Comparative study of physical growth and nutritional status of schoolchildren (1997 and 2009)

Crescimento físico e estado nutricional de escolares: estudo comparativo – 1997 e 2009

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Abstract – Physical growth and nutritional status are excellent health indicators since they permit the establishment of growth monitoring charts, especially for schoolchildren. The objective of this study was to compare the growth profile and nutritional status of schoolchildren between two samples (1997 and 2009). The data of physical growth and nutritional status obtained for the present sample of 645 schoolchildren (270 boys and 375 girls). The children were classified according to the body mass index (BMI)-for-age reference values of the WHO child growth standards. Although no significant differences in height or body weight were observed between the children studied, these variables tended to increase from the first to the second sample and in the two genders. With respect to the adequacy of BMI in boys, there was an increase in the percentage of children with low BMI-for-age, doubling of the percentage of obese children, and a reduction in the percentage of children with overweight. An increase in the number of subjects with low body weight, overweight and obesity and a decrease in the number of subjects with adequate BMI-for-age were noted among girls. In conclusion, there were no significant changes in the physical growth indicators (weight, height and BMI) over the period comprising the two samples (1997 and 2009). However, height, body weight and the number of subjects with risk of obesity and obesity tended to increase, especially among girls.
Key words: Growth; Nutritional status; Schoolchildren.

Resumo – *O crescimento físico e estado nutricional são considerados excelentes indicadores de saúde, ao permitir o estabelecimento de padrões de monitoramento do desenvolvimento, principalmente de escolares. O estudo objetivou comparar o perfil de crescimento e estado nutricional de escolares em dois momentos 1997 e 2009. Os dados do crescimento físico e do estado nutricional da amostra atual foram 645 escolares (270 do sexo masculino e 375 do sexo feminino). Foi utilizada a adequação IMC/Idade, utilizando-se como padrão de referência as curvas de crescimento da Organização Mundial da Saúde (OMS). Embora não tenham sido verificadas diferenças estatisticamente significativas nos indicadores estatura e massa corporal dos escolares, foi possível observar uma tendência de aumento destas variáveis entre as duas amostras e em ambos os sexos. Em relação à adequação do IMC, observou-se um aumento no percentual de rapazes com IMC baixo para a idade, a duplicação do percentual de obesos e uma redução no percentual de sujeitos com sobrepeso. No grupo feminino, percebeu-se um aumento na quantidade de indivíduos com Baixo Peso, Sobrepeso e Obesidade e um decréscimo no número de escolares com IMC adequado para idade. Pode-se concluir que os indicadores de crescimento físico (peso, estatura e IMC) não apresentaram mudanças significativas no período de tempo compreendido entre as duas amostras (1997 e 2009). No entanto, foi possível verificar uma tendência para incremento na estatura, na massa corporal e no número de sujeitos com Risco para Obesidade e Obesidade, principalmente no sexo feminino.*
Palavras-chave: *Crescimento físico; Estado nutricional; Escolares.*

INTRODUCTION

The World Health Organization (WHO)[1] has emphasized the need for studies investigating the growth rates and nutritional status of different populations, especially children and adolescents, from underdeveloped and developing countries. Detailed information about these variables is important to establish growth monitoring charts[2]. In view of their close dependence on different environmental factors, these health indicators reflect the past and present living conditions of children and adolescents[3] since diseases and nutrition disorders invariably affect child development, irrespective of their etiology[4].

Although inadequate nutrition and low body weight continue to be a problem in many developing countries, obesity now poses an equally serious threat to young people's health[5-7]. For the first time in 200 years, the mean life expectancy of children and adolescents may decline due to this increase in obesity[8]. In Brazil, the growing replacement of the food shortage problem by dietary excess, which is characterized by an important reduction in malnutrition and an increase in the prevalence of obesity, has been observed for more than a decade. It is estimated that 13% of Brazilian children are currently obese and 20% are overweight. In relative terms, the rates of overweight and obesity have increased more than in other countries[9].

In view of the complexity and variability of the nutritional profile in the Brazilian population, nutrition surveys of schoolchildren are an important tool to understand the growth dynamics and nutritional status of children and adolescents in Brazil[10]. In this respect, many studies have been conducted in Brazil to identify and monitor the behavior of these variables[11-23], especially in the State of Santa Catarina[13,15]. In 1997, Machado and Krebs[12] investigated the physical growth profile and nutritional status of schoolchildren aged 10 to 14 years from the Island of Santa Catarina and observed significant rates of overweight and obesity. In view of these findings and of the relevance of monitoring the development of schoolchildren, the objective of the present study was to identify possible changes in the physical growth profile and nutritional status of schoolchildren from the Island of Santa Catarina by comparing current data with those obtained for the sample investigated by Machado and Krebs[12] in 1997.

METHODOLOGICAL PROCEDURES

This study compared the physical growth variables (height, body weight and body mass index [BMI]) of two distinct samples. The past sample (called 1997) consisted of 365 schoolchildren (168 boys and 197 girls). The data were collected in October 1997 in different districts of the Island of Santa Catarina[12], except for the headquarter district. The present sample (called 2009) consisted of 645 schoolchildren (270 boys and 375 girls). The data of this sample were collected between April and July 2009. For the purpose of comparison, the same age range (10 to 14 years) and geographic area were defined for collection of the data of the present sample.

A non-probability sampling procedure based on accessibility was used. Criteria for inclusion were place of residence in Florianopolis/SC/Brazil, age of 10 to 14 years, and absence of any physical deformity that could interfere with the height measurement. After approval of the study by Universidade do Estado de Santa Catarina - UDESC (protocol 1740/2008), contact was made with the schools selected for data collection. Next, a free informed consent form was sent to the parents or legal guardians to authorize the participation of their children in the study.

The data of both samples (1997 and 2009) were collected in the schools by trained examiners. The protocol proposed by Gordon[6] was adopted for the measurement of body weight and height. For the evaluation of physical growth, the children were classified according to the BMI-for-age values of the WHO child growth standards[1]. The following BMI-for-age cut-off values were adopted: low BMI for age (Z score < -2), adequate BMI for age (Z score ³ − 2 and < + 1), overweight (Z score ³ + 1 and < +2), and obesity (Z score ³ +2). In the present study, the term "risk of obesity" instead of "overweight" is used for conceptual reasons. Since the data of the 1997 study were obtained using other standards, the authors were asked for their authorization for new data processing.

For analysis of the data, the Kolmogorov-Smirnov test was first applied, which showed a normal distribution of body weight, height, and BMI (p<0.449). Descriptive (mean, standard deviation, absolute and relative frequency, and delta percent change) and inferential statistics were used. Means were compared by the Student t-test for independent samples and analysis of variance (one-way ANOVA) was used to evaluate possible differences in growth variables and nutritional

status (body weight, height, and BMI) according to gender, age and sample studied (1997 and 2009). The *post hoc* Newman-Keuls test was used to determine in which groups possible differences existed. In addition, chi-square adjustment was used to compare the frequency of observed values in the BMI-for-age classification and the frequency of expected values between genders and samples. The level of significance was set at p<0.01 for all tests.

RESULTS

The mean height and body weight of the schoolchildren are shown in Table 1. Boys of the 2009 sample were taller than boys of the 1997 sample at most ages, although the differences were not significant at the level of significance adopted for this study. Greater mean heights in the 2009 sample were also observed for girls at most ages, but the differences were again not significant. Mean body weight values were also higher in the 2009 sample in both boys and girls at most ages, but no significant differences were observed between the two samples. Although this was not a longitudinal study, an increase of height and body weight with age was noted for the two genders and in the two samples (1997 and 2009), as indicated by the observation of significant differences at some ages.

Figure 1 illustrates the dynamics of height according to age and gender in the two samples. In general, the subjects of this study presented an increase of height with age as expected. In the 1997 sample, girls began their growth spurt (indi-

cated by an increase in height) at about 11 years of age, with girls exceeding boys in height at 12 and 13 years (Figure 1). However, no significant differences between genders were observed at any age (10 years: p<0.897; 11 years: p<0.956; 12 years: p<0.894; 13 years: p<0.987; 14 years: p<0.892). In the 2009 sample, the onset of the growth spurt in girls tended to be earlier, possibly at 10 years of age. However, again no significant differences were observed between genders at the respective ages (10 years: p<0.757; 11 years: p<0.923; 12 years: p<0.856; 13 years: p<0.863; 14 years: p<0.838).

Figure 2 illustrates the dynamics of body weight according to gender and age in the two samples. As can be seen, in the 1997 samples girls were heavier than boys at about 11 years of age and continued to be until 14 years. However, a significant difference between genders was only observed at 12 years (p<0.007). In the 2009 sample, girls also presented a higher body weight than boys. This fact was observed as early as at 10 years of age. However, again no significant differences were observed between genders at the respective ages (10 years: p<0.899; 11 years: p<0.786; 12 years: p<0.899; 13 years: p<0.934; 14 years: p<0.892).

Analysis of the crude BMI values described in Table 2 showed lower mean values for boys of the 2009 sample at some ages (10 and 11 years) when compared to the 1997 sample. The opposite was observed at 12 and 13 years of age, with BMI being lower in the 1997 sample. Girls of the 2009 sample presented lower BMI than those of the 1997 sample at all ages, except for 10 years. However, no significant differences were observed at any age.

Table 1. Mean height and body weight of schoolchildren of the 1997 and 2009 samples according to age and gender.

| Gender and age					Body weight (kg)			
	1997	2009	Δ%	p	1997	2009	Δ%	p
Boys								
10 years	137.8±8.9	139.9±8.9	1.5	0.627	34.1±5.9	34.5±9.4	1.2	0.833
11 years	142.4±7.0	143.2±8.4	0.6	0.644	36.3±6.3	36.9±9.2	1.6	0.884
12 years	147.0±7.3	148.3±5.1	0.9	0.340	39.8±7.9	41.9±8.6	5.3	0.270
13 years	154.2±8.3	156.9±8.9	1.7	0.488	44.7±9.1	46.7±11.3	4.5	0.304
14 years	160.6±7.0	160.2±10.2	-0.2	0.795	47.8±7.1	48.0±9.9	0.4	0.902
p	0.001	0.001	-	-	0.001	0.001	-	-
Girls								
10 years	139.3±5.6	139.4±8.1	0.1	0.956	32.8±4.4	35.4±8.8	7.9	0.549
11 years	141.4±7.5	146.4±9.3	3.5	0.020	36.6±9.2	38.7±8.8	5.7	0.689
12 years	150.0±6.0	151.8±8.0	1.2	0.313	43.7±8.9	42.7±8.6	-2.3	0.592
13 years	155.0±7.1	156.2±8.1	0.8	0.427	46.9±8.8	47.4±10.8	1.1	0.803
14 years	156.4±6.9	158.6±6.8	1.4	0.390	49.3±8.9	49.5±8.3	0.4	0.940
p	0.001	0.001	-	-	0.001	0.001	-	-
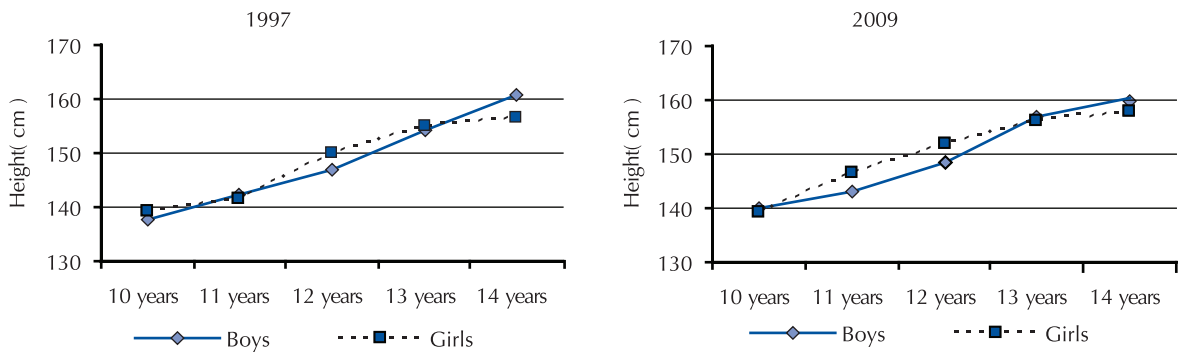
Figura 1. Dynamics of height according to age and gender in the two samples.
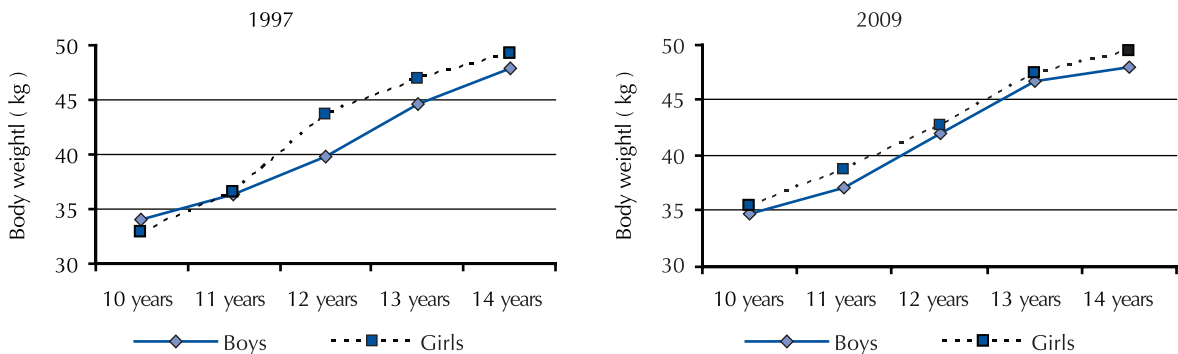

Figura 2. Dynamics of body weight [according to age and gender in the two samples.

With respect to the adequacy of BMI (Table 3), significant differences were observed between the 1997 and 2009 samples for boys (c_2 = 19.670; p<0.001). There was an increase in the percentage of subjects with low BMI-for-age, doubling of the percentage of obese subjects, and reduction in the percentage of subjects at risk of obesity. For girls, comparison of the 1997 and 2009 samples showed a significant increase in the number of subjects with low BMI, risk of obesity and obesity, and a decrease in the number of subjects with adequate BMI-for-age (c_2 = 39.178; p<0.001).

Comparison of the adequacy of BMI between genders showed significant differences (c_2 = 9.523; p<0.013). In the 1997 sample, the percentage of schoolchildren with adequate BMI-for-age and obesity was higher among girls and the percentage of children with low BMI and risk of obesity was higher among boys. In the 2009 sample, the percentage of subjects with risk of obesity and obesity was higher among girls, although no significant differences were observed between BMI categories (c_2 = 5.025; p<0.170).

Table 2. Mean body mass index of schoolchildren of the 1997 and 2009 samples according to age and gender.

Gender and age	Body mass index (unidade ?)			
	1997	2009	Δ%	p
Boys				
10 years	17.9±2.17	17.5±3.74	-2.2	0.875
11 years	18.0±1.58	17.8±3.25	-1.1	0.992
12 years	18.3±2.88	19.0±3.68	3.8	0.968
13 years	18.6±2.33	18.7±3.11	0.5	0.855
14 years	18.5±2.51	18.5±2.55	0.0	0.934
p	0.895	0.798	-	-
Girls				
10 years	16.8±1.58	18.0±3.35	7.1	0.581
11 years	18.1±3.45	17.9±3.09	-1.1	0.994
12 years	19.3±3.20	18.3±3.49	-5.2	0.857
13 years	19.4±2.61	19.3±3.60	-0.5	0.938
14 years	20.1±3.12	19.6±3.31	-2.5	0.541
p	0.107	0.798	-	-

Table 3. Adequacy of body mass index in schoolchildren of the 1997 and 2009 samples.

Adequacy of BMI	Boys				Girls			
	1997		2009		1997		2009	
	N	%	N	%	N	%	N	%
Low	4	2.4	11	4.1	3	1.5	9	2.4
Adequate	120	71.4	193	71.5	157	79.7	259	69.1
Risk of obesity	37	22.0	43	15.9	28	14.2	68	18.1
Obesity	7	4.2	23	8.5	9	4.6	39	10.4

DISCUSSION

The present results showed no significant differences in the height of boys or girls between the 1997 and 2009 samples. However, girls of the 1997 sample presented a greater height at ages 12 and 13, whereas girls of the 2009 sample achieved greater height at 11 and 12 years, a finding demonstrating anticipation of the growth spurt. The greater heights at these ages observed for the 2009 sample agree with Pires and Lopes[14], who evaluated the physical growth of male and female schoolchildren from the city of Florianópolis and observed significant differences in height in favor of girls at ages 11 and 12. This anticipation might be explained by factors related to the phenomenon of biopsychosocial stimulation, as well as by increased living standards, improved health conditions, and access to better quality food[2,10,18].

Lower crude heights than those reported by Pires and Lopes[14] were obtained in the present study for girls and boys at all ages and in the two years of data collection. Fagundes[26], investigating the physical growth of schoolchildren from different regions in the State of Santa Catarina between 2003 and 2004, also observed greater heights in girls than boys aged 11 to 13 years. Similar to the study of Pires and Lopes[14], the height values reported by Fagundes[26] were also higher than those obtained in the present study for boys and girls of all ages and for the two samples (1997 and 2009). This lower height of the present subjects might be explained by ethnic and cultural factors related to the dietary habits of the population studied. This suggestion is based on the trend of lower heights reported by Machado and Krebs[12] who studied a sample from the same geographic region, and is supported by the comparison of the height values obtained for the two samples with those of studies conducted in different regions of Brazil (Apucarana[27], Rio de Janeiro[11], and northwestern Rio Grande do Sul[28]). Another aspect is that the growth spurt may also be anticipated in boys as suggested by other studies[18].

There were no significant differences in the body weight of boys or girls between 1997 and 2009. However, it should be noted that girls presented a higher body weight than boys at practically all ages in the two samples investigated (except at 10 years in the 1997 sample). As observed for height, the body weight values of the 1997 and 2009 samples tended to be lower than those reported in the cited studies.

Although the present study was not a longitudinal investigation, a tendency towards a linear increase of height with age was observed, in agreement with other studies[18,25]. Like height, body weight also tended to increase linearly with age despite the greater variability (unstable) of this variable. These findings suggest harmonious growth since increases in height were accompanied by body weight gains. Similar results have been reported in other studies[14,18,24,25,28,29].

With respect to BMI adequacy, significant differences were observed between the 1997 and 2009 samples, with the observation of an increase in the frequency of obese individuals. In addition, with respect to gender, there was an increase in the number of obese subjects among boys and in the number of subjects with risk of obesity and obesity among girls. However, BMI values were lower in boys and girls of the 1997 and 2009 samples at all ages when compared to the study of Guedes et al[27]. The same trend was observed for boys after age 11 and for girls aged 10 and 11 years when compared to the study of Anjos et al[11]. In general, the results obtained indicate that malnutrition is not a matter of concern for the population studied since the percentages of low BMI-for-age were low, despite a discrete increase of these percentages from 1997 to 2009, in agreement with the findings of national surveys[10,11,30]. However, the increase in the number of subjects with risk of obesity and obesity particularly among girls alerts to the need for a more effective monitoring of physical growth variables in children and adolescents in view of the global epidemic character of risk of obesity and obesity in adults.

CONCLUSION

Comparison of physical growth and nutritional status of schoolchildren showed no significant changes in height, body weight or BMI over the period comprising the two samples (1997 and 2009). However, height, body weight and the number of subjects with risk of obesity and obesity tended to increase, particularly among girls. It is therefore suggested to continue monitoring indicators of growth and nutritional status in schoolchildren from this geographic region since these changes occur slowly and are only observed after a long period of time.

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