

NUTRITIONAL STATUS OF CHILDREN AND ADOLESCENTS: FACTORS ASSOCIATED TO OVERWEIGHT AND FAT ACCUMULATION

Cristina Carpentieri Zollner Salvador¹, Pedro Makumbundu Kitoko²,
Ana Maria Dianezi Gambardella³

DOI: dx.doi.org/10.7322/jhdg.88969

Abstract

Objective: To estimate prevalence and identify factors associated with the nutritional status of individuals aged 8 to 17 years old in schools located at 3 administrative regions in the city of Vitória, Brazil. **Methods:** The nutritional status of 400 students was assessed based on a cross-sectional study. Association between overweight and fat accumulation around waist was tested considering the variables: sexual maturation stage, income level, number of siblings, maternal Body Mass Index (BMI) and physical activity. Individuals considered stunting had height-for-age < -2 Z-scores of median value for the reference population; wasting, those with BMI < 5th percentile; overweight, those with BMI ≥ 85th percentile. Waist circumference was measured under the following parameter: percentile ≥ 90 of the British population. **Results:** Prevalence was 4.0% stunting, 4.8% wasting, 21.3% overweight and 27.3% fat accumulation around the waist. In the multiple linear model, variables associated with overweight were the following: initial and intermediate stages of *sexual maturation*, *maternal BMI* > 25kg/m², and high income level. Fat accumulation around the waist was associated to the following variables: *maternal BMI* > 25kg/m², high income level, *age* < 14, and *sedentary* > 28 hours/week. **Conclusions:** Low prevalence of nutritional deficits and high prevalence of overweight and fat accumulation around the waist were found. Higher prevalence rate occurred among individuals showing the following characteristics: higher income level; overweight mother; within initial and intermediate stages of sexual maturation; below 14 years old; sedentary.

Key words: nutritional status, sexual maturation, stunting, overweight, abdominal obesity, adolescent

INTRODUCTION

Adolescence is an important period for human growth and development. In this stage of life, the individual undergoes fast-paced physical and psychosocial changes, setting patterns for adult life¹.

During adolescence nutritional problems coming from earlier life stages can be more easily solved. Good eating habits and healthy life style may be adopted and kept through adulthood. Therefore, monitoring adolescents' nutritional status may avoid or postpone the onset of chronic diseases in later stages².

Population-based studies in Brazil on the nutritional status of children and adolescents address critical rises on overweight during last decades, with higher concentration of cases in individuals pursuing higher incomes. In a few

Brazilian cities, rates are similar or even higher to those in developed countries e.g., Pelotas and Santos, with 25.9% and 33.7% respectively, compared to average 31.9% in the USA. In Brazilian adult population, the rate is about 50%³⁻⁶.

Results are worrisome considering that obesity is an illness and also a powerful risk factor for other health problems, e.g. cardiovascular diseases, hypertension, some types of cancer, diabetes mellitus, and psychosocial disturbs. It is also associated with a rise on risk of early death^{2,7}.

Some authors have shown the type of obesity with fat accumulation around the waist is associated with higher risk of metabolic diseases⁷.

Obesity prevention mechanisms are required, given the difficulty to reverse it in adulthood, when changes on eating and physical activities habits are already set, besides the body's trend to maintain

1 Nutritionist at the Espírito Santo state Department of Health – Vitória/ES – Brazil - CEP 29050-625.

2 President of the Espírito Santo state Council of Food and Nutritional Security - Vitória/ES – Brazil.

3 Professor at the Faculty of Public Health, University of São Paulo - São Paulo - SP - Brazil.

Corresponding author: zollner@usp.br

Aplicação do estudo (novidade): crianças e adolescentes nos estágios de maturação sexual inicial ou intermediária são mais sedentárias e com maior sobrepeso. Nas famílias de maior renda, há maior sobrepeso e obesidade.

Suggested citation: Gambardella AMD, Salvador CZS, Kitoko PM. Nutritional status of children and adolescents: factors associated to overweight and fat accumulation. *Journal of Human Growth and Development*, 24(3): 313-319
Manuscript submitted Jun 05 2014, accepted for publication Sep 18 2014.

the highest achieved weight. Nevertheless, treating obesity at this stage demands special attention, as a calorie-restricted diet may affect growth, reinforcing needs for prevention^{2,8}.

Whereas obesity has become a public health issue and require actions for prevention and control, national survey Pesquisas de Orçamentos Familiares 2008-2009 (Survey on Families' Budgets) conducted by the Brazilian Institute of Geography and Statistics - IBGE shows a deficit value higher than expected for healthy populations (in spite of a gradual decrease on nutritional deficiencies in last decades). This happens particularly among bellow-5-year children, with higher concentration in individuals with low incomes (8.2%) when compared to wealthier ones (3.1%)⁵, leaving space for monitoring such deficits.

Thus, the objective is to describe the factors associated to overweight and fat accumulation in school children and adolescents.

METHODS

The study design is cross-sectional, population-based. Assessed population was composed of 4th-to-9th grade students from public and private Elementary Schools within three administrative regions in the city of Vitória, capital of Espírito Santo state, Brazil.

A sample of 450 students was randomly chosen from 14.734 students. Size of initial sample was determined by the formula:

$$n = \frac{N \cdot n_0}{N + n_0}$$

where: n = sample size; N = total individuals; n₀ = first approximation to the size of obtained sample, dividing 1 by the adopted acceptable sampling error: 0.05.

In first stage, 18 schools (12 public and 6 private) were randomly chosen out of 42, considering the proportion of their distribution. Public and private schools were listed according to the 3 administrative regions (out of 7) selected by the Education Department of Vitória (Continental, Maruípe e Jucutuquara), in order to assure the sample's representativeness.

In second stage, students were chosen by systematic sampling on a 450-student base, 25 students per each school. 404 students were interviewed and 4 were excluded, summing 400 students in total, with 11.1% loss.

The survey used for data collection was previously tested in 2 schools, which were excluded from the sampling process.

Methods described by LOHMAN et al.⁹ were utilized for weight, height and waist perimeter measurement. Anthropometric measurements were done twice and median value was adopted. Interviewers were trained for standardization of the anthropometric measurements, according to the recommendations given by LOHMAN et al.⁹ and HABICHT et al.^{9,10}.

In order to analyze anthropometric data within the studied population, height/age index and

Body Mass Index (BMI) were applied, based on reference values from the *National Center for Health Statistics* - NCHS, specific for each age and sex².

Students showing stunted-growth had height/age index 2 z-scored below the median value for the reference population; wasting those with BMI below percentile 5 and overweight those with BMI³ percentile 85¹.

Classification of waist perimeter followed parameters proposed by MCARTHY et al.¹¹, who consider cut-points higher or equal to percentile 90 as indicative of fat accumulation around the waist¹¹.

For classification of maternal nutritional status, BMI values proposed by WHO were chosen: low weight < 18.5 kg/m²; normal weight ³ 18,5 e < 25 kg/m²; pre-obese, obese degree I, II e III ³ 25 kg/m².¹² Owing to the low frequency of low-weight mothers (2.8%), normal-weight ones were summed.

Data on sexual maturation was provided through self-assessment by students. They were shown Tanner stages pictures without the interviewer's interference¹³. In case of differences between stage of pubic hair (P) and breasts (M) in girls, as well as pubic hair (P) and genitalia (G) in boys, the medium was used. For example, when P3 and G2 were mentioned by boys, T 2^{1/2} was considered instead. A variable was classified in three stages: initial (T1 and T1^{1/2}), intermediate (T2 to T3^{1/2}) and final (T4 to T5).

Socioeconomic information was obtained by using the National Economic Indicator (IEN), based on 12 final goods¹⁴. Values were divided in four: low income rate, low-intermediate, upper-intermediate and high.

Data on physical activity was extracted from the type of sport or other kinds of physical activity practiced in the last 12 months, along with daily time practicing and week frequency. Engagement in P.E. classes and in other routine activities was also verified. Students doing physical activities for at least 5 hours a week were considered moderate or intense active¹⁵.

Data on sedentarism was calculated by summing the total time (in minutes) during which the student watched TV, played videogame or used the computer over the week. Those spending at least 28 hours doing such activities were considered sedentary¹⁶.

Dependent variables "overweight" and "fat accumulation around the waist" were analyzed, initially, by comparing frequency distribution to independent variables under study (sexual maturation, age range, sex, number of siblings, incomes, maternal BMI, physical activity and sedentarism). Then simple general linear regression was used to calculate reasons of non-adjusted prevalence for each variable.

Two models for calculating generalized linear regression (GLM) were built: first, to identify variables associated with overweight and second, to identify those associated with the fat accumulation around the waist. Multiple general linear regressions allowed assessing the effects of different variables addressing the students' nutritional status, using prevalence rate (PR) to

evaluate such effects for “overweight” and “fat accumulation around the waist”.

Simple and multiple general regressions were not used for dependent variables “stunting” and “wasting” due to low found prevalence. Software Stata, 9.2 version, was employed to calculate simple generalized linear regression (SGL) and multiple generalized linear regression (MGL), binomial family with log link. For the selection of variables under study to be included in MGL in each model, it was adopted the critical level $p \leq 0.20$ of simple analysis. Variables were added to the model, once at a time, in p-value crescent order. In MGL, level of significance $\alpha = 0.05$ was used.

The analysis of independent variables’ influence on overweight considered as dependent variable: $(y) = \text{BMI}/\text{age}/\text{sex}$ (Percentile $< 85 = 0$; Percentile $> 85 = 1$). For fat accumulation around the waist, dependent variable was $(y) = \text{waist perimeter}/\text{age}/\text{sex}$ (Percentile $< 90 = 0$; Percentile $> 90 = 1$).

This study was approved by the Committee of Ethics for Research from the Faculty of Public Health, University of São Paulo COEP (157/05), research protocol #1339, in 29th May 2005. All the

parents/people in charge of the students signed a free and clarified Consent Term.

RESULTS

In total, 400 students were interviewed, 211 boys (52.8%) and 189 girls (47.3%), from 4th to 9th grade of Elementary School of 18 schools in the city of Vitória.

Based on the adopted parameters, 4.0% of students were stunted (16 students), 4.8% had wasting (19 students), 21.3% were overweight (85 students) and 27.3% had fat accumulation around the waist (109 students).

Simple general regression analysis reveals higher prevalence of overweight among students in initial sexual maturation stage (23.3%), younger than 12 years (25.2%), male (22.7%), with one siblings or none (22.7%), doing physical activities < 5 hours per week (21.7%), sedentary > 28 hours per week (25.8%), pursuing higher incomes (28.0%) and maternal BMI $> 25 \text{ kg/m}^2$ (30.4%). Variables sexual maturation, age range, sedentarism, family incomes and maternal BMI had level of significance to become part of multiple general linear regression ($p \leq 0.20$) (Table 1).

Table 1: Distribution of 4th-to-9th grade students from public and private Elementary Schools, according to overweight and variables under study. Vitória, ES, Brazil, 2007

Variable Category	Nutritional status				n	Total %	PR	p
	BMI < 85 n	%	BMI ≥ 85 n	%				
Sexual maturation								
Initial	79	76.7	24	23.3	103	100	1.89	0.090
Intermediate	179	77.2	53	22.8	232	100	1.86	
Final	57	87.7	8	12.3	65	100	1	0.079
Age range								
8 – 12 years	151	74.8	51	25.2	202	100	1	
12 – 14 years	103	81.7	23	18.3	126	100	0.72	0.148
14 – 17 years	61	84.7	11	15.3	72	100	0.61	0.097
Sex								
Female	152	80.4	37	19.6	189			
Male	163	77.3	48	22.7	211	100	11.16	0.440
Number of siblings								
0 to 1 sibling	167	77.3	49	22.7	216	100	1	
2 siblings or more	148	80.4	36	19.6	184	100	0.86	0.449
Physical activity								
0 – 5 hours/week	170	78.3	47	21.7	217	100	1	
5 hours/week or more	145	79.2	38	20.8	183	100	0.96	0.828
Sedentarism								
0 – 28 hours/week	183	82.4	39	17.6	222	100	1	
28 hours/week or more	132	74.2	46	25.8	178	100	1.47	0.046
Incomes (IEN)								
1 ^o quarter	84	84,0	16	16,0	100	100	1	
2 ^o quarter	82	82,0		18	18,0	100	1.13	0.707
3 ^o quarter	77	77,0	23	23,0	100	100	1.44	0.216
4 ^o quarter	72	72,0	28	28,0	100	100	1.75	0.045
Maternal BMI								
< 25 kg/m ²	159	84.1	69.6	30	15,9	189	1	
> 25 kg/m ²	94	69,6	41	30.4	135	100	1.91	0.002
Total	315	78.7	85	21.3	400	100		

In multiple general linear regression model, prevalence rate was higher among individuals in initial and intermediate sexual maturation stages, whose mothers had BMI > 25 kg/m² and pursuing higher incomes, for $\alpha = 0.05$ (Table 2).

For fat accumulation around the waist, prevalence was higher among students in initial sexual maturation stage (28.2%), younger than 12

years (29.7%), female (29.1%), with one sibling or none (29.2%), doing physical activities < 5 hours per week (28.1%), sedentary > 28 hours per week (35.4%), pursuing higher incomes (34.0%) and maternal BMI e" 25 kg/m² (37;8%). Same variables in overweight had level of significance to be part of multiple general linear regression ($p \geq 0.20$), except for sexual maturation (Table 3).

Table 2: Prevalence rate (PR) and overweight confidence intervals (CI_{95%}), according to the following variables: sexual maturation, maternal BMI and incomes. Vitória, ES, Brazil, 2007

Variable	Category	Non-adjusted PR	Adjusted PR (IC _{95%})	p
Sexual maturation	Initial	1.89	2.19 (1.0655 – 4.5052)	0.033
	Intermediate	1.86	2.13 (1.0743 – 4.2469)	0.030
	Final	1	1	
Maternal BMI	< 25 kg/m ²	1	1	
	> 25 kg/m ²	1.91	2.04 (1.3574 – 3.0872)	0.001
Incomes (IEN)	1 ^o quarter	1	1	
	2 ^o quarter	1.13	1.11 (0.6047 – 2.0541)	0.728
	3 ^o quarter	1.44	1.34 (0.7498 – 2.3847)	0.325
	4 ^o quarter	1.75	1.78 (1.0257 – 3.0893)	0.040

Table 3: Distribution of 4th-to-9th grade students from public and private Elementary Schools, according to fat accumulation around the waist and variables under study. Vitória, ES, Brazil, 2007

Variable Category	Nutritional status				Total		PR	p
	BMI < 85		BMI ≥ 85		n	%		
	n	%	n	%	n	%		
Sexual maturaten								
Initial	74	71.8	29	28.2	103	100	1.15	0.616
Intermediate	168	72.4	64	27.6	232	100	1.12	0.637
Final	49	75.4	16	24.6	65	100	1	
Age range								
8 – 12 years	142	70.3	60	29.7	202	100	1	
12 – 14 years	89	70.6	37	29.4	126	100	0.99	0.948
14 – 17 years	60	83.3	12	16.7	72	100	0.04	0.043
Sex								
Female	134	70.9	55	29.1	189	100	1	
Male	157	74.4	54	25.6	211	100	0.88	0.432
Number of siblings								
0 to 1 sibling	153	70.8	63	29.2	216	100	1	
2 siblings or more	138	75.0	46	25.0	184	100	0.86	0.353
Physical activity								
0 – 5 hours/week	156	71.9	61	28.1	217	100	1	
5 hours/week or more	135	73.8	48	26.2	183	100	0.93	0.674
Sedentarism								
0 – 28 hours/week	176	79.3	46	20.7	222	100	1	
28 hours/week or more	115	64.6	63	35.4	178	100	1.71	0.001
Incomes (IEN)								
1 ^o quarter	84	84.0	16	16.0	100	100	1	
2 ^o quarter	71	71.0	29	29.0	100	100	1.81	0.032
3 ^o quarter	70	70.0	30	30.0	100	100	1.88	0.022
4 ^o quarter	66	66.0	34	34.0	100	100	2,13	0.054
BMI maternal								
< 25 kg/m ²	149	78.8	40	21.2	189	100	1	
> 25 kg/m ²	84	62.2	51	37.8	135	100	1.79	0.001
Total	291	72.7	109	27.3	400	100		

In multiple general linear regression, individuals with higher incomes, sedentary and whose mothers had BMI ≥ 25 kg/m², had higher

prevalence rate of fat accumulation around the waist and individuals over 14 years, lower prevalence rate for $\alpha = 0.05$ (Table 4).

Table 4: Prevalence rate (PR) and confidence intervals (CI_{95%}) for fat accumulation around the waist, according to the variables: maternal BMI, incomes, age range e sedentarism. Vitória, ES, Brazil 2007

Variable	Category	Non-adjusted PR	Adjusted PR (IC _{95%})	p
Maternal BMI	< 25 kg/m ²	1	1	
	> 25 kg/m ²	1.79	1.78 (1.2683 – 2,5085)	0.001
Incomes (IEN)	1 ^o quarter	1	1	
	2 ^o quarter	1.81	1.69 (0.9968 – 2,856)	0.051
	3 ^o quarter	1.88	1.54 (0.9056 – 2,6227)	0.111
	4 ^o quarter	2,13	1.88 (1.1120 – 3,1427)	0.017
Sedentarism	< 28 h/sem	1	1	
	> 28 h/sem	1.71	1.70 (1.2361 – 2,3356)	0.001
Age range	8 – 12	1	1	
	12 – 14	0.99	0.87 (0.6296 – 1.202)	0.398
	14 – 17	0.56	0.49 (0.2839 – 0.8330)	0.009

DISCUSSION

Nutritional deficiencies are not a major problem within the assessed group. Low prevalence of stunting (4.0%) and wasting (4.8%) are next to the expected for a healthy population: 2.3% and 5.0% respectively. Such results corroborate population studies in Brazil showing low prevalence of nutritional deficits among children and adolescents. This rate has been decreasing over the course of last decades^{2,3,5}.

Overweight and fat accumulation around the waist had high prevalence within the group: 21.3% and 27.3% respectively. Such values are above the expected for a healthy population, which are 15% and 10% respectively, according to adopted criteria. Results are not to be compared with other studies, considering different criteria employed for nutritional assessment. Nevertheless, it is unquestionable the increase on prevalence of obesity in Brazilian adolescents, overcoming nutritional deficiencies^{2-5,17,18}.

Brazilian studies confirm higher prevalence of overweight and fat accumulation around the waist in wealthier individuals (about twice more), unlike findings in developed countries, where the opposite is verified, even among children and adolescents^{5,18-21}.

It is worth mentioning that almost one third of these individuals showed bad distribution of body fat (a risk for metabolic diseases), with prevalence of fat accumulation around the waist almost ¼ more than overweight (considering BMI percentile > 85^o).

PNDS-2006 describes more disturbing results, as half of the assessed Brazilian women between 15 and 49 years had fat accumulation around the waist. In 45 to 40 years age range, frequency reached about 75%²².

Such findings reinforce the need for waist circumference measurement in health units as a trial for individuals under risk of metabolic diseases.

Maternal BMI was also associated to problems related to obesity. Individuals with mothers pursuing BMI ≥ 25 kg/m² showed prevalence rate of 2.04 times and 1.75 times for overweight and fat accumulation around the waist, when compared to students whose mothers had BMI < 25 kg/m².

Some authors confirm such results; however, there is not clear evidence that obesity is determined by genetics or environmental factors^{23,24,25}. Sharing similar socio-environmental and culture backgrounds may be associated to close nutritional status between mothers and their children, although problems may appear in different periods^{23,24}.

It is worth remarking that sedentarism was more strongly associated to fat accumulation around the waist than overweight. Simple analysis had this variable associated to two factors, but it did not last in multiple analyses.

Physical activity did not have level of significance for this study. This may reflect reverse causality, owing to cross-sectional approach, as obesity might have motivated individuals to start physical activities or yet because of limitations on sample collection.

Variable sedentarism measured the period in which these individuals were inactive, with reduction on energy expenditure, and probably higher consumption of food, possibly stimulated by media²⁵. Studies show that less one hour per day (during one year) of television, video and computer may reduce 2% in prevalence of overweight^{26,27}.

Week hours spent in sedentary activities is averagely 28 hours/week, whereas physical activities did not reach 4 hours/week, with an average of 1.8 hours/week, i.e. 50% of students practiced less than 2 hours per week of physical activities.

Considering sexual maturation, students in initial and intermediate stages had overweight

prevalence rate about twice more than those in final stage. Such result corresponds to the literature, as adolescents in final development stage are expected to be thinner and those in stages 1 and 2 of pubertal development occasionally show an increase on body BMI^{28,29}.

Thus, we define the quality of public health at any given time must be compatible with future generations enjoying health in an equivalent way. Public health practitioners must also integrate sustainability in the definition of public health public health measures include ensuring a safe and healthy environment, clean water, safe workplaces; promotion of healthy behaviors such as hand washing and breast feeding; and, preventing

infectious diseases such as delivery of vaccinations and distribution of condoms to control the spread of sexually transmitted diseases³⁰, including reduction and variable of sedentarism.

In conclusion, low prevalence of nutritional deficiencies and high prevalence of indicators associated to obesity were found. Prevalence rate is higher in wealthier students, those whose mothers had BMI > 25 kg/m², sedentary ones, within initial or intermediate sexual maturation state, and below 14 years old.

Results follow trends observed in other Brazilian states over the course of the last decade. More studies are needed for monitoring nutritional status of adolescents in the city of Vitória.

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RESUMO

Objetivo: estimar as prevalências e identificar os fatores associados ao estado nutricional de indivíduos de 8 a 17 anos matriculados em escolas de 3 regiões administrativas do município de Vitória. **Método:** avaliou-se o estado nutricional de 400 alunos a partir de um estudo transversal. Testou-se a associação entre o sobrepeso e o acúmulo de gordura na cintura com as variáveis: estágio de maturação sexual, nível socioeconômico, número de irmãos, IMC materno e atividade física. Considerou-se em déficit de estatura os indivíduos com índice estatura/idade < -2 escores z do valor mediano da população de referência, em déficit de peso aqueles com Índice de Massa Corporal (IMC) < percentil 5 e com sobrepeso IMC e" percentil 85. Para o perímetro da cintura, adotou-se como parâmetro o percentil e" 90 da população britânica. **Resultados:** encontrou-se prevalência de 4,0% de déficit de estatura, 4,8% de déficit de peso, 21,3% de sobrepeso e 27,3% de acúmulo de gordura na cintura. No modelo de regressão linear múltipla as variáveis associadas ao sobrepeso foram maturação sexual em estágio inicial e intermediário, IMC materno e"25kg/m² e maior renda. Para acúmulo de gordura na cintura as variáveis associadas foram IMC materno e"25kg/m², maior renda, menores de 14 anos e sedentarismo e"28 horas/semana. **Conclusões:** observou-se baixa prevalência de déficit nutricional e elevada de sobrepeso e acúmulo de gordura na cintura, apresentando maior razão de prevalência entre os indivíduos com maior renda, com mães que apresentaram sobrepeso, nos estágios de maturação sexual inicial ou intermediária, menores de 14 anos e sedentários.

Palavras-chave: estado nutricional, maturação sexual, déficit de estatura, sobrepeso, obesidade abdominal, adolescente.