ORIGINAL ARTICLE

NUTRITIONAL STATUS OF CHILDREN ENROLLED IN MUNICIPAL EARLY CHILDHOOD EDUCATION SCHOOLS IN 2004 AND 2018

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Highlight: (1) The prevalence of childhood overweight grew from 20.9% in 2004 to 26.8% in 2018. (2) The prevalence of obesity quadrupled, from 1.5% to 6.8% from 2004 to 2018. (3) Children under 2 years old in 2018 had a higher risk of overweight and obesity.

PRE-PROOF

(as accepted)

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ABSTRACT

This study aims to describe the nutritional status of children enrolled in Municipal Early Childhood Education Schools in the city of Pelotas, RS, in 2004 and 2018. Twenty-four schools were included in 2004, and another 29 were added in 2018. Anthropometric assessment, for both years, was carried out in the schools, following the technical

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guidelines of the Food and Nutrition Surveillance System. Nutritional status was classified according to body mass index for age according to the growth curves proposed by the World Health Organization. Prevalence was calculated using a significance level of 5%, and the mean BMI of the two studies was compared using the T-test. Statistical analysis was performed using Stata version 15.0. In 2004, about 70% of children were normal; in 2018, this prevalence declined to 54.6%. There was a significant increase in the prevalence of overweight from 2004 (20.9%) to 2018 (26.8%), and higher among girls in both years. The results highlight the nutrition transition in children, highlighting the importance of public policies and actions to promote healthy eating and prevent childhood obesity.

Keywords: Nutritional Status; Preschool; Nutritional Transition; Childhood Obesity;

INTRODUCTION

Nutritional status corresponds to the balance between nutrient intake and the body's energy expenditure to meet nutritional needs, presenting several assessment forms, each with different advantages and limitations. Hydrodensitometry, air displacement plethysmography (BOD POD), bioelectrical impedance, dual-energy x-ray absorptiometry (DXA), and computed tomography are among them [1]. However, due to the high cost of these different methods, anthropometry, which assesses nutritional status through measurements such as weight and height, is accessible and minimally invasive and is universally accepted and considered the best parameter for the nutritional diagnosis of population groups, expressing the degree of adjustment between genetic growth potential and beneficial or adverse environmental factors [2, 3].

In the world scenario, in 2020, overweight was prevalent in about 22.0% of children under five years of age, respectively [4]. In Brazil, the prevalence of overweight in this age group was 7.0% in 2019, with the South region recording the highest prevalence in the country (8.5%) [5]. The National Survey of Demography and Health of Children and Women (PNDS) [6] and the National Health Survey (PNS)[7] have demonstrated over the years that nutritional deficits have significantly reduced in Brazil (from 2006 to 2019). However, the trend of increasing prevalence of overweight has evolved more and more

rapidly, which is worrying. A study that evaluated nutritional indicators in four birth cohorts in Pelotas, RS, from 1982 to 2015 stated the transition between nutritional disorders. Still, it was not possible to define between which decades it occurred[8].

A review study on the nutritional assessment of children attending daycare centers or early childhood education schools over 23 years observed a high prevalence of overweight and absence of acute malnutrition, indicating the process of nutritional transition in this population[3]. This study aims to present the nutritional status of all children enrolled in Municipal Schools of Early Childhood Education (EMEI) in the city of Pelotas, RS, in 2004 and 2018.

MATERIALS AND METHODS

Two cross-sectional studies were conducted in Pelotas, RS, with children enrolled in Municipal Schools of Early Childhood Education (EMEIs). In 2004, there were 25 EMEIs in the city, and 24 were included in the study; only one school did not participate because it was the only one operating part-time at the time. In 2018, there were 29 EMEIs, and all were included in the study. The method used in both studies was similar in their respective data collection and had the same objective, including the assessment of nutritional status, mainly by measuring the weight and height of each child, in addition to some questions related to their health.

To be considered eligible, the child, aged up to 72 months, had to be enrolled and attending school during the period of the studies. Children who were absent from school at least three times or whose guardians did not agree to participate in the research were considered either losses or refusals respectively. Before the beginning of the study, meetings were held at schools with the principal and teachers to present the project and agree on how the data collection would be carried out.

In both studies, the anthropometric assessment of each child was carried out at the school by undergraduate students from the Faculty of Nutrition of the Federal University of Pelotas (UFPel), previously trained by a nutritionist who coordinated the research. Before the beginning of anthropometric data collection, the approval of the parents or guardians of the children was requested through the Informed Consent Form

(ICF), which presented information about the research and the contact of those responsible for the study to clarify any doubts.

In 2004, children's weight and height measurements were collected using a portable digital electronic scale (SECA) with a capacity of 150 kg and an accuracy of 100 g, along with a locally made wooden anthropometer based on the AHRTAG [9] model, both measured according to the technique standardized by Lohmann. In the 2018 study, the weight and height of the children were measured using the Tanita Solar Scale digital model 1631, with a capacity of 150 kg and an accuracy of 200 g, as well as the SECA anthropometer model 417 for children aged 0 to 2 years, and model 213 for children over 2 years of age, following the technical guidelines of the Food and Nutrition Surveillance System (SISVAN).

The outcome of the study was defined as nutritional status classified according to the body mass index for age (BMI/A), which expresses the relationship between weight in kilograms and height in meters squared. The anthropometric data from the 2004 study were reanalyzed according to the growth curves for children under five years of age proposed by the World Health Organization (WHO) in 2006 and for children over five years of age, the curves proposed by the WHO in 2007. BMI/A <-2 z-score was classified as underweight and z-score ≥-2 and ≤+1 were classified as normal; BMI/A ≥+1 and ≤+2 z-score was considered as a risk of overweight for children under five years of age and overweight for those over five years of age; BMI/A ≥+2 and ≤+3 z-score was considered overweight for children under five years of age and obesity for those over five years of age, and BMI/A >+3 z-score was classified as obesity for children under five years of age and severe obesity for those over five years of age. The independent variables were sex (male and female) and age in five categories (<24 months, 24 to 35.9 months, 36 to 47.9 months, 48 to 59.9 months, and ≥ 60 months). Age was calculated by the difference between the date of data collection and the child's date of birth.

A database was created using the *Epidata* 3.111 software for each study. The data were double-entered, and after comparison and detection of possible errors (*validate*), they were transferred to the *Stata* statistical package, version 15.0[12], to be analyzed. The *Anthro Plus program* was used to conduct the anthropometric assessment

of the studies, and after analysis, the data were transferred to their respective databases in *Stata*. The analysis of the BMI/A distribution was first performed for the total number of children and then stratified by sex, according to age, for each of the studies. The prevalence and confidence interval were calculated with a significance level of 5% ($p<0.05$) of each z-score interval, mean and standard deviation of the general nutritional status of all children, and the comparison of the mean BMI/A of the two studies was performed using the t-test.

The Municipal Department of Education authorized both studies in Pelotas. The 2004 study was approved by the Faculty of Medicine Ethics Committee of UFPel, affiliated with the National Council of Ethics in Research (CONEP). The 2018 study received approval from the Research Ethics Committee of the Faculty of Nursing and Obstetrics at UFPel under protocol No. 2,781,251. Parents and teachers were assured complete confidentiality regarding the information gathered during the studies. After data collection, the school team, including the principal, coordinators, and teachers, had access to the research results.

RESULTS

A total of 4,987 children were included in the 2004 and 2018 studies. However, each study will present the results to compare the nutritional status of children attending EMEIs. In 2004, 1,354 children were evaluated, of which 1,352 children had their weight and height measured, which represents 99.8% of the total number of children enrolled in the 24 EMEIs, 52.8% were girls, and most of them were in the age group of 60 to 72 months. In 2018, 3,633 children were evaluated; of these, 3,632 were weighed and measured, representing 99.9% of the children enrolled in the 29 EMEIs existing that year, 51.6% of whom were boys and 33.8% aged 60 to 72 months (Table 1).

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Table 1. Demographic characteristics of children enrolled in Municipal Schools of Early Childhood Education in the city of Pelotas, RS. 2004 and 2018.

Variables	2004		2018	
	N	%	N	%
Sex				
Male	639	47.2	1.875	51.6
Female	715	52.8	1.758	48.4
Age (in months)				
<24	105	7.8	453	12.5
24 – 35.9	187	13.8	467	12.9
36 – 47.9	228	16.8	614	16.9
48 – 59.9	297	21.9	871	24.0
60 – 72.0	537	39.7	1.228	33.8
TOTAL	1354	100	3.633	100

In general, the BMI/A distribution showed different prevalences between the two assessments. Table 2 shows that in 2004, of the 1,352 children whose weight and height were measured, 70.4% were classified as normal, 6.7% were overweight or obese, and 1.5% were obese or severely obese. When analyzing the children in 2018, of the 3,662 children evaluated, 54.6% were normal, 11.1% were overweight or obese, and 6.8% were classified as obese or severely obese. Considering whether the child is a boy or a girl, it was possible to observe that in 2004, boys had a higher prevalence of overweight and obesity than girls, while the risk of overweight was more prevalent in females, 21.3% (95%CI: 18.3 - 24.3). In 2018, there was a difference in the frequency of overweight and obesity; the frequency of overweight was 12.3% (95%CI: 10.8 - 13.8) in girls and 10.0% (95%CI: 8.7 - 11.4) in boys and the frequency of obesity of 7.7% (95%CI: 6.4 - 8.9) in girls and 5.9% (95%CI: 4.8 - 6.9) in boys.

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Table 2. Distribution of BMI-for-age of children enrolled in Municipal Schools of Early Childhood Education in the city of Pelotas, RS. 2004 and 2018**.**

Variable	2004		2018	
	Total			
	N	% (95% CI)	N	% (95% CI)
BMI-for-age (z-score)				
< -2	6	0.4 (0.1, 0.8)	26	0.7 (0.4, 1.0)
≥ -2 to ≤ +1	952	70.4 (68.0, 2.9)	1.982	54.6 (53.0, 56.2)
> +1 to ≤ +2	283	20.9 (18.8, 23.1)	975	26.8 (25.4, 28.3)
> +2 to ≤ +3	91	6.7 (5.4, 8.1)	404	11.1 (10.1, 12.2)
> +3	20	1.5 (0.8, 2.1)	245	6.8 (5.9, 7.6)
Total	1.352	100	3.632	100
	Boys			
BMI-for-age (z-score)				
< -2	3	0.5 (0.1, 1.0)	10	0.5 (0.2, 0.8)
≥ -2 to ≤ +1	445	69.8 (66.2, 73.3)	1.028	54.8 (52.6, 57.1)
> +1 to ≤ +2	131	20.5 (17.4, 23.7)	539	28.8 (26.7, 30.8)
> +2 to ≤ +3	47	7.4 (5.3, 9.4)	188	10.0 (8.7, 11.4)
> +3	12	1.9 (0.8, 2.9)	110	5.9 (4.8, 6.9)
Total	638	100	1.875	100
	Girls			
BMI-for-age (z-score)				
< -2	3	0.4 (0.1, 0.9)	16	0.9 (0.4, 1.4)
≥ -2 to ≤ +1	507	71.0 (67.7, 74.4)	954	54.3 (52.0, 56.6)
> +1 to ≤ +2	152	21.3 (18.3, 24.3)	436	24.8 (22.8, 26.8)
> +2 to ≤ +3	44	6.2 (4.4, 7.9)	216	12.3 (10.8, 13.8)
> +3	8	1.1 (0.3, 1.8)	135	7.7 (6.4, 8.9)
Total	714	100	1.757	100
	Children under 2 years old			
BMI-for-age (z-score)				
< -2	0	0	6	1.3 (0.6, 2.9)
≥ -2 to ≤ +1	64	60.9 (51.2, 69.9)	226	49.9 (45.3, 54.5)
> +1 to ≤ +2	35	33.3 (24.9, 43.0)	126	27.8 (23.9, 32.1)
> +2 to ≤ +3	5	4.8 (2.0, 11.1)	74	16.3 (13.2, 20.0)
> +3	1	0.9 (0.1, 0.6)	21	4.6 (3.0, 7.0)
Total	105	100	453	100
	Over 2 years old			
BMI-for-age (z-score)				
< -2	6	0.5 (0.02, 1.1)	20	0.6 (0.4, 0.9)
≥ -2 to ≤ +1	888	71.2 (68.6, 73.7)	1756	55.2 (53.5, 56.9)
> +1 to ≤ +2	248	19.9 (17.8, 22.2)	849	26.7 (25.2, 28.3)
> +2 to ≤ +3	86	6.8 (5.6, 8.4)	330	10.3 (9.3, 11.5)
> +3	19	1.5 (0.9, 2.4)	224	7.0 (6.2, 7.9)
Total	1247	100	3179	100

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When the nutritional status was analyzed according to age group in a dichotomous manner, it was noted that in 2004, overweight and obesity were higher among children over two years of age; however, the prevalence of risk of overweight was higher, 33.3% (95%CI: 24.9 - 43.0), in children under two years of age when compared to older children, 19.9% (95%CI: 17.8 - 22.2). Among the children evaluated in 2018, children under two years of age had higher prevalences of underweight, risk of overweight and overweight, which was 16.3% (95%CI: 13.2 - 20.0) with a significant difference about those over two years of age, 10.3% (95%CI: 9.3 - 11.5).

Table 3 shows the mean BMI/A according to age and sex of the preschool children. It is observed that the mean BMI/A of children in 2018 was significantly higher than that of children in 2004 ($p<0.05$), except for children aged 24 to 35.9 months. Regarding gender, the mean BMI/A practically doubled in 2018 ($p<0.001$) among both boys and girls.

Table 3. Mean body mass index for age according to age and sex of children enrolled in Municipal Schools of Early Childhood Education in the city of Pelotas. RS. 2004 and 2018.

	Mean BMI/A (95%CI)		
Variable	**2004**	**2018**	**P-value***
Age (in months)			
<24	0.72 (0.55, 0.89)	1.05 (0.93, 1.16)	0.012
24 - 35.9	0.72 (0.58, 0.86)	0.86 (0.75, 0.96)	0.158
36 - 47.9	0.68 (0.57, 0.80)	0.98 (0.87, 1.09)	0.002
48 - 59.9	0.53 (0.41, 0.64)	1.04 (0.95, 1.14)	< 0.001
60 – 72.0	0.40 (0.31, 0.50)	0.99 (0.91, 1.07)	< 0.001
Sex			
Male	0.56 (0.48, 0.65)	1.02 (0.96, 1.07)	< 0.001
Female	0.53 (0.46, 0.60)	0.96 (0.89, 1.03)	< 0.001

*T-Test

Figure 1 shows that children enrolled in EMEIs in 2004 presented a lower prevalence of risk of overweight, overweight, obesity, and severe obesity, with a statistically significant difference from children in 2018. The prevalence of underweight was similar between the two studies.

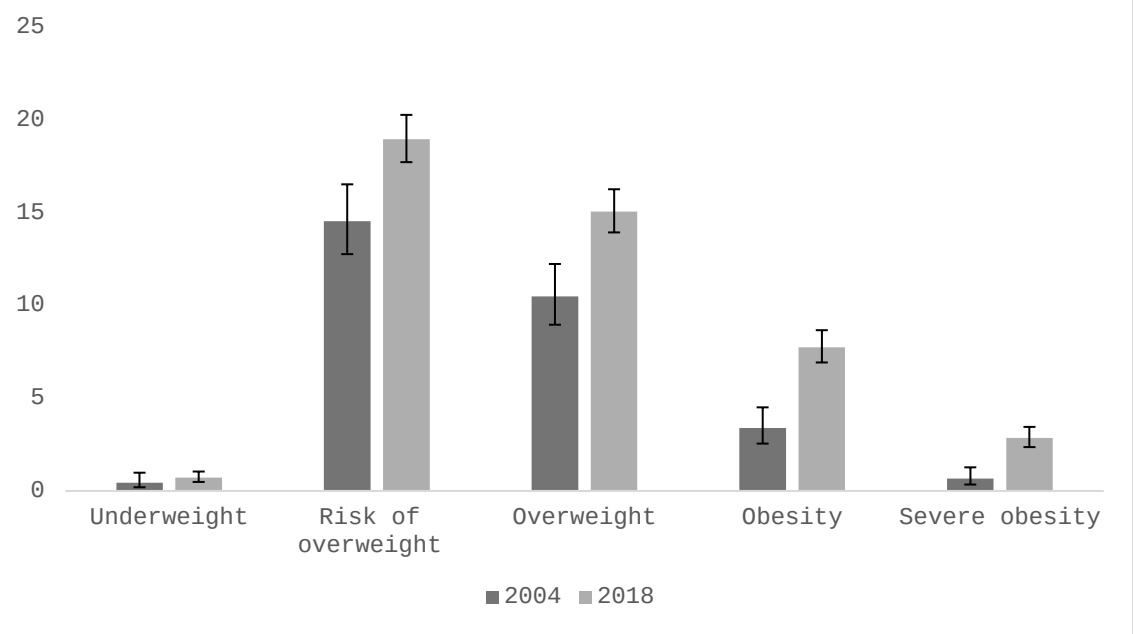

Figure 1. Prevalence of underweight, risk of overweight, overweight, and obesity according to body mass index for age in children enrolled in Municipal Schools of Early Childhood Education in Pelotas, RS. 2004 and 2018.

DISCUSSION

This study identified, in 14 years, a significant increase in the prevalence of overweight among children attending EMEIs in the city of Pelotas, RS. The increase in excess weight is significant from the z-score of +1 when analyzed for the whole group. Considering the results in the z-score category from >+1 to ≤+2, overweight increased from 20.9% in 2004 to 26.8% in 2018.

The continuous growth of childhood and adult obesity worldwide has been considered an epidemic[14]. In recent years, there have been major changes in nutritional indicators. The National Demographic and Health Survey (PNDS)[6] showed a downward trend in the prevalence of child nutritional deficit, with a statistically significant reduction in W/A and H/A deficits from 1996 to 2006. In 2019, according to the National Study of Child Food and Nutrition (ENANI)[5], the prevalence of deficits for the W/A and H/A indices was low (2.9 and 7.0%, respectively). However, overweight, regardless of family income and maternal education, has increased, presenting the highest prevalence in the southern region of Brazil (12.0%). Among the children enrolled in the EMEIs of Pelotas,

RS, with the same age group, overweight was 6.7% in 2004 and 11.1% in 2018. Evaluating the z-score above +3, obesity more than quadrupled, from 1.5% in 2004 to 6.8% in 2018. Systematic review studies have identified that the increase in childhood obesity in recent years is concerning, as the earlier it appears, the greater the risk of the child becoming an obese adult and developing chronic non-communicable diseases early 16. For boys, the greatest increase in the prevalence of overweight also occurred from the z-score of +1, and for girls, a significant increase was found in the categories above the +2 z-score. Results show that the prevalence of overweight/obesity (z-score > +2 to ≤ +3) among girls doubled, from 6.2% in 2004 to 12.3% in 2018.

In the world scenario, Brazil is among the countries with a moderate prevalence of overweight, ranging from 5 to 10%; however, in the present study, it varied from 15 to 20%, corresponding to frequencies found in countries in the Middle East and Central America, which have already reached high prevalences of overweight and obesity[17, 18].

Considering the age of the children, it is observed that there was a significant increase in the frequency of overweight and obesity among children under two years of age. Underweight, on the other hand, was more prevalent among children under two years of age in 2018. However, it is still considered low compared to the prevalence observed in the ENANI, which ranged from 2.5 to 5.0% in this age group[5].

When analyzing the mean BMI/A based on the children's age categories in months, there was a significant increase in children aged 48 months and older, nearly doubling from 2004 to 2018, both among older children and across both boys and girls, with boys showing higher values. A study of preschool children in Macaé, RJ, also found a higher mean BMI/A among boys[19].

The evolution of overweight and obesity among preschool children from 2004 to 2018 can be compared similarly when looking at the PNDS (2006) and the ENANI (2019), where overweight is rare, and the risk of malnutrition is still frequently discussed until the incidence of overweight reaches 18.3% in Brazil. The current situation classifies the children evaluated as a risk group, making them a priority for more careful and intensive monitoring by Primary Health Care professionals and Social Assistance and Education services and professionals [20]. It is necessary to intensify the care of children

through systematic monitoring of growth in height and weight gain in order to identify those with weight gain above the expected in relation to the standards so that nutritional interventions can be made, avoiding the increase of the obesity epidemic.

The Ministry of Health has implemented several measures to prevent the accelerated increase in excess weight and its consequences. One of these is the Strategic Action Plan for Combating Chronic and Non-Communicable Diseases in Brazil, which recently underwent a review and updated its goals. According to the WHO, the prevalence of overweight children rose from 4.8% to 5.9% between 1990 and 2018, an increase of more than 9 million children. However, due to the lack of periodic national data, the reduction in the prevalence of obesity in children was not included as a goal in this latest version of the NCD Plan, and data cannot be reported. Nevertheless, one of the established goals for risk factors is to reduce the prevalence of obesity in children and adolescents by 2%[21].

As an exclusive guideline concerning infant feeding, in 2019, the Ministry of Health published the Food Guide for Brazilian Children Under Two Years of Age[22], which serves as a basis for health promotion actions and interventions. Every health professional should know and use this instrument in their clinical practice because it is a specific guideline for children. In this sense, the results indicate that it is necessary to establish goals concerning the nutritional status of Brazilian children and promote comprehensive child health care, associating health services with education to contribute to the goal of reducing obesity in children[21].

The advantage of this study is the methodology used, which was the same in both years of the study, preserving the comparability of the two studies and their replication. The use of the BMI/A anthropometric index for assessing nutritional status is also noteworthy, as it is a simple and non-invasive method for anthropometry compared to the WHO reference standard[23]. Furthermore, this study makes an original contribution since it includes all children enrolled in all municipal schools of early childhood education in the city of Pelotas, RS, over a broad period, providing knowledge of the change in the nutritional profile of this population. A possible limitation is the fact that different children were evaluated in each of the studies. However, this limitation becomes

irrelevant when the objective is to show the nutritional status of preschool children enrolled in the EMEIs at different times. Another limitation may be the error in obtaining anthropometric measurements, but it can be mitigated by training and standardization at the beginning and during fieldwork.

CONCLUSION

In summary, this study provides essential information indicating the change in the nutritional status of preschool children attending municipal early childhood education schools. In this regard, it is recommended that early childhood education schools be one of the environments to be explored for health promotion and overweight prevention actions since many children attend full-time and have most of their meals at school. It is pertinent that this environment is an integral source of child development, both with activities carried out with children in the classroom and with food and nutrition education actions with families aimed at the well-being and health of these children.

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