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Effect of Eating Frequency on Body Composition in 9 – 11-Year-Old Children

Abstract

The aim of this study was twofold: a) to examine the association between eating frequency and body composition in children, and b) to identify possible factors that may explain this relationship. Body composition (anthropometry) and dietary intake (3-day food records) were assessed in a cohort of 151 children. After excluding the underreporters ($n = 20$), data from 131 children (66 boys and 65 girls) aged 9.9 ± 0.1 yr with a BMI of 19.6 ± 0.4 kg/m^2 (means ± se) were used for further analysis. Children were categorized in tertiles based on the daily number of eating episodes. Physical activity was assessed in a subgroup of 48 volunteers with 4-day accelerometry (RT3, Stayhealthy Inc., ■*city, state*, USA). The number of eating episodes was inversely associated ($p < 0.05$) with the sum of skinfolds ($r = -0.17$) and % body fat ($r = -0.18$) after controlling for age and sex. Frequent eaters presented lower total ($p < 0.05$) and central adiposity ($p < 0.01$) compared with the infrequent ones. This was despite the fact that energy intake was higher for the frequent eaters (2077.0 ± 64.3 vs. 1813.0 ± 37.8 kcals/day for the frequent and the infrequent eaters, respectively, $p < 0.05$). Actually, frequent eaters devoted more time to physical activity than infrequent ones (624.7 ± 13.5 vs. 559.2 ± 23.1 min/day, $p < 0.05$). In conclusion, high eating frequency was associated with more favorable body composition in this cohort of school children. Increased energy expenditure due to physical activity may, at least in part, explain the favorable body composition of children who eat frequently.

Key words
Eating frequency · childhood obesity · physical activity

Introduction

Childhood obesity has increased dramatically over the past decades [37]. Pediatric obesity prevention has become a top priority for public health, since obesity is associated with insulin resistance, diabetes and other risk factors for cardiovascular diseases in adulthood, such as hypertension and dyslipidemia [2]. Among others, a high number of eating episodes has been proposed as a factor associated with increased body weight and fat [6, 9, 28].

Since the early study of Fabry et al. [9], conflicting data appear in the literature on this issue, with some studies reporting no relationship between meal frequency and body composition and others suggesting that a nibbling meal pattern may help in the avoidance of obesity [5, 6, 29, 34, 36]. The contradictory views could be, at least in part, a matter of methodology. Underreporting is one possible reason and might have significantly influenced the final conclusions in previous studies. Of those studies that accounted for underreporters, two reported a lack of association [5, 34] and two others found a negative relationship between meal frequency and body composition [6, 36].

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Bibliography
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A number of studies investigated the factors that may explain the negative association between meal frequency and body composition in adults [1]. For instance, Kinabo and Durnin [18] reported no effect of increased meal frequency on the thermic effect of food and the basal metabolic rate, while Kirk [19] suggested that a higher carbohydrate to fat intake ratio might explain the favorable body composition of frequent eaters. It is worth noting that very limited information exists on the association between meal frequency and body composition in children 9 – 12 years old [9, 30] and, to our knowledge, no data exist on the factors that might contribute to this relationship.

The aim of this study was twofold: a) to examine the association between eating frequency and body composition in school children, and b) to identify possible factors that may explain this relationship.

Methods

Subjects

One hundred and fifty-one 9 – 11-yr-old children (9.9 ± 0.1; mean ± s. e.), all living in Athens, Greece, volunteered for this study. Children were from a large school complex and their overweight and obesity rates were similar to the national data [22]. Actually, 24.5 % of these children were overweight and obese, 7.4 % were underweight and 67.2 % had normal body weight. Parents of all children were informed of the study before they signed the informed consent for their children to participate. Overweight and obesity were defined according to age- and sex-specific cutoffs for body mass index (BMI) [4]. BMI age- and sex-specific cutoff values were also used for the underweight definition [25]. The study was approved by the Harokopio University's ethics committee.

Anthropometric measures

Body mass was recorded with an accuracy of 0.1 kg with a digital scale (SECA, ■*city*, Germany). Subjects were weighed without shoes, in their lightest clothing. Standing height was measured without shoes to the nearest 0.5 cm with the use of a stadiometer (SECA, ■*city*, Germany). Body mass index was calculated as mass (kg) divided by height squared (m^2). Skinfold thickness was measured at four sites (triceps, biceps, subscapular and suprailiac) on the right side of the body [13]. Each skinfold was measured twice, by the same investigator, with a Lange caliper (Beta Technology Inc., ■*city*, UK). If the readings differed by > 1 mm, a third measurement was taken. Trunk to extremity ratio (TER), an index of body fat distribution [17], was calculated by dividing the sum of central (subscapular, suprailiac) with the sum of peripheral skinfolds (triceps, biceps). Percent (%) body fat was estimated from triceps and subscapular skinfolds [33] from which fat mass and fat free mass were calculated.

Dietary assessment

Dietary intake was assessed with 3-day food records collected from children with their parents' assistance. All subjects were provided with a dated diary and were instructed by a nutritionist on how to keep a record of the amount and type of food consumed on three consecutive days, either from Thursday to Saturday or from Sunday to Tuesday. Great care was taken to record the time, amount, and the preparation method of the consumed food items. An estimate of portion size for the most commonly consumed food items was made by using sets of photographs depicting the relevant foods. When necessary, the nutritionist checked and completed the records in a personal interview with each subject or parent. Total energy intake, amount and % of total energy intake from carbohydrates, fats and proteins were calculated using the Nutritionist V program (First DataBank, Version 1.0, ■*city, state*, USA) adapted for Greek foods.

Underreporters were identified using the energy intake (EI) to predict the basal metabolic rate (BMR) ratio (EI/BMR) and the age- and sex-specific cutoff values [32]. BMR was estimated according to Schofield [31] equations. The cutoff values for EI/BMR were 1.04 for boys and 1.01 for girls [32]. Underreporters (n = 20 [6 obese and 14 normal; 6 boys and 14 girls]) with mean age 10.5 ± 0.2 (range: 8.9 – 11.3) yr, BMI 24.2 ± 0.9 (range: 16.8 – 30.7) kg/m^2, and caloric intake 1385 ± 49.7 (range: 903 – 1671) kcals/day were excluded from further statistical analyses. Accordingly, data from 131 children were used in the analysis (66 boys and 65 girls). Youths were categorized in tertiles according to the daily number of eating episodes. This grouping was done separately for boys and girls, but data were also treated irrespectively of gender due to the small sample size. The upper tertile (III or 3rd) describes the frequent eaters and the lower tertile (I or 1st) the non-frequent eaters. The border values, the median and the range for each tertile, irrespective of gender, were: lower (1st) tertile: ≤ 4.1 eating episodes (median: 3.6, range: 2.5 – 4.1); middle (2nd): 4.2 – 5.4 (median: 4.8); upper (3rd): ≥ 5.5 episodes (median: 6, range: 5.5 – 8). Eating frequency was calculated for each child as the mean daily number of eating episodes (including all meals and snacks) derived from the three days of observation. In order for a reported intake to be classified as an eating occasion, it had to be separated from the preceding or following eating event by at least 15 min and provide at least 50 kcals [12]. Meals were defined as the three main eating events – at morning (breakfast), midday (lunch) and evening (dinner) – whereas snacks were defined as smaller and less structured than meal eating events that were consumed at times other than meals [11]. The reproducibility of food records for measuring eating frequency was checked in a subgroup of 32 children (r = 0.95).

Physical activity assessment

Physical activity was assessed in a subgroup of 48 subjects (age: 10.1 ± 0.1 yr, BMI: 19.9 ± 0.8 kg/m^2, caloric intake: 2037.8 ± 60.7 kcals/day; 24 boys) who volunteered to use the triaxial accelerometer (RT3, Stayhealthy, Inc., ■*city, state*, USA). The accelerometer is a small (7.7 × 5.5 × 2.7 cm), light-weighted (65.2 g) device that records the body's acceleration in the 3 axes. Accelerometer is initialized and downloaded via a computer interface and has no external controls that can be manipulated. The software package for the RT3 provides minute-by-minute activity counts for each of the three dimensions, as well as the vector magnitude. From these data, daily sedentary time and total physical activity were calculated. The accelerometer was stored in a belt, which the children wore around their waist from the time they got up in the morning until they went to bed at night, except for bathing and showering for 3 weekdays and 1 weekend day. These days coincided with the application of food diaries. Children also recorded in a diary the time when the monitor was attached and

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Table **1** Anthropometric characteristics of the children placed in tertiles according to the daily number of eating episodes

	Tertile I			*Tertile II*			*Tertile III*		
	Boys n = 20	***Girls n = 23***	***All n = 43***	***Boys n = 24***	***Girls n = 20***	***All n = 44***	***Boys n = 24***	***Girls n = 20***	***All n = 44***
Age (yr)	9.7 ± 0.2	10.0 ± 0.2	10.0 ± 0.2	10.0 ± 0.2	9.8 ± 0.2	10.0 ± 0.2	9.7 ± 0.2	9.9 ± 0.2	9.7 ± 0.1
Body mass (kg)	39.8 ± 2.4	44.4 ± 2.6	42.4 ± 1.8	38.7 ± 2.6	37.8 ± 2.0	38.3 ± 1.7	39.1 ± 2.2	36.5 ± 2.2	37.9 ± 1.5
BMI (kg/m²)	19.8 ± 1.0	21.4 ± 1.0	20.9 ± 0.7	18.9 ± 0.8	19.2 ± 0.9	19.0 ± 0.6	20.1 ± 0.8	18.8 ± 0.9	19.5 ± 0.6
Body fat (%) *	25.0 ± 2.9	29.1 ± 2.6	27.3 ± 2.0	21.9 ± 2.1	23.5 ± 1.9	22.6 ± 1.4	23.9 ± 1.9	20.8 ± 1.7	22.5 ± 1.3
Sum of 4 skinfolds (mm)†	54.8 ± 8.4	73.3 ± 8.6	65.1 ± 6.0	47.2 ± 6.0	54.4 ± 6.3	50.0 ± 2.5	53.5 ± 5.8	45.3 ± 4.9	50.0 ± 2.0
Fat mass (kg)	11.0 ± 1.9	14.1 ± 1.9	12.7 ± 1.4	9.6 ± 1.6	9.5 ± 1.3	9.6 ± 1.0	10.2 ± 1.4	7.8 ± 0.8	9.1 ± 0.9
Fat free mass (kg)	28.8 ± 1.0	30.3 ± 1.1	29.7 ± 0.8	29.1 ± 1.1	28.3 ± 0.8	28.7 ± 0.7	28.9 ± 0.9	28.7 ± 1.8	28.8 ± 1.0
FFM/body mass†	0.75 ± 0.03	0.71 ± 0.02	0.73 ± 0.02	0.78 ± 0.02	0.76 ± 0.02	0.77 ± 0.02	0.76 ± 0.02	0.79 ± 0.02	0.78 ± 0.01

Values are means ± SE; tertile I = infrequent eaters; tertile III■ = frequent eaters; FFM = fat free mass; BMI = body mass index; * p < 0.05 for the effect of eating episodes number when all children were considered as a group; † p = 0.066 ■*tertile II not menmtioned?*

removed each day. The mean value for the 4 days was calculated for each child. In particular, activity counts less than 100 per minute indicated sedentary behavior, whereas a number higher than 100 counts/min indicated physical activity [8]. Before data collection, accelerometers were calibrated with the use of a calibrator provided by the manufacturers. The validity of the triaxial accelerometer in measuring physical activity in children is high when compared with doubly labelled water [14].

Statistical analysis

All parameters were normally distributed and, therefore, associations were tested with the Pearson correlation coefficient after controlling for age and sex. Analysis of covariance (ANCOVA), with age and sex as covariates, and a Tukey test were employed to assign specific differences between tertiles of eating episodes, snacks and meals. Gender differences were also evaluated with an ANCOVA, using age as a covariate. The normality of distribution and the ANCOVA were performed with the Statistica package (Version 5.0, ■*city, state*, USA), whereas correlations were performed with the SPSS (version 10.0 for Windows). Significance level was set at 0.05. Data are presented as means ± se.

Results

The anthropometric characteristics of the subjects placed in the three tertiles, according to the number of their daily eating episodes, are shown in Table **1**. Number of eating episodes had a significant impact on % body fat ($p < 0.05$, Table **1**). Trunk to extremity skinfold ratio was also lower, indicative of lower central obesity, in the second and the third compared with the first tertile ($p < 0.01$, Fig. **1**). The number of eating episodes was inversely associated ($p < 0.05$) with the sum of skinfolds ($r = -0.17$) and % body fat ($r = -0.18$), after controlling for age and sex.

The favorable body composition and body fat distribution was evident in the frequent eaters despite their higher energy intake (2077.0 ± 64.3 vs. 1813.0 ± 37.8 kcals/day, for the frequent and the infrequent eaters, respectively, $p < 0.05$, Fig. **2**). Percent carbohydrate intake was higher, whereas percent of fat intake was lower in the children in the upper compared with those in the lower tertile (CHO intake: 47.0 ± 0.5 vs. 43.3 ± 0.6% and fat intake: 38.8 ± 0.5 vs. 42.1 ± 0.5% for the 3rd and the 1st tertile, respectively, $p < 0.05$). Accordingly, the carbohydrate to fat intake ratio was higher in the frequent eaters ($p < 0.05$, Fig. **2**). Total physical activity was also higher in the frequent eaters than in the infrequent ones (624.7 ± 13.5 vs. 559.2 ± 23.1 min/day, respectively, $p < 0.05$, $n = 48$, Fig. **3**). Physical activity was associated with lower % body fat ($r = -0.34$, $p < 0.05$) and TER ($r = -0.50$, $p < 0.01$). No difference was detected between boys and girls with regard to body composition, energy intake and physical activity when children were categorized according to the number of eating episodes (Table **1** and Fig. **1** to **3**). Finally, frequent snackers presented a body composition similar to the infrequent ones, but the former group spent more time in physical activity ($p < 0.01$) that the latter one (Table **2**).

Discussion

The main finding of this study was that an increased number of eating episodes was associated with lower total and central adiposity in this cohort of 9 – 11-yr-old children. This occurred despite the higher energy intake of the frequent eaters compared with the non-frequent eaters. Elevated physical activity of the frequent eaters may, at least partially, explain these findings. To the authors' knowledge, this is the first study to suggest that physical activity may explain the beneficial effect of frequent eating on body composition in children. This effect was investigated by examining physical activity with accelerometry in a subgroup of these children and by excluding the underreporters from the analysis.

The negative association between eating frequency and body composition in the present study is in agreement with early data of Fabry et al. [9], but in contrast with those presented by Ruxton et al. [30]. It is worth noting that none of the above studies eliminated the underreporters from their analysis. A number of stud-

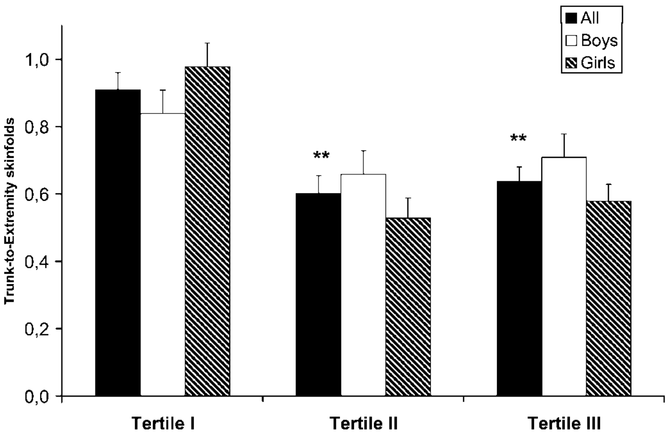

Fig. 1 Trunk to extremity skinfold ratio for the 9–11-year-old children placed in tertiles according to the number of eating episodes (means ± SE; n = 47). ** $p < 0.01$ in comparison with tertile I; tertile I = infrequent eaters; tertile III = frequent eaters. ■*tertile II not menmtioned?*

ies in adults show either an inverse or a lack of association between meal frequency and body fatness [6,7,16,23,29,34,36]. However, at least three of these studies have been criticized because they did not account for the underreporters [7,16,23]. Of the studies that excluded underreporters, two found an inverse association [6,36] and one study reported no relationship between eating frequency and obesity [34]. In the present study, underreporters were excluded and this strengthens our findings. Underreporting in the present study (13.2%) was higher than that reported for a European sample of 6–13-year-old boys and girls (2 and 3%, respectively) [32].

The beneficial effect of increased eating frequency on body composition was evident despite the higher caloric intake of the frequent eaters in this cohort of children. This means that energy expenditure should have been elevated in the frequent eaters to compensate for their increased energy intake. From the energy expenditure components, thermic effect of food (TEF) has been shown to be elevated with the increasing number of eating episodes in some [21] but not all studies [18]. However, energy expenditure from TEF is only a small portion of daily energy expenditure and therefore it could not explain the lower body fat mass of the frequent eaters compared with the infrequent eaters in the present study. Energy expenditure due to physical activity and basal metabolic rate account for 15–30% and 60–70% of the total daily energy expended, respectively. To our knowledge, no study has examined the difference in physical activity levels between children who are frequent and non-frequent eaters. In adults, the pattern of food intake may have no effect in daily energy expenditure, as previously suggested [35].

In the present study, total physical activity was higher in the frequent eaters and this could, at least partially, explain their favorable body composition compared with the infrequent eaters. The results of this investigation cannot make a suggestion on the possible physiological mechanism behind these findings. It has been suggested that elevated physical activity may prevent an increase in body weight and body fat by promoting the development of lean body mass [6]. Indeed, a 6% increase in lean body mass has been shown after 12 weeks of exercise training in chil-

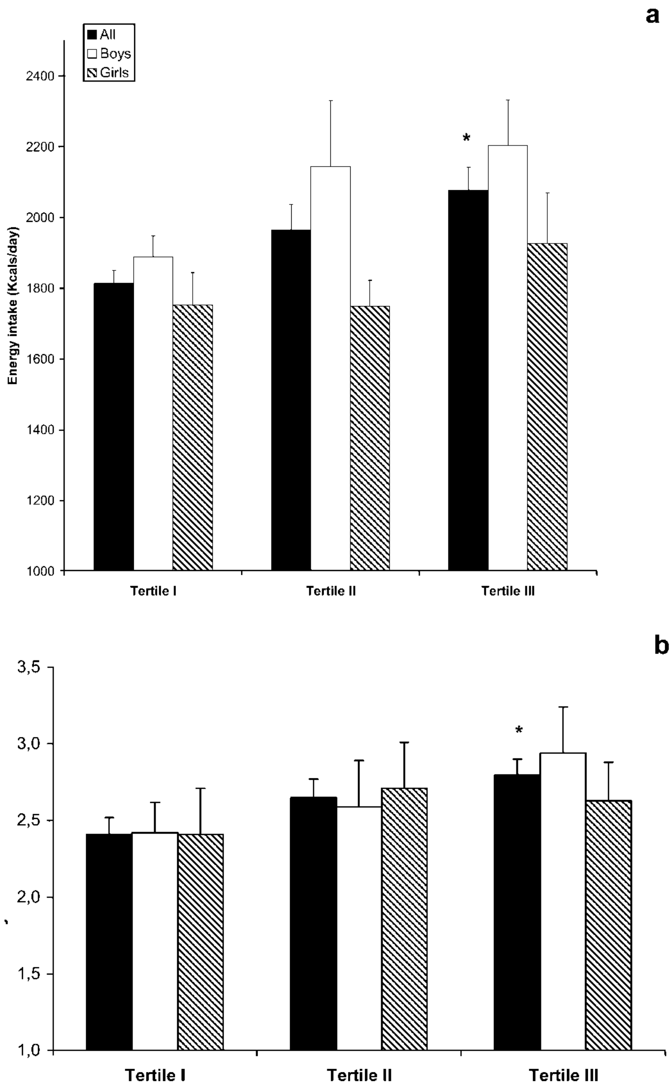

Fig. 2 **a** and **b** Daily energy intake (**a**) and carbohydrate to fat intake ratio (**b**) for the 9–11-year-old children placed in tertiles according to the number of eating episodes (means ± SE, n = 131). * $p < 0.05$ in comparison with tertile I. Tertile I = infrequent eaters; tertile III = frequent eaters.

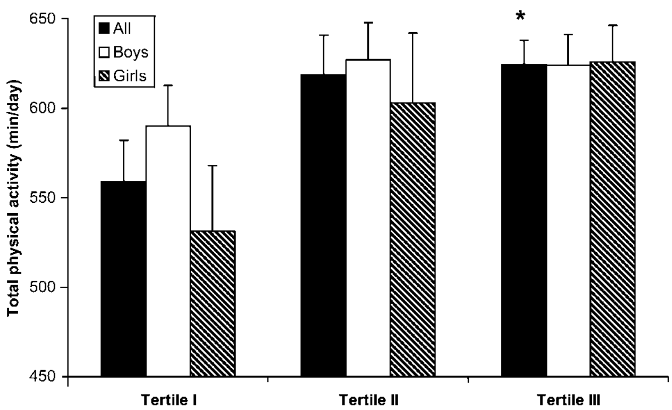

Fig. 3 Total physical activity for the 9–11-year-old children placed in tertiles according to the number of eating episodes (means ± SE, n = 48). * $p < 0.05$ in comparison with tertile I. Tertile I = infrequent eaters; tertile III = frequent eaters.

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Table **2A** Anthropometric characteristics and physical activity of the children placed in tertiles according to the daily number of snacks

	Tertile I n = 42	*Tertile II n = 41*	*Tertile III n = 46*
Age (yr)	9.9 ± 0.2	10.1 ± 0.2	9.8 ± 0.2
Body mass (kg)	39.8 ± 1.8	38.3 ± 1.5	40.2 ± 1.8
BMI (kg/m²)	19.8 ± 0.7	19.1 ± 0.7	20.2 ± 0.6
Body fat (%)	25.1 ± 1.7	22.5 ± 1.5	24.5 ± 1.6
Sum of 4 skinfolds (mm)	57.8 ± 5.2	50.8 ± 4.8	55.9 ± 4.9
TER (units)	0.81 ± 0.04	0.65 ± 0.03	0.70 ± 0.03
Energy intake (kcals/day)	1990 ± 71	1906 ± 58	1967 ± 60
Physical activity (min/day)	562.2 ± 14.4	597.6 ± 11.2	639.6 ± 10.5**

Values are means ± SE; tertile I = infrequent eaters; tertile III■ = frequent eaters; BMI = body mass index; TER = trunk to extremity skinfolds ratio; ** p < 0.01 vs. tertile I; † p = 0.08; analysis was adjusted for age and sex ■*tertile II not menmtioned?*

Table **2B** Anthropometric characteristics and physical activity of the children placed in tertiles according to the daily number of meals

	Tertile I n = 45	*Tertile II n = 41*	*Tertile III n = 43*
Age (yr)	10.0 ± 0.2	9.7 ± 0.1	10.0 ± 0.2
Body mass (kg)	42.4 ± 1.7	37.7 ± 1.6	38.1 ± 1.7
BMI (kg/m²)†	20.9 ± 0.6	18.9 ± 0.6	19.3 ± 0.7
Body fat (%)	26.1 ± 1.7	22.9 ± 1.7	23.1 ± 1.4
Sum of 4 skinfolds (mm)	60.8 ± 5.3	50.9 ± 4.8	52.5 ± 4.6
TER (units)	0.82 ± 0.04	0.71 ± 0.04	0.66 ± 0.03
Energy intake (kcals/day)	1748 ± 41	2025 ± 62**	2104 ± 70**
Physical activity (min/day)	610.1 ± 13.0	598.7 ± 12.5	592.8 ± 13.4

Values are means ± SE; tertile I = infrequent eaters; tertile III = frequent eaters; BMI = body mass index; TER = trunk to extremity skinfolds ratio; ** p < 0.01 vs. tertile I; † p = 0.08; analysis was adjusted for age and sex ■*tertile II not menmtioned?*

dren [26]. In the present study, lean body mass adjusted for body mass, age and gender had a strong tendency (p = 0.067) to be higher in the frequent eaters (Table **1**) who spent more time on physical activity each day. The results of this study also suggest that children who devote more time to physical activity may adopt a healthier lifestyle as reflected by the higher carbohydrate to fat ratio computed for these children. An increased carbohydrate to fat intake ratio has been suggested, by some authors, to result in body weight and body fat reduction [3,15]. Other studies, however, reported no effect of dietary carbohydrate to fat ratio on body fat storage [20,24]. Given these results, it seems that the findings of the present study may simply reflect a healthier lifestyle adopted by frequent eaters.

An interesting finding was that an increased number of eating episodes was associated with lower central adiposity. Central adiposity in childhood is associated with certain factors that are related to cardiovascular risk, such as hyperinsulinemia, insulin resistance and arterial stiffness [10]. Our findings suggest that the frequency of eating episodes might affect the degree of central adiposity in children. Other factors, such as elevated physical activity and a high cardiorespiratory fitness, may also contribute to a lower central adiposity in children [27].

Physical activity was evaluated in a subgroup of these children and this is a limitation of the study. Thus, present findings need to be confirmed by large-scale investigations. Body fatness and fat distribution were assessed with skinfolds. No doubt that direct measures of body fat such as computed tomography and magnetic resonance imaging would be of great value in future studies. Finally, other factors, which were not assessed in this study, could also have affected these results. No doubt that genes, parental control on children's food choices, parental obesity and breakfast skipping are some of the parameters that also affect pediatric obesity and should be incorporated in a future study examining the effect of meal frequency on body composition [23].

In conclusion, the results of the present study suggest that eating frequency is inversely related to body fat levels and body fat distribution in this cohort of school-age children. This was despite the fact that energy intake was higher for the frequent compared with the non-frequent eaters. The greater amount of time devoted to physical activity by the frequent eaters might, at least in part, explain these findings. These results could be added to the existing literature suggesting that elevated physical activity should be one of the main targets for childhood obesity prevention programs.

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References

1 Bellisle F, McDevitt R, Prentice AM. Meal frequency and energy balance. Br J Nutr 1997; 77: S57 – S70
2 Berenson GS. Longitudinal changes in cardiovascular risk from childhood to young adulthood in offspring of parents with coronary artery disease: the Bogalusa Heart Study. JAMA 1997; 278: 1749 – 1754
3 Bolton-Smith C, Woodward M. Dietary composition and fat to sugar ratios in relation to obesity. Int J Obes Relat Metab Disord 1994; 18: 820 – 828
4 Cole TJ, Bellizi C, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000; 320: 1240 – 1243

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AK-PDF tt.mm.jj Verlag Thieme/Hentze
ef-Upload tt.mm.jj Datum 07.08.2006

5 Crawley H, Summerbell CD. Feeding frequency and BMI among teenagers aged 16 – 17 years. Int J Obes Relat Metab Disord 1997; 21: 159 – 161
6 Drummond S, Crombie NE, Cursiter MC, Kirk TR. Evidence that eating frequency is inversely related to body weight status in male, but not female, non-obese adults reporting valid dietary intakes. Int J Obes Relat Metab Disord 1998; 22: 105 – 122
7 Edelstein SL, Barrett-Connor EL, Wingard DL, Cohn B. Increased meal frequency associated with decreased cholesterol concentrations; Rancho Bernardo, CA, 1984 – 1987. Am J Clin Nutr 1992; 55: 664 – 669
8 Ekelund U, Sjostrom M, Yngve A, Poortvliet E, Nilsson A, Froberg K, Wedderkopp N, Westerterp K. Physical activity assessed by activity monitor and doubly labeled water in children. Med Sci Sports Exerc 2001; 33: 275 – 281
9 Fabry P, Hejda S, Cerny K, Osancova K, Pechar J. Effect of meal frequency in schoolchildren: changes in weight-height proportion and skinfold thickness. Am J Clin Nutr 1966; 18: 358 – 361
10 Ferreira I, Snijder MB, Twisk JWR, van Mechelen W, Kemper HCG, Seidell JC, Stehouwer. Central fat mass versus peripheral fat and lean mass: opposite (adverse versus favorable) associations with arterial stifness: the Amsterdam Growth and Health Longitudinal Study. J Clin Endocrinol Metab 2004; 89: 2632 – 2639
11 Gatenby SJ. Eating frequency: methodological and dietary aspects. Br J Nutr 1997; 77: S7 – S20
12 Gibney MJ, Wolever TMS. Periodicity of eating and human health: present perspective and future directions. Br J Nutr 1997; 77: S3 – S5
13 Heyward VH, Stolarczyk LM. Applied Body Composition Assessment. Champaign, IL: Human Kinetics, 1996
14 Hoos MB, Plasqui G, Gerver WJ, Westerterp KR. Physical activity level measured by doubly labeled water and accelerometry in children. Eur J Appl Physiol 2003; 89: 624 – 626
15 Horton TJ, Drougas H, Brachey A, Reed JC, Peters JC, Hill JO. Fat and carbohydrate overfeeding in humans: different effects on energy storage. Am J Clin Nutr 1995; 62: 19 – 29
16 Kant AK, Schatzkin A, Craubard BI, Ballard Barbash R. Frequency of eating occasions and weight change in the NHANES I Epidemiological Follow-up Study. Int J Obes Relat Metab Disord 1995; 9: 468 – 474
17 Katzmarzyk PT, Malina RM, Perusse L, Rice T, Province MA, Rao DC, Bouchard C. Familial resemblance in fatness and fat distribution. Am J Human Biol 2000; 12: 395 – 404
18 Kinabo JL, Durnin JV. Effect of meal frequency on the thermic effect of food in women. Eur J Clin Nutr 1990; 44: 389 – 395
19 Kirk TR. Role of dietary carbohydrate and frequent eating in bodyweight control. Proc Nutr Soc 2000; 59: 349 – 358
20 Lammert O, Grunnet N, Faber P, Bjornsbo KS, Dich J, Larsen LO, Neese RA, Hellerstein MK, Quistorff B. Effects of isoenergetic overfeeding of either carbohydrate or fat in young men. Br J Nutr 2000; 84: 233 – 245
21 LeBlanc J, Mercier I, Nadeau A. Components of postprandial thermogenesis in relation to meal frequency in humans. Can J Physiol 1993; 71: 879 – 883
22 Lobstein T, Frelut ML. Prevalence of overweight among children in Europe. Obes Rev 2003; 4: 195 – 200
23 Ma Y, Bertone ER, Stanek EJ, Reed GW, Hebert JR, Cohen NL, Merriam PA, Ockene IS. Association between eating patterns and obesity in a free-living USA adult population. Am J Epidemiol 2003; 158: 85 – 92
24 McDevitt RM, Poppitt SD, Murgatroyd PR, Prentice AM. Macronutrient disposal during controlled overfeeding with glucose, fructose, sucrose, or fat in lean and obese women. Am J Clin Nutr 2000; 72: 369 – 377
25 Must A, Dallal GE, Dietz WH. Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ht2) and triceps skinfold thickness. Am J Clin Nutr 1991; 53: 839 – 846
26 Nassis GP, Papantakou K, Skenderi K, Triandafillopoulou M, Kavouras SA, Yannakoulia M, Chrousos GP, Sidossis LS. Aerobic exercise training improves insulin sensitivity without changes in body weight, body fat, adiponectin and inflammatory markers in overweight and obese girls. Metab Clin Exp 2005; 54: 1472 – 1479
27 Nassis GP, Psarra G, Sidossis LS. Central and total adiposity are lower in overweight and obese children with high cardiorespiratory fitness. Eur J Clin Nutr 2005; 59: 137 – 141
28 Nicklas TA, Morales M, Linares A, Yang SJ, Baranowski T, De Moor C, Berenson G. Children's meal patterns have changed over a 21-year period: the Bogalusa Heart Study. J Am Diet Assoc 2004; 104: 753 – 761
29 Ruidavets JB, Bongard V, Bataille V, Gourdy P, Ferrieres J. Eating frequency and body fatness in middle-aged men. Int J Obes Relat Metab Disord 2002; 26: 1476 – 1483
30 Ruxton CHS, Kirk TR, Belton NR. The contribution of specific dietary patterns to energy and nutrient intakes in 7 – 8-year-old Scottish schoolchildren. III. Snacking habits. J Hum Nutr Diet 1996; 9: 23 – 31
31 Schofield WN. Predicting basal metabolic rate, new standards and review of previous work. Hum Nutr Clin 1985; 39 C (Suppl 1): 5 – 41
32 Sichert-Hellert W, Kersting M, Schoch G. Underreporting of energy intake in 1 to 18-year-old German children and adolescents. Z Ernahrungswiss 1998; 37: 242 – 251
33 Slaughter MH, Lohman TG, Boileau RA, Horswill CA, Stillman RJ, Van Loan MB, Bemben DA. Skinfold equations for estimation of body fatness in children and youth. Hum Biol 1988; 60: 709 – 723
34 Summerbell CD, Moody RC, Shanks J, Stock MJ, Geissler C. Relationship between feeding pattern and body mass index in 220 free-living people in four age groups. Eur J Clin Nutr 1996; 50: 513 – 519
35 Verboeket-van de Venne WP, Westerterp KR, Kester AD. Effect of the pattern of food intake on human energy metabolism. Br J Nutr 1993; 70: 103 – 115
36 Whybrow S, Kirk TR. Nutrient intakes and snacking frequency in female students. J Hum Nutr Diet 1997; 10: 237 – 244
37 Wang Y, Monteiro C, Popkin BM. Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China and Russia. Am J Clin Nutr 2002; 75: 971 – 977