Incidence of overweight/obesity in preschool children during a two-year follow-up[1]

Incidência de sobrepeso/obesidade em pré-escolares durante dois anos de acompanhamento

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A B S T R A C T

Objective

To analyze the incidence of overweight/obesity and associated factors in children aged six years or less during a two-year follow-up.

Methods

This longitudinal cohort study followed 242 preschoolers from *Florianópolis, Santa Catarina*, from 2008 to 2010. The outcome was overweight/obesity (Z-score $>+2$) measured by accumulated incidence. The Chi-square test measured the differences between the study factors. The association between overweight/obesity and associated factors was analyzed by adjusted and crude rate ratios.

Results

Nine (4.00%) of the 222 non-overweight/obese children in 2008 were overweight/obese in 2010, indicating an accumulated incidence of overweight/obesity of 4.05% (1.4-6.7). The study accumulated incidence of overweight/obesity was 20.25/year/1000, similar to the incidence density of 20.65/year/1000.

Conclusion

After adjustment, none of the study factors were associated with overweight/obesity. However, the lack of studies that investigate the incidence of overweight and obesity in preschoolers calls for longitudinal studies with larger samples that analyze not only the incidence of overweight/obesity but also other factors, such as the influence of parents' nutritional status on their offspring's nutritional status.

Indexing terms: Child, preschooler. Incidence. Obesity. Overweight.

R E S U M O

Objetivo

Analisar a incidência de sobrepeso/obesidade e fatores associados em crianças com até seis anos de idade durante dois anos de acompanhamento.

Métodos

Trata-se de estudo longitudinal, de coorte de pré-escolares (n=242) de Florianópolis, Santa Catarina, acompanhados entre 2008 e 2010. O desfecho foi o sobrepeso/obesidade (escore-Z >+2) mensurado por meio da incidência acumulada. O teste Qui-quadrado foi utilizado para verificar diferenças entre os fatores avaliados. A análise de associação entre o sobrepeso/obesidade e os fatores foi feita por meio da razão de incidência, com realização de análises brutas e ajustadas.

Resultados

Entre as 222 crianças sem sobrepeso/obesidade em 2008, nove (4,00%) delas passaram a essa condição em 2010, sendo encontrada uma incidência acumulada de sobrepeso/obesidade de 4,05% (1,4-6,7). A incidência acumulada de sobrepeso/obesidade deste estudo foi de 20,25/ano/1000, semelhante à densidade de incidência que resultou em 20,65/ano/1000.

Conclusão

Nenhum dos fatores investigados associou-se significativamente ao sobrepeso/obesidade nesta população após a análise ajustada. No entanto, a carência de estudos que investiguem a incidência de sobrepeso e obesidade em pré-escolares revela a necessidade de que novos estudos longitudinais sejam realizados a fim de abranger um maior número de pré-escolares e incluir, além da incidência de sobrepeso/obesidade, outros fatores, como a influência do estado nutricional dos pais no estado nutricional dos filhos.

Termos de indexação: *Pré-escolar. Incidência. Obesidade. Sobrepeso.*

I N T R O D U C T I O N

In the last three decades, the growing prevalence of overweight/obesity in children and adolescents has been observed in many countries, including Brazil[1-5]. This phenomenon has been subject to studies and interventions by distinct scientists and institutions throughout the world, mainly of the health field, since plenty of scientific evidence show that overweight/obesity in this age group can persist through adulthood and promote other chronic noncommunicable diseases, increasing morbidity and mortality[6,7].

Nutritional status monitoring is essential to knowing the health conditions of the pediatric population[8-10]. Hence, *Unidades de Educação Infantil* (UEI, Child Education Centers) play an important role in the development of children aged six years or less because they allow the monitoring of the children's nutritional status; health promotion; and the identification of nutritional disorders and their distribution, social inequalities, and especially, the need of specific health and nutrition actions[11-18].

Thus, the use of anthropometric indices based on weight and height measurements is an important and valid strategy for analyzing nutritional status and following child growth, especially in population studies[8-10,18,19].

National and international studies confirm that overweight/obesity has become one of the main nutrition problems also in children aged six

years or less[1-5,8-22]. Despite the importance of nutritional status monitoring, most studies on early childhood obesity focus exclusively on cross-sectional assessments[8-22]. These studies are essentially prevalence studies, which calculate, estimate, or identify the frequency or number of overweight/obese cases in a given population and point in time, but they do not distinguish between new and old cases of the disease[23].

Studies that assess longitudinal changes in preschoolers' nutritional status are scarce[24]. Even scarcer are studies that assess the incidence of overweight/obesity in this age group - studies that calculate, estimate, or identify new cases[23,24]. The identification of new childhood cases of overweight/obesity can help to increase the efficacy of the health and nutritional care provided to this group, justifying the study.

The present study aims to analyze the incidence of overweight/obesity and associated factors in preschoolers attending the child education centers of *Florianópolis* (SC) over a two-year period.

METHODS

This longitudinal study included preschoolers aged four months to six years enrolled in seven public child education centers run by *Florianópolis'* Municipal Department of Education that participate in the Healthy Daycare Centers Project, a project conducted by *Santa Catarina's Centro Colaborador em Alimentação e Nutrição do Escolar* (Cecane, Schoolchildren's Food and Nutrition Collaborating Center). The said project develops health, food, and nutrition actions in health-promoting schools[25]. These child education centers were deliberately selected to participate in the study because they are located in four neighborhoods (or health territories) covered by trainees attending the class Nutrition in Public Health, of the *Universidade Federal de Santa Catarina's* (UFSC) undergraduate nutrition program. The neighborhoods were *Agronômica, Córrego Grande, Saco Grande,* and *Rio Tavares*.

The Healthy Daycare Centers Project followed the children attending the child education centers for two years. This study cohort consists of the children anthropometrically assessed in April 2008 and April 2010. Since the project involves teaching/assistance activities developed jointly by the university and city hall, all children enrolled in the seven study centers should be included in the study. Therefore, this study involved a dynamic population and assumed that all children covered by the abovementioned project were anthropometrically assessed in 2008 (n=670). However, the cohort was defined as a fixed population, so only the children anthropometrically assessed on both occasions were included (n=242). Child education centers have a considerable child turnover. Additionally, many have to leave because these centers have an age limit (only those whose sixth birthday was after March 31, 2010, were allowed to attend the center in 2010).

To analyze incidence, all children diagnosed with overweight/obesity in 2008 were excluded from the cohort, a requirement for determining the new cases of overweight/obesity during the follow-up period.

Data collection for analyzing overweight/obesity-related factors was done in April 2010. For this purpose, a questionnaire created specifically for this study was sent to the children's parents along with the school schedule. Therefore, the study included only the children anthropo-metrically assessed on the two abovementioned occasions whose parents filled out the questionnaire and consented to their participation. The study variables were gender (male, female), age group (≤2 years, >2 years), program (part-time, full-time), type of institution (municipal or partner), family income per member (by income quartile), and parents' education level (≤7 years of formal education, >7 years of formal education). The parents' years of formal education was given by adding all the grades they passed, each grade considered one year of formal education, starting with the first grade of elementary school.

Weight, length (for those aged less than two years) or height, age, and gender were collected as recommended by the World Health Organization[26] (WHO) in 1995 and Lohman[27]. Anthropometric measurements were performed by trained undergraduate students, supervised by the main researcher.

The outcome variable was overweight, which includes obesity, and is expressed herein as overweight/obesity, defined by a Z-score >+2 for Body Mass Index (BMI)-for-age and gender, according to the WHO curves[28,29]. The preschoolers were then divided into two groups: not overweight/obese (Z-score ≤+2) and overweight/obese (Z-score >+2).

Nutritional status was determined by the software Anthro Plus, and the statistical analyses were performed by the software Data Analysis and Statistical Software (Stata) version 11.0.

Outcome was measured by accumulated incidence and incidence density. Accumulated incidence was given by the number of new overweight/obese cases during the study period divided by the population exposed to the risk of overweight/obesity at the beginning of the follow-up. Incidence density was given by dividing the total number of cases in the study period by the number of children-year[23].

The Chi-square test measured the differences in the proportion of overweight/obesity at the end of two years and the changes between the categories of the study factors with a Confidence Interval of 95% (95%CI) and a significance level of 5% ($p<0.05$). The Rate Ratio (RR) measured the association between overweight/obesity and the study factors. Crude and adjusted Poisson regression analyses were performed with robust variance estimation for the RR and respective 95%CI.

This study was approved by UFSC's Human Research Ethics Committee under protocol number 090/08. Only children whose parents or guardians signed an informed consent form were included in the study.

RESULTS

Of the 670 children enrolled in 2008, 242 (36.1%) composed the study cohort. Of these, 222 (91.7%) were not overweight/obesity in 2008, thereby included in the analysis of incidence.

Table 1 compares the individual characteristics of the 670 children aged six years or less assessed in 2008 and those assessed in 2010 selected to compose the study cohort. The 95%CI and *p*-value of the initial population and cohort profiles are similar, except for age, weight, and height. In 2008, the mean ages (± standard deviation) of the population and cohort were 44.6 (±19.1) and 31.5 (±12.9) months, respectively, since children aged more than four years in 2008 were not present in 2010, so they were excluded from the cohort given that at age six years they complete child education in these centers. The same reason explains the different mean weights and heights of the population and cohort of 2008.

Although the mean age of the cohort in 2008 was smaller, the Z-scores of the BMI-for-age, weight-for-age, and height-for-age of the cohort in 2008 and 2010 were similar, reducing the likelihood of bias.

The mean family income of the cohort was 2.7 minimum salaries (R$1,377.00), and the median was 2.35 minimum salaries (R$1,198.50).

Table 2 shows other cohort characteristics, such as family income per member and parents' education level. Approximately half of the cohort had a family income per member equal to R$300.00 or less, and a little more than 60% of the parents had more than seven years of formal education.

According to BMI-for-age, the prevalence of overweight/obesity in the cohort decreased from 8.3% (95%CI: 4.5-12.1) in 2008 to 7% (95%CI: 3.5-10.5) in 2010, but the difference is not significant. Figure 1 shows the prevalence of non-overweight/obese and overweight/obese children by gender. Although in 2008 overweight/

Table 1. Characteristics of the study population in 2008 compared with the characteristics of the children selected for the study cohort in 2008 by gender, age, type of institution, program, nutritional status according to body mass index-for-age, and mean age, gender, height, and Z-score. *Florianópolis* (SC), Brazil, 2008.

Individual characteristics	Population 2008 N=670 (%)		95%CI	Cohort 2008 N=242 (%)		95%CI	p
Gender							
Female	333 (49.7)		(45.9-53.5)	117 (48.3)		(44.9-58.5)	0.598
Male	337 (50.3)		(46.5-54.1)	125 (51.7)		(41.5-55.1)	
Age							
≤24 months	133 (19.9)		(16.9-22.9)	80 (33.1)		(26.7-39.5)	<0.001
>24 months	537 (80.1)		(77.1-83.1)	162 (66.9)		(60.5-73.3)	
Institution							
Public	583 (87.0)		(84.5-89.5)	222 (91.7)		(87.9-95.5)	0.006
Partner	87 (13.0)		(10.5-15.5)	20 (8.3)		(4.5-12.1)	
*Program**							
Part-time	93 (13.9)		(11.3-16.5)	30 (12.4)		(7.9-16.9)	0.213
Full-time	543 (81.0)		(78.0-84.0)	212 (87.6)		(83.1-92.1)	
Nutritional status†							
Overweight/obese	52 (7.8)		(4.1 - 11.5)	20 (8.3)		(4.5-12.1)	0.721
Not overweight/obese	617 (92.2)		(88.5 - 95.9)	222 (91.7)		(87.9-95.5)	
Characteristics	Mean	±	SD	Mean	±	SD	
Age (months)	44.60	±	19.10	31.50	±	12.90	<0.001
Weight (kg)	16.30	±	4.40	13.70	±	3.00	<0.001
Height (cm)	98.90	±	13.10	90.40	±	10.50	<0.001
BMI	16.40	±	1.70	16.60	±	1.50	0.106
BMI-for-age Z-score	0.56	±	1.602	0.64	±	0.97	0.290
Weight-for-age Z-score	0.24	±	1.03	0.28	±	0.98	0.601
Height-for-age Z-score	-0.23	±	1.06	-0.25	±	1.09	0.803

Note: *Data missing for 34 children in the population of 2008; †Data of a child with Z-score >+5 were removed from the nutritional status analysis. 95%CI: Confidence Interval of 95%; BMI: Body Mass Index; SD: Standard Deviation.

Table 2. Family income per member and parents' education level of the children reassessed in 2010. *Florianópolis* (SC), 2010.

Family characteristics*	N (%)		95%CI	
Income per member†				
1st and 2nd quartiles (≤R$300.00)	83 (51.5)		(40.6-62.9)	
3rd and 4th quartiles (>R$300.00)	78 (48.4)		(37.2-60.3)	
Education level‡	*Maternal*	*Paternal*		
≤7 years of formal education	45 (36.6)	46 (39.6)	(-0.1-3.3)	(0.0-0.0)
>7 years of formal education	78 (63.4)	70 (60.4)	(8.4-17.6)	(10.6-20.4)

Note: *Data collected in 2010; †Income data collected in 2010; information not available for 81 children; ‡Education level data of 119 mothers and 126 fathers were missing.
95%CI: Confidence Interval of 95%.

obesity was more prevalent in males, over two years its prevalence in males decreased from 10.4 to 7.2%, and in females it increased from 6.0 to 6.8%. However, the differences were not significant.

Nine (4%) of the 222 non-overweight/obese children in 2008 were overweight/obese in 2010. On the other hand, only eight (40%) of the twenty overweight/obese children in 2008 were still overweight/obese in 2010.
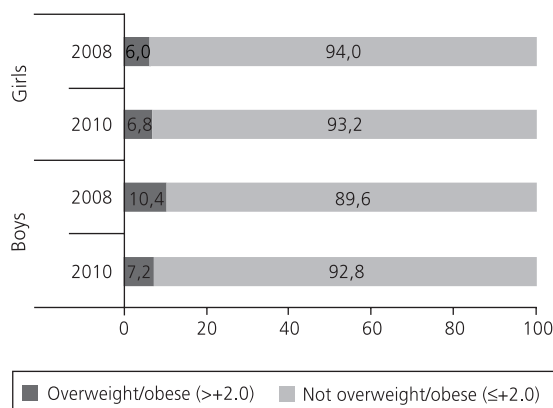
Figure 1. Prevalence of overweight/obesity in the cohort in 2008 and 2010 by gender. *Florianópolis* (SC)*,* Brazil, 2010.

Note: *p*-values=0.790 in girls and 0.372 in boys.

Considering the number of overweight/obese children in 2008, the accumulated incidence was nine new cases in two years, which corresponds to an incidence of 4.05% (1.4-6.7) in the study cohort. The incidence density was very similar at 4.13% (1.4-6.8). Hence, the accumulated incidence of overweight/obesity in the study cohort was 20.25/year/1000, similar to the incidence density of 20.65/year/1000.

Table 3 shows the overweight/obesity rate ratios, crude and adjusted for gender, age group, family income per member, and parents' education level.

None of these factors were significantly associated with overweight/obesity in this cohort. It was not possible to analyze the effect of the program (part-time or full-time) and type of institution (municipal or partner) on outcome because none of the non-overweight/obese children attending the centers part-time or attending partner centers were overweight or obese at the end of the two-year follow-up.

DISCUSSION

In 2008 the prevalence of overweight/obesity in the study cohort (7.8%) was half of that found by the *Pesquisa Orçamento Familiares* (Family Budget Survey) of 2008-2009[2], which

Table 3. Rate ratio by gender, age group, family income per member, and parents' education level. *Florianópolis* (SC), 2010.

Characteristics*	N	Crude analysis		Adjusted analysis
		Incidence (%)	RR (95%CI)	RR (95%CI)
Gender			*p*=0.714	*p*=0.541
Male	112	3.6	1.00	1.00
Female	110	4.5	1.27 (0.35-4.63)	1.51 (0.40-5.69)
Age			*p*=0.512	*p*=0.605
≤24 months	72	2.8	1.00	1.00
>24 months	150	4.7	1.68 (0.36-7.91)	1.51 (0.32-7.18)
Income per member†			*p*=0.367	*p*=0.629
1st and 2nd quartiles	81	6.2	1.00	1.00
3rd and 4th quartiles	68	2.9	0.48 (0.10-2.39)	0.67 (0.13-3.45)
Mother's education level‡			*p*=0.079	*p*=0.079
≤7 years of formal education	41	9.8	1.00	1.00
>7 years of formal education	71	1.4	0.14 (0.02-1.25)	0.14 (0.02-1.25)
Father's education level‡			*p*=0.369	*p*=0.950
≤7 years of formal education	43	7.0	1.00	1.00
>7 years of formal education	64	3.1	0.45 (0.08-2.58)	0.95 (0.20-4.56)

Note: *Data collected in 2010; †Income data collected in 2010. This information is missing for 81 children; ‡Analysis includes only the education level data of 112 mothers and 107 fathers. This data was missing for 119 mothers and 126 fathers; *p*-value with Yates' correction.
95%CI: Confidence Interval of 95%; RR: Rate Ratio.

found a prevalence of 16.2% in five-year-old Brazilians. It was also smaller than the prevalence of 12.5% found in four-year-olds from *Feira de Santana* (BA)[30], and similar to those found by the *Pesquisa Nacional de Demografia e Saúde* (PNDS, National Survey on Demography and Health) of 2006[31] (6.6%) and by a study done in *São Leopoldo* (RS) (9.8%)[8] with children below five years of age. The four studies above assessed overweight/obesity using the reference populations of the WHO's curves[28,29] and the same cut-off points used herein.

Low family income per member may justify the prevalence of overweight/obesity even though income was not associated with overweight/obesity in the study cohort. Moreover, self-reported income requires caution because sometimes family members have informal jobs, preventing them from reporting accurate incomes, or underreport income when low income is a selection criterion of public child education centers[32].

Regarding education, 36.6% of the mothers and 39.6% of the fathers did not complete elementary school, and only 8.1% and 4.3%, respectively, had higher education. Parents' education level was not associated with overweight/obesity. Knowing the parents' education level is important because education directly influences child care, job opportunities, and salaries that promote better life conditions[32]. Food availability increases with family purchasing power and education level. Parents' education level, especially the mother's, also promotes better use of the income and access to public services[33].

Although higher maternal education levels did not affect the rate ratio significantly (RR=0.14; 95%CI=0.02-1.25) (Table 3), they tended to protect against overweight/obesity, opposing most studies conducted in Brazil[31,34-37] and other medium-income countries where higher maternal education level is usually associated with childhood overweight/obesity.

The number of children attending the study child education centers who continued to be overweight/obese after two years is concerning. However, the scarcity of studies with similar design, or the authors' inability to find them, limits interpreting the dimension of the study results, since the Brazilian literature has no parameters for such comparison. Studies on the food and nutrition of Brazilian preschoolers published from 2008 to April 2014 and indexed in the Scientific Electronic Library Online (SciELO) database are essentially cross-sectional or prevalence studies[8-22]. This scarcity reinforces the need of studies with other designs, especially observational follow-up or interventional design.

Nine children (4.05%) in the study cohort became overweight/obese in the two-year follow-up. A study done in *Pelotas* (RS) with 1,273 children aged one to four years found that 10.9% became overweight/obese over a three-year follow-up and that one-third of the overweight 12-month-old children were still overweight/obese at age four years[24]. In the study cohort, 40.0% of the children were still overweight/obese after two years. These data indicate that accumulated incidence decreases over time, reinforcing the need of long-term actions.

Gender, age group, program (part-time, full-time), type of institution (public, partner), family income per member, and parents' education level were not associated with overweight/obesity in the study cohort. Possible explanations for the absence of associations include sample size and number of new cases of overweight/obesity in the two-year study period. The limited information on family income and parents' education level should also be considered explanations. Nevertheless, children with missing family income per member and parents' education level were still included in the regression analysis to prevent the test from losing power between groups, so these results were probably unaffected. In this sense, new studies with larger samples, longer follow-ups, and better collection of socioeconomic variables are needed to overcome the study limitations.

The fact that 60% of the overweight/obese children in 2008 were not overweight/obese in 2010 draws attention. This may be due to center attendance, where nutritional status is monitored regularly, to the health-promoting actions conducted in the study centers, and/or to specific health and nutrition actions described in the Introduction. However, this explanation should be taken with caution because of the aforementioned study design-related issues. In this sense, this also reinforces the importance of conducting intervention studies that prevent and treat preschooler overweight/obesity and allow assessment of intervention effectiveness.

The lack of studies on the incidence of preschooler overweight and obesity calls for new longitudinal studies with a larger number of preschoolers that investigate not only the incidence of overweight/obesity but also other factors, such as the influence of the parents' nutritional status on the offspring's nutritional status, food intake, breastfeeding habits, and physical activity, among others.

ACKNOWLEDGMENTS

COLLABORATORS

CFB MENEZES helped to collect and analyze the data, and write and review the manuscript. J NEVES helped to plan the study, collect and analyze the data, and review the manuscript. PS GONSALEZ helped to analyze the data and review the manuscript. FAG VASCONCELOS coordinated the study planning and design, supervised data collection, data analysis, and manuscript writing, and reviewed the manuscript.

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