Factors associated with obesity in school children

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Abstract

Objective: To analyze the relationship between obesity, physical activity and hours of sleep in schoolchildren and parental schooling and obesity.

Methods: We measured the weight, height, body mass index and adiposity (subscapular to triceps skinfold ratio) of children. The children were classified as normal, underweight, overweight or obese, according to body mass index per age. Four hundred and fifty-two schoolchildren were evaluated; 68 children with excess weight and obesity and 97 normal children were selected to answer a questionnaire regarding daily physical activity and sleeping hours, as well as parental schooling, physical activity, weight and height.

Results: The prevalence of excess weight and obesity was of 21.1% in boys and 22.9% in girls. Adiposity was different between normal children and the other groups (p < 0.01). In children with excess weight and obesity, adiposity was directly correlated with daily sitting hours and inversely correlated with daily sleeping hours (p < 0.05). Schooling was lower in mothers of overweight and obese children was lower than in mothers of normal children (p < 0.01). The frequency of excess weight and obesity in the parents of overweight/obese children was higher than in the parents of normal children (p < 0.01). Most parents had a sedentary life style.

Conclusion: We observed an association between excess weight and obesity in children and inactivity. The time spent sleeping was a positive factor for maintaining a balance between weight and height. Maternal schooling and the presence of excess weight/obesity in parents were significantly associated with childhood obesity.

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Introduction

Obesity is currently regarded as a public health problem that affects both young people and adults.[1] The data about Brazilian children obtained by the Brazilian Institute for Food and Nutrition (INAN) and by the Brazilian Survey on Nutrition and Health (PNSN) in 1989 demonstrate that nearly one and a half million children suffer from obesity, whose prevalence is higher among girls and in well developed regions.[2] However, this profile has been changing, and obesity has been increasing among boys and in underprivileged social classes.[3]

The onset of obesity may occur at any age, and is triggered by factors such as early weaning, inadequate food intake, eating disorders and problems related to family relationship, especially during growth spurts.[4] Whitaker et al.[5] and Price[6] show that it is necessary to identify overweight children as soon as possible in order to prevent them from becoming obese adults. These authors mention two factors that may double the risk of obesity among young adults: obesity in either of the parents or childhood obesity. Neither of the factors should be considered in isolation, but rather as a combination. Cutting et al.[7] concluded that a sedentary lifestyle and inadequate family meal patterns may contribute towards early-onset obesity. On the other hand, the interrelationship between young athletes, and guidance and encouragement by parents have been reported as having a positive effect on the prevention of obesity.[8]

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In the last decades children have become less active as a result of their easy access to technological advances. A positive relationship has been observed between lack of activity (e.g.: time spent watching television) and an increase in adiposity in school-aged children.[9,10] Physical activity, however, reduces the risk of obesity by regulating the energy balance or improving the ratio of lean-to-fat tissue

The aim of the present study was to investigate the relationship between daily activities and number of hours of sleep and overweight and obesity in school-aged children. Some familial factors were also analyzed, such as educational level, parental obesity and parental physical activity patterns in comparison to childhood obesity.

Materials and Methods

The study was carried out in 2000 and included both male and female students aged between 6 and 10 years, as part of the PREVINE (Nutritional Study and Surveillance of Students) project developed by Universidade Católica de Brasília (UCB). The aim of this study was to assess and record the weight, height and the BMI of elementary to high school students for the early diagnosis of overweight, obesity or underweight, as well as for the guidance of students and parents. The study was approved by the research ethics committee of Universidade Católica de Brasília. The PREVINE project included students from Centro Educacional da Católica de Brasília, a private school inside the campus of UCB in which middle and upper-middle class children from the town of Taguatinga are enrolled. A total of approximately 2,500 students participated in the project, which corresponds to nearly 2.1% of the students enrolled in private schools in Brasília.[12] All students could participate in the PREVINE project provided their parents signed an authorization for their inclusion in the study.

The anthropometric assessment of the students was performed at the Laboratory of Nutritional Assessment (LAN) of UCB, where they had their weight, height, and triceps and subscapular skinfold thicknesses measured. Measuring instruments included a metal Sanny® tape measure mounted to the wall (Kirchnner & Wilhelm, Medizintechnik, Germany), with a precision of 2 m/0.1 cm for height measurement; a digital Filizola® scales (Indústria Filizola S/A, Brazil) with a capacity for 0 to 150 kg/100 g for weight measurement, and a Lange skinfold caliper (Beta Technology Incorporated, Cambridge, Maryland, USA) with a precision of 0.5 mm for skinfold thickness measurement. All anthropometric measurements were made according to the Anthropometric Standardization Reference Manual.[13]

In the first part of the study, we calculated the body mass index (BMI) of the children by dividing their weight (kg) by their squared height (m). The body fat percentage (%BF) was estimated using the triceps and subscapular skinfold thicknesses.[14] Students were then classified as normal, overweight, or obese depending on their BMI for age, considering the thresholds proposed by Cole et al.,[15] and as underweight in cases with a BMI for age below the 5th percentile[16] (Table 1).

In the second part of the study, we matched the children according to sex and age and split them into two groups: OW+O (overweight and obese children) and a control group (healthy children). The control group included only 50 children of each sex due to time restrictions, since the interviews were time-consuming and could only be conducted outside of classtime.

Parents were allowed to answer the questionnaire at home. Parental physical activity was assessed by a questionnaire adapted from Ross & Jackson,[17] in which participants had to indicate whether they had a sedentary lifestyle or did little or moderate to intense physical activity, according to the models proposed. Daily recalls,

Table 1 - BMI for age of children from 6 to 10 classified as underweight, overweight, or obese[15,16]

Age (years)	Male			Female		
	Underweight (≤)	Overweight (≥)	Obesity (≥)	Underweight (≤)	Overweight (≥)	Obesity (≥)
6	13.7	17.5	19.8	13.4	17.3	19.6
6.5	13.7	17.7	20.2	13.4	17.5	20.1
7	13.7	17.9	20.6	13.4	17.7	20.5
7.5	13.7	18.2	21.1	13.5	18.0	21.0
8	13.8	18.4	21.6	13.5	18.3	21.6
8.5	13.8	18.7	22.2	13.6	18.7	22.2
9	13.9	19.1	22.8	13.7	19.1	22.8
9.5	14.1	19.5	23.4	13.8	19.4	23.5
10.0	14.2	19.8	24.0	14.0	19.9	24.1
10.5	14.3	20.2	24.6	14.2	20.3	24.8
11	14.5	20.5	25.1	14.4	20.7	25.4

adapted from Sallis et al.,[18] were used to assess the children's physical activity, and the amount of time spent sitting, number of hours of sleep and leisure-time physical activities also were recorded. In case of children, questions about sports activities and about the habit of going to clubs and fitness centers and engaging in free time activities also were included. All questionnaires were previously tested to identify possible difficulties in filling them out.

Means (x), standard deviation (SD) and frequency (%) were calculated for the statistical analysis. Pearson's correlation coefficient was used to assess the level of association between the variables analyzed. Student's t test was used to compare the mean results of the analyzed variables and χ^2 was used for comparison of frequencies. Multiple linear regression was used to detect the influence of variables over overweight and obesity. A p value below or equal to 0.05 was considered to be statistically significant for a 95%CI. The data were analyzed through SPSS 10.0 (SPSS Inc.) statistical package.

Results

Students

In the first part of the study, 452 students were assessed - 203 boys (44.9%) and 249 girls (55.1%). Among the assessed boys, 85 (41.9%) were 6 to 8 years old and 118 (58.1%) were 9 and 10 years old. As to girls, 112 (45.0%) were 6 to 8 years old and 137 (55.0%) were 9 and 10 years old.

Table 2 shows the frequency of healthy, underweight, overweight and obese children. The concomitance of obesity and overweight was similar for both sexes, amounting to 21.1% in boys and 22.9% in girls.

The mean body fat percentage increased from underweight to healthy children and from healthy children to overweight and obese children, in both boys and girls (Table 3). Significant differences were observed (p<0.01). Healthy girls had a higher body fat percentage than boys (p < 0.01).

Table 2 - Distribution of normal, underweight, overweight and obese children based on BMI/age[15,16] (Brasília, DF)

Diagnosis	Boys		Girls		General	
	n	%	n	%	n	%
Normal	156	76.8	182	73.1	338	74.8
Overweight	34	16.7	42	16.9	76	16.8
Obesity	9	4.4	15	6.0	24	5.3
Underweight	4	2.0	10	4.0	14	3.1
Total	203		249		452	

Table 3 - Mean values and standard deviation (x±sd) of adiposity[14] in normal, underweight, overweight and obese children based on BMI/age[15,16] (Brasília, DF)

	Body fat (x±dp)		
	Boys	**Girls**	**General**
Normal*	16.3±4.2 [156]	19.1±4.0 [182]	17.8±4.4 [338]
Overweight†	26.9±4.9 [34]	27.6±4.3 [42]	27.3±4.5 [76]
Obesity†	40.1±7.2 [9]	33.8±3.8 [15]	36.2±6.0 [24]
Underweight†	12.0±1.9 [4]	14.0±4.3 [10]	13.5±3.8 [14]
Total	19.1±7.5 [203]	21.2±6.2 [249]	20.3±6.9 [452]

[ ]: number of children;
(*) and (†): significant difference (p < 0.01) in all columns.

There was agreement between the diagnosis of overweight and obesity according to the BMI for age[15] and excess adiposity in children, in accordance with the threshold values for body fat proposed by Lohman[19] (20% for boys and 25% for girls). The frequency of excess adiposity between healthy boys and girls or false negatives according to the BMI for age was of 20.0% and 18.2% respectively, most cases relating to threshold values for high adiposity. The concordance between excess adiposity and overweight and obesity ranged between 97.3% for girls and 95.2% for boys, which indicates a low occurrence of false positives when the BMI for age was used.

In the second part of the study, overweight and obese children (43 boys and 57 girls from the OW+O group) and 50 healthy children of each sex in the control group were interviewed, randomly selected (drawn out), after being age- and sex-matched, in comparison with overweight and obese children. The participation of families with overweight and obese children was small (61.8%), consisting of 33 boys and 35 girls, comparatively to the families with healthy children (97%).

The children's daily physical activity and number of hours of sleep are shown in Table 4. Notably, around 75% of children's daily routine is distributed between hours of sleep and hours spent sitting. Differences were observed between the groups regarding the "amount of time spent sitting", which was longer for the OW+O group than for the control group in both boys and girls. The difference is significant (p < 0.05) when we compare healthy and obese children.

The body fat percentage of children in the OW+O group is directly and significantly (r = +0.306; p = 0.05) correlated with the mean daily time spent sitting, and inversely and significantly correlated (r = -0,278; p < 0.02) with the mean number of hours of sleep (Figures 1 and 2). The same pattern was observed using BMI instead of body fat percentage. Correlations were not significant for the children in the control group.

Table 4 - Mean daily sleeping hours, sitting hours and leisure activities of normal, overweight and obese children (Brasília, DF)

| | | Daily activities (hours) (x±dp) | | |
		Leisure	Sitting	Sleeping
Boys				
Normal	[47]	5.63±1.21	9.36±1.71	8.99±0.99
Overweight	[27]	5.91±1.07	9.53±1.58	9.10±1.46
Obesity	[6]	6.33±0.52	10.59±1.27	8.68±0.89
Girls				
Normal	[50]	5.64±1.13	9.32±1.78	9.27±1.12
Overweight	[26]	5.65±1.30	9.36±1.78	9.37±1.35
Obesity	[9]	6.40±0.93	10.03±1.29	8.60±0.65
General				
Normal	[97]	5.63±1.16	9.34±1.74[*]	9.14±1.06
Overweight	[53]	5.78±1.19	9.45±1.66	9.23±1.40
Obesity	[15]	6.37±0.77	10.25±1.27[†]	8.63±0.73

[ ]: number of children;
(*) and (†): significant difference (p < 0.05).

Sports were practiced by boys (63.8%) more often than by girls (43.5%) [p < 0.01], and also were more frequent among healthy children than among overweight ones. The sports most widely practiced by boys were swimming and indoor soccer (futsal), whereas girls preferred swimming and tennis.

The habit of going to clubs and fitness centers was similar between groups and sexes, and the multiple regression analysis did not show any correlation of body fat with these parameters.
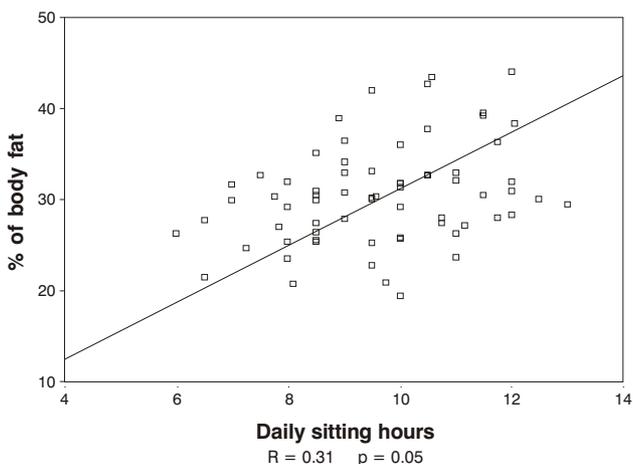

Figure 2 – Dispersion graphic and linear regression between body fat percentage and mean number of hours of sleep of overweight and obese children (Brasília, DF, Brazil).

Parents

Table 5 shows parental educational level. The study population is notably of a different type, since over 50% of parents have a university degree or are in undergraduate school. A low educational level is more frequent, while lack of a university degree is less frequent, in mothers of children in the OW+O group when compared to the control group. The statistical analysis of the data revealed a significant and inverse correlation (r = -0.239, p < 0.01) between maternal education and occurrence of overweight and obesity in children. This was not observed in paternal education.

Figure 1 – Dispersion graphic and linear regression between body fat percentage and the mean daily time spent sitting of overweight and obese children (Brasília, DF, Brazil).
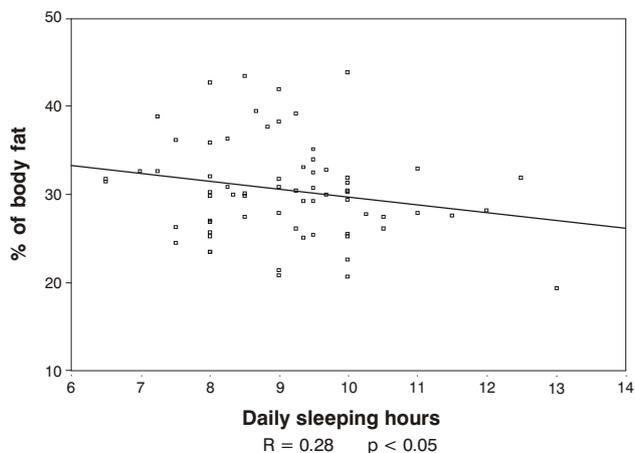
Table 5 - Distribution of educational level of parents of overweight and obese children (Brasília, DF)

| | | Children | |
		Normal	Overweight/Obese
Father		[91]	[65]
	E	%	%
	1	5.5	9.2
	2	7.4	27.7
	3	57.1	63.1
Mother		[97]	[66]
	E	%	%
	1	2.1	7.6
	2	35.1	43.9
	3	62.9	48.5

[ ]: number of parents; E: educational level - 1 = elementary school;
2 = high school and 3 = university.

Weight and height were recorded by parents and confirmed by direct assessment during the interviews, showing good concordance between the values. Considerable differences were found on comparing the occurrence of overweight and obesity in parents of children in the control and OW+O groups (Table 6). Mean BMI is significantly higher in parents of children in the OW+O group comparatively to the parents of children in the control group (p < 0.01). The frequency of overweight and obesity also is remarkably higher in parents of children in the OW+O group comparatively to the parents of children in the control group. The frequency of overweight and obesity among the mothers of children in the control group was 22.73% while for mothers of children in the OW+O group it was 35.07%. The occurrence of overweight and obesity among the fathers of children in the control group was 48.19% whereas for fathers of children in the OW+O group it was 74.33% (p < 0.01). The frequency of overweight and obesity in children was 51.8% when both parents were obese, 50% when one of the parents was obese and 19.6% when none of the parents was obese. There was a strongly positive correlation between parental and child overweight and obesity (p < 0.001).

Table 6 - Body mass index and frequency of overweight and obesity in parents of normal and overweight/obese children (Brasília, DF)

	Children	
	Normal[†]	Overweight/ obese[‡]
Father	**[91]**	**[64]**
BMI (x±dp)	25.9±4.0	27.3±3.1
Nutritional status (%)*		
Normal	49.5	25.0
Overweight	38.5	56.3
Obese	12.1	18.8
Mother	**[96]**	**[67]**
BMI (x±dp)	23.8±3.7	24.6±3.7
Nutritional status (%)*		
Normal	74.0	65.7
Overweight	19.8	25.4
Obese	6.2	9.0

[ ]: number of parents;
BMI: body mass index;
* Criteria of WHO[1];
[†] and [‡]: significant difference between the means and frequencies (p < 0.01).

The amount of daily physical activity of parents revealed their tendency towards a sedentary lifestyle, especially the mothers. No significant association was found between physical activity and the occurrence of overweight and obesity in children.

Discussion and conclusions

The prevalence of overweight and obesity in school-aged children in our study corroborates the results obtained from other studies conducted in Brazil[20] and in South America[21] showing that childhood overweight and obesity should be addressed as a major public health problem. The PREVINE project, conducted by Universidade Católica de Brasília, has tested and implemented an annual assessment of school-aged children, from elementary to high school, using a printed card, and the BMI for age as a diagnostic tool.

The tendency towards a sedentary lifestyle shown in the present study, given the association between the amount of time children spend sitting and their body fat percentage, is in agreement with the findings of other authors[9,10], suggesting that inactivity plays a major role in the development of childhood obesity. On the other hand, the fact that the number of hours of sleep observed in this study may favor a decrease in body fat shows that sleep may act positively towards maintaining body composition in children and should therefore be encouraged, especially in overweight and obesity ones. We have found no other reports in the literature on this issue. However, it should be underscored that correlations in both cases, albeit significant, were low, thus suggesting the need for further investigation, especially into the influence of sleep on energy balance in children, which could be regarded as preliminary results.

The familial characteristic of obesity is widely known[22] given the concomitance between child and parental obesity. The importance of education, especially maternal education, is shown by the higher occurrence of overweight and obesity in students whose mothers had a lower educational level, which suggests that maternal education is a risk factor for childhood obesity.

The present study shows a high occurrence of overweight and obesity in middle-class and upper-middle class students in Brasília (DF), with rates greater than 20% for both sexes. The classification used, based on the international BMI for age standard, revealed good correlation with adiposity. Among the analyzed factors, the following could be considered to predispose to overweight and obesity in students: inactivity, fewer hours of sleep, lower level of maternal education and occurrence of overweight or obesity in one or both parents. It must be noted that the results of our study were obtained from a relatively small sample of middle-class and upper middle-class students in Brasília, and should therefore be further investigated before they are extended to schoolchildren of other regions in Brazil.

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The prevalence of overweight and obesity in children is increasing worldwide, and currently 1 child in 10 is overweight or obese [4]. Results of longitudinal study in United State suggest that obese adolescents are likely to stay obese into adulthood, and among individuals who were obese as adolescents, incident of severe obesity was 37.1% in men and 51.3% in women [5]. In lower- to middle-income countries, obesity co-exists with undernutrition where most overweight and obese children being concentrated in urban areas and presents serious social and psychological impacts [6].Â Factors associated with overweight/obesity.