p.

[8] Mills PK, Beeson WL, Phillips RL, Fraser GE. Cancer incidence among California Seventh-day Adventists, 1976–1982. American Journal of Clinical Nutrition 1994;59(Suppl.):1136S–342S.
[9] Harman SK, Parnell WR. The nutritional health of New Zealand vegetarian and non-vegetarian Seventh-day Adventists: selected vitamin, mineral and lipid levels. New Zealand Medical Journal 1998;111:91–4.
[10] Fonnebo V. The healthy Seventh-day Adventist lifestyle: what is the Norwegian experience? American Journal of Clinical Nutrition 1994;59(Suppl.):1124S–9S.
[11] National Institute of Nutrition. Risks and benefits of vegetarian diets. NIN Review 1990;5(Suppl.):n°1.
[12] Anderson JW, Smith BM, Gustafson NJ. Health benefits and practical aspects of high fiber diets. American Journal of Clinical Nutrition 1994;59(Suppl.):1232S–47S.
[13] Haddad EH, Berr LS, Kettering JD, Hubbard RW, Peters WR. Dietary intake and biochemical hematological, and immune status of vegans compared with nonvegetarians. American Journal of Clinical Nutrition 1999;70(Suppl.):586S–93S.
[14] Persky VW, Chatterton RT, Van Horn LV, Grant MD, Langenberg P, Marvin J. Hormone levels in vegetarian and nonvegetarian teenage girls: potential implications for breast cancer risk. Cancer Research 1992;50:578–83.
[15] Dagnelie PC, Van Dusseldorp M, Van Stavaren WA, Hautvast JGAJ. Effects of macrobiotic diets on linear growth in infants and children until 10 years of age. European Journal of Clinical Nutrition 1994;48:103S–12S.
[16] Van Dusseldorp M, Arts ICW, Bergsma JS, Jong N, Dagnelie PC, Van Stavaren WA. Catch-up growth in children fed a macrobiotic diet in early childhood. Journal of Nutrition 1996;126:2977–83.
[17] Soares EA. Dietas vegetarianas: tipos, origens e implicações nutricionais. Cadernos de Nutrição da Sociedade Brasileira de Alimentação e Nutrição 1990;1:3–19.
[18] Messina M, Messina V. The dietitian's guide to vegetarian diets—Issues and applications. Maryland, Aspen Publishers 1996;511p.
[19] Sabaté J, Lindsted KD, Harris RD, Johnston PK. Anthropometric parameters of schoolchildren with different life-styles. American Journal of Disease of Children 1990;144:1159–63.
[20] Sabaté J, Llorca C, Sánchez A. Lower height of lacto-ovo-vegetarian girls at preadolescence: An indicator of physical maturation delay? Journal of The American Dietetic Association 1992;92:1264–5.
[21] Pronczuck A, Kipervarg Y, Hayes KC. Vegetarians have higher plasma alpha-tocopherol relative to cholesterol than do nonvegetarians. Journal of The American College of Nutrition 1992;11:50–5.
[22] Alexander D, Ball MJ, Mann J. Nutrient intake and hematological status and age-sex matched omnivores. European Journal of Clinical Nutrition 1994;48:538–46.
[23] Specker BL. Nutritional concerns of lactating women consuming vegetarian diets. American Journal of Clinical Nutrition 1994;59(Suppl.):1182S–90S.
[24] Nathan I, Hackett AF, Kirby AS. The dietary intake of a group of vegetarian children aged 7–11 years compared with matched omnivores. British Journal of Nutrition 1996;75:533–44.
[25] Nathan I, Hackett AF, Kirby SA. Longitudinal study of the growth of matched pairs of vegetarian and omnivorous children, aged 7–11 years, in the North-West of England. European Journal of Clinical Nutrition 1997;51:20–5.
[26] Tanner JM. Growth at adolescence. Oxford, Blackwell Scientific Publication, 1962.
[27] Van Wieringen JC, Wafelbakker F, Verbrugge HP, De Hass JM. Growth diagrams, 1965, Netherlands, Leiden, Netherlands Institute of Preventive Medicine, 1971.
[28] Pollock ML, Wilmore JH. Exercício na saúde e na doença. 2ª. ed., Rio de Janeiro, Medsi, 1993;cap. 6.
[29] Durnin JVGA, Rahaman MM. The assessment of the amount of fat in the human body from measurements of skinfold thickness. British Journal of Nutrition 1967;21:681–9.
[30] Durnin JVGA, Womersley J. Body fat assessed from body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. British Journal of Nutrition 1974;32:77–97.
[31] World Health Organization. Physical status: the use and interpretation of anthropometry. Geneva, WHO (World Health Organization. Technical Report Series, 854), 1995;263–311.

[32] National Centers for Health Statistics (NCHS). Physical growth: National Center for Health Statistics percentiles. American Journal of Clinical Nutrition 1979;32:607–29.
[33] American College of Sports Medicine. Position stand on the recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Medicine and Science in Sports and Exercise 1998;30:975–91.
[34] FAO/OMS/UNU. Necessidades de energía y de proteínas. Genebra, Organización Mundial de la Salud. Serie de Informes Técnicos, 724, 1985;220p.
[35] Donovan UM, Gibson RS. Iron and zinc status of young women aged 14 to 19 years consuming vegetarian and omnivorous diets. Journal of The American College of Nutrition 1995;14:463–72.
[36] Soares EA, Portella ES, Ishi M. Relação de medidas caseiras de 320 alimentos e respectivas gramagens. São Paulo, Ceane, 1991;34p.
[37] Pinheiro ABV, Lacerda EMA, Benzecry EH, Gomes MCS, Costa VM. Tabela para Avaliação de Consumo Alimentar em Medidas Caseiras. 4ª. ed., Rio de Janeiro, Produção Independente, 1998;75 p.
[38] Centro de Informática em Saúde da Escola Paulista de Medicina. Programa de apoio à Nutrição, 1993. Universidade Federal de São Paulo, versão 2.0.
[39] National Research Council (U.S.). Commission on life sciences. Subcommittee on the tenth edition of the RDAs. Recommended Dietary Allowances. Washington, DC, National Academy Press, 1989;284p.
[40] World Health Organization. Diet, Nutrition and Prevention of Chronic Diseases. Geneva, WHO (World Health Organization. Technical Report Series, 797), 1990;104–17.
[41] Institute of Medicine. Food and Nutrition Board, Dietary Reference Intakes for calcium, phosphorus, magnesium, vitamin D, and fluoride. Washington, DC, National Academy Press, 1997.
[42] McCoy H, Kenney M, Kirby A, Disney G, Ercanli FG, Glover E, Korslund M, Lewis H, Liebman M, Livant E, Moak S, Stallings SF, Wakefield T, Schilling P, Ritchey SJ. Nutrient intake of females adolescents from eight southern states. Journal of The American Dietetic Association 1984;84:1453–60.
[43] Tojo R, Leis R, Queiro T. Nutrition en el adolescente. Factores de riesgo biopsicosociales. Anales Espanhois de Pediatria 1991;35(Suppl.):74S–783S.
[44] Sánchez A, Kissinger DG, Phillips RJ. A hypothesis on the etiological role of diet on age of menarche. Medical Hypothesis 1981;7:139–45.
[45] Kissinger DG, Sanchez A. The association of dietary factors with the age of menarche. Nutrition Research 1987;7:471–9.
[46] Instituto Nacional de Alimentação e Nutrição (INAN). Pesquisa nacional sobre saúde e nutrição (PNSN): perfil de crescimento da população brasileira de 0 a 25 anos. Brasília, Ministério da Saúde, 1990;60p.
[47] Sabaté J, Lindsted KD, Harris R, Sanchez A. Attained height of lacto-ovo vegetarian children and adolescents. European Journal of Clinical Nutrition 1991;45:51–8.
[48] Tayter M, Stanek KL. Anthropometric and dietary assessment of omnivore and lacto-ovo-vegetarian children. Journal of The American Dietetic Association 1989;89:1661–3.
[49] Taber LAL, Cook RA. Dietary and anthropometric assessment of adult omnivores, fish-eaters, and lacto-ovo-vegetarians. Journal of The American Dietetic Association 1980;76:21–9.
[50] Janelle KC, Barr SI. Nutrient intakes and eating behavior scores of vegetarian and nonvegetarian women. Journal of The American Dietetic Association 1995;95:180–9.
[51] Dwyer JT, Dietz WH, Andrews EM, Suskind RM. Nutritional status of vegetarian children. American Journal of Clinical Nutrition 1982;35:204–16.
[52] Guo SS, Roche AF, Chumlea WC, Gardner JD, Siervogel R. The predictive value of body mass index for overweight at 35y. American Journal of Clinical Nutrition 1994;59:810–9.
[53] Rolland-Cachera MF, Sempé M, Guilloud-Bataille M. Adiposity indices in children. American Journal of Clinical Nutrition 1982;36:178–84.
[54] American College of Sports Medicine. Special communication: Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. Journal of The American Medical Association 1995;273:402–7.
[55] Sanders TAB, Reddy S. Vegetarian diets and children. American Journal of Clinical Nutrition 1994; 59(Suppl.):1176S–81S.

[56] Cooper R, Allen A, Goldberg R, Trevisan M, Horn LV, Liu K, Steinhauer M, Rubstein A, Stamler J. Seventh-Day Adventist adolescents—lifestyle patterns and cardiovascular risk factors. Western Journal of Medicine 1994;140:471–7.
[57] Hebbelinck M, Clarys P, De Malsche A. Growth, development, and physical fitness of flemish vegetarian children, adolescents, and young adults. American Journal of Clinical Nutrition 1999;70(Suppl. 3):579S–85S.
[58] Jacobs C, Dwyer JT. Vegetarian children: appropriate and inappropriate diets. American Journal of Clinical Nutrition 1988;48:811–8.
[59] Neumark-Sztainer D, Story M, Resnick MD, Blum RW. Adolescent vegetarians: A Behavioral profile of a school-based population in Minnesota. Archives of Pediatric and Adolescence Medicine 1997;151:833–8.
[60] Krondl M. Food habit determinants of North American adolescents: nutritional implications. L'Alimentation des Adolescents. Centre de Recherche et D'information Nutritionnelles: Maison de la Chimmie 1988:111–7.
[61] Shultz TD, Leklem JE. Dietary status of Seventh-day Adventists and nonvegetarians. Journal of The American Dietetic Association 1983;83:27–33.
[62] Fraser GE, Dysinger W, Best C, Chan R. Ischaemic heart disease risk factors in middle-aged Seventh-Day Adventist men and their neighbours. American Journal of Epidemiology 1987;126:638–46.
[63] Calvo MS, Kumar R, Heath HIII. Persistently elevated parathyroid hormone secretion and action in young women after four weeks of ingesting high phosphorus, low calcium diets. Journal of Clinical and Endocrinology Metabolism 1990;70:1334–42.
[64] Abdulla M, Aly K, Anderson I, Asp N, Birkhed D, Denker I, Johansson C, Jägerstad M, Kolar K, Nair BM, Nilsson-Ehle P, Nordéan A, Rassner S, Svensson S, Akesson B, Öckerman P. Nutrient intake and health status of lactovegetarians: chemical analyses of diets using the duplicate portion sampling technique. American Journal of Clinical Nutrition 1984;40:325–38.
[65] White EGA. Ciência do bom viver. 4ª. ed. São Paulo, Casa publicadora brasileira, 1990;342p.
[66] Tungtronochitr R, Pongpaew P, Prayurahong B. Vitamin B-12, folic acid and haematological status of 132 Thai vegetarians. International Journal of Vitaminology Nutrition Research 1992;63:201–7.