Adequacy of energy consumption and macronutrients of children under six years of age

Adequação do consumo energético e de macronutrientes de crianças menores de seis anos

Adecuación del consumo energético y de macronutrientes de niños con menos de seis años

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ABSTRACT

Objective: To recognize the adequacy of dietary energy consumption and macronutrients of children under the age of six in the urban zone of Pelotas, in Southern Brazil.

Methods: A cross-sectional study that comprises the fourth evaluation of a temporal series study conducted in the city of Pelotas, Rio Grande do Sul, Brazil, in 2008. The sample consisted of 799 children under six years of age. In order to evaluate caloric intake rates and macronutrient percentage of contribution to the overall food diet calories, the dietary reference intakes (DRI) of the Institute of Medicine were used. These analyses included descriptions of the sample and chi-square test in order to assess associations at a 5% significance level.

Results: The deficient caloric intake was prevalent among male (58.0%) and female (63.0%) children aged six months or less. An excessive caloric intake was noted in children aged 7 to 12 months and one to two years: 61.3 and 73.5% for boys, and 56.0 and 74.1% for girls, respectively. Among the children aged three years or more, 44.9% of boys and of 47.4% of girls presented proper caloric intake rates for their age group. The energy intake deriving from macronutrients was adequate regarding carbohydrates and proteins; and 54.5% of the studied children aged between one and three years presented deficient intake of lipids.

Conclusions: The need of healthy dieting practices stimulation was clear in order to balance the energetic intake rates and the distribution of macronutrients consumption within this target age group.

Key-words: energy intake; macronutrients; children.

RESUMO

Objetivo: Conhecer a adequação do consumo energético e de macronutrientes da alimentação de crianças menores de seis anos de idade da zona urbana de Pelotas, Rio Grande do Sul.

Métodos: Recorte de um estudo transversal que compõe a quarta avaliação de uma pesquisa de série temporal realizada na cidade de Pelotas, Rio Grande do Sul, em 2008. A amostra foi constituída por 799 crianças menores de seis anos de idade. Para avaliação da ingestão calórica e da contribuição percentual de macronutrientes no total de calorias da dieta, foram utilizadas as ingestões dietéticas de referência do Instituto de Medicina. As análises incluíram a descrição da amostra e o teste do qui-quadrado para avaliação das associações, considerando-se um nível de significância de 5%.

Resultados: A ingestão calórica deficiente foi maior nos meninos (58,0%) e meninas (63,0%) com idade igual ou menor do que seis meses. Foi observada ingestão calórica

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Fonte financiadora: Fundo Nacional de Saúde/Ministério da Saúde (n. 2799/2003)
Conflito de interesse: nada a declarar

Recebido em: 5/3/2012
Aprovado em: 11/6/2012

excessiva nas idades entre 7 e 12 meses e um e dois anos: 61,3 e 73,5% nos meninos e 56,0 e 74,1% nas meninas, respectivamente. A maioria das crianças com três anos de idade ou mais (meninos com 44,9% e meninas com 47,4%) apresentou ingestão calórica adequada para a idade. A ingestão energética de macronutrientes apresentou-se adequada para carboidratos e proteínas e apontou que 54,5% das crianças tinham ingestão deficiente de lipídeos na faixa etária de um a três anos.

Conclusões: Foi evidenciada a necessidade do estímulo de hábitos alimentares saudáveis que equilibrem a ingestão energética e distribuam o consumo de macronutrientes nesse grupo etário.

Palavras-chave: ingestão de energia; macronutrientes; crianças.

RESUMEN

Objetivo: Conocer la adecuación del consumo energético y de macronutrientes de la alimentación de niños menores de seis años de edad del área urbana de Pelotas, Rio Grande do Sul.

Métodos: Recorte de un estudio transversal que compone la cuarta evaluación de una investigación de serie atemporal realizada en la ciudad de Pelotas, Rio Grande do Sul, en 2008. La muestra se constituyó por 799 niños con menos de seis años de edad. Para evaluar la ingestión calórica y el aporte porcentual de macronutrientes en el total de calorías de la dieta, se utilizaron las Ingestiones Dietéticas de Referencia del Instituto de Medicina. Los análisis incluyeron la descripción de la muestra y prueba de chi cuadrado para evaluación de las asociaciones, considerándose un nivel de significancia de 5%.

Resultados: La ingestión calórica deficiente fue más grande en los muchachos (58,0%) y muchachas (63,0%) con edad igual o inferior a seis meses. Se observó ingestión calórica excesiva en las edades entre 7 y 12 meses y uno y dos años: 61,3 y 73,5% en los muchachos y 56,0 y 74,1% en las muchachas, respectivamente. La mayoría de los niños con tres años de edad o más (44,9% muchachos y 47,4% muchachas) presentó ingestión calórica adecuada para la edad. La ingestión energética de macronutrientes se presentó adecuada para carbohidratos y proteínas y señaló que 54,5% de los niños tenían ingestión deficiente de lípidos en la franja de edad de uno a tres años.

Conclusións: Se evidenció la necesidad del estímulo de hábitos alimentares sanos que equilibren la ingestión energética y distribuyan el consumo de macronutrientes en ese grupo de edad.

Palabras clave: ingestión de energía; macronutrientes; niños.

Introduction

A diet in proper proportions and quality is essential for the growth and development of children in the first years of life. A healthy diet provides the energy and nutrients needed for a proper body performance and maintenance of health[1].

The process of formation of eating habits suffers various influences, such as the type of feeding in the first 6 months of life, the dynamic of introduction of foods in the 1st year, dietary experiences in childhood, family habits, and socioeconomic conditions, consolidating itself between 2 and 3 years of age[2,3]. In preschool, the child begins to grow more slowly and, therefore, there is a decreased appetite. Thus, a balanced diet at this stage of life ensures proper growth[4].

The increasing number of non-communicable chronic diseases and obesity, as well as the association of the latter with diet, justifies the development of studies on food consumption in the world[5]. Childhood is a very frequently studied period, since the feeding pattern in this phase is related to diet in adolescence. According to Wang *et al*[6], individuals with high consumption of carbohydrates, meats, fats, fruits and vegetables in childhood maintained the same diet during adolescence.

Therefore, knowing the adequacy of dietary energy and macronutrients consumption in preschool children is critical to identify aspects that may be corrected and encouraged in order to promote healthy eating habits that can last for a lifetime.

Methods

This research is part of a cross-sectional study that comprises the fourth assessment in temporal series study, conducted in the municipality of Pelotas, state of Rio Grande do Sul, in 2008. The aim was to assess the iron fortification of wheat and corn flours on anemia in children under 6 years old.

Because this was a study evaluating the impact of intervention, the sample size was calculated to detect a difference of 0.5g/dL in mean hemoglobin between the groups assessed before and after the intervention. Thus, it was necessary to study about 900 children under 6 years old to identify, on average, 30 children by census sector. The remaining data on methodology are described in a previous publication[7].

Sampling was performed in multiple stages in order to obtain an equiprobabilistic sample, i.e., with an equal chance of inclusion for all children living in the urban area of Pelotas within the age group studied. Children with malformations and/or carriers of genetic diseases that could affect food intake were not included in the study.

A pre-coded questionnaire was administered to the mother or caretaker, including demographic information (sex, age), socioeconomic information (mother's education, socioeconomic status) and children's eating habits (food frequency questionnaire, referring to the period of 1 year, built for this study).

To calculate the recommended caloric intake, we used the criteria provided by the National Academy of Sciences (NAS) from the Institute of Medicine (IOM), called Dietary Recommended Intakes — DRI[8], using the value of estimated energy requirement (EER) for each child, according to sex and age. To obtain the prevalences of proper caloric intake, the intake that did not reach 100% of the recommendation was classified as deficient, the one that met the recommendation was classified as adequate, and the intake that was higher than the recommendation, was classified as excessive.

For children on exclusive or partial breastfeeding, the volume of breast milk ingested was estimated (according to age and weight percentile) and its energy supply was calculated based on the recommendation of the World Health Organization (WHO)[9].

The analysis of the percentage contribution of macronutrients in the diet's total calories was based on the Acceptable Macronutrient Distribution Ranges - AMDR[8], for both sexes, considering only the age group from 12 months or more, because before this age, there were no recommendations available. A diet that provided between 45–65% of carbohydrates for children from 12 months was regarded as a diet with adequate carbohydrate distribution. Regarding proteins, the ideal distribution was a contribution of between 5–20% of calories from this nutrient among children from 12 to 36 months, and between 10–30% for older children. Regarding lipids, adequate intake corresponded to 30–40% of the total calories for children from 12 to 36 months, and from 25–35% for the older. In the description of macronutrients adequacy prevalences, the percentages of distribution that did not meet the recommendations were classified as deficient, and those which surpassed, were regarded as excessive.

To collect data, we selected nine interviewers, all nutritionists who worked full time and were trained to administer the surveys. Data were processed through double entry with information consistency checked on Epi-info 6.04. The foods and meals registered in food frequency questionnaires (FFQs) were analyzed in relation to their nutritional composition in the program HHHQ – Diet Sys Analysis Software, Version 4.02, National Cancer Institute, 1999. For the descriptive and bivariate analyses, we used the STATA software, version 10.0. We performed the chi-square test for associations between the explanatory variables and outcomes, considering the heterogeneity test between nominal categorical variables and of linear trend for ordinal ones. The level of significance was set at 5%.

Written consent of the parent or the guardian was obtained before data collection. This study was submitted to the Research Ethics Committee of the Medical School within Universidade Federal de Pelotas (protocol n. 011/2008) and followed resolution 196/96, which regulates research involving human beings.

Results

The present study analyzed 799 children under 6 years of age, most of them white (75.8%) and male (52.3%), aged 48 to 59 months (19.6%). Around 46.0% of children were born to mothers with 9 or more years of schooling, and approximately 49.0% were from families with incomes between one and three minimum wages (Table 1).

Table 1 - Characteristics of children younger than 6 years studied in the municipality of Pelotas, Rio Grande do Sul, 2008

	Frequency (n)	Percentage (%)
Sex		
Male	418	52.3
Female	381	47.7
Age (in months)		
0–11	134	16.8
12–23	111	13.9
24–35	116	14.5
36–47	140	17.5
48–59	157	19.6
60–71	141	17.7
Skin color		
White	603	75.8
Not white	193	24.2
Years of maternal education		
0–4 years	121	15.2
5–8 years	312	39.1
9 or more	364	45.7
Family Income (minimum wages)		
<1	192	24.1
1.00–2.99	388	48.7
3.00–5.99	144	18.1
6 or more	73	9.1

In two children the food frequency questionnaires were not used, because the mothers did not answer it. According to caloric recommendation for males[8] (Table 2), 58.0% of children aged 6 months or less presented deficient caloric intake. A similar fact occurred among females, from which 63.0% presented the same problem. It was also observed excessive caloric intake in both sexes in the age range 13–35 months: 73.5% among boys and 74.1% among girls. Most children aged 36 months or more (44.9% boys and 47.4% girls) presented adequate caloric intake. However, dietary inadequacies can still be observed in both sexes in the two categories (excessive and deficient).

Considering that the diet's caloric source comes from macronutrients, their percentage distribution was assessed in the diet of children aged 1 year or more, because there are no recommendations for children under 1. Therefore, 132 children were excluded from the analysis.

As Table 3 shows, in percentage terms, carbohydrate intake was adequate for most children in the age groups studied (87.4% between 1-3 years and 89.0% with 4 years or more). Likewise, with respect to proteins, most children presented adequate distribution and, in the age group from 4 years or more, the consumption of protein met the recommended levels. However, the caloric distribution concerning the percentage of lipids, in relation to other macronutrients, showed higher prevalence for the two categories. At the age range 1–3 years, almost 55.0% of children had a poor distribution and, among those with 4 years or more, 13.0% presented excessive distribution of lipids in relation to the recommendation for this age group.

Subsequently, bivariate analyses were performed to test the association of the caloric intake adequacy with age, maternal education and family income of children by sex, as shown in Tables 4 and 5. A significant relationship was found between caloric intake and age ($p<0.01$) in both sexes and in family income for girls ($p=0.01$). However, we did not observe the same behavior of the three levels of ingestion adequacy among the age groups. The variables family income and maternal education were not associated with boys' caloric intake.

Discussion

The use of the Dietary Reference Intakes stands as an advance in the field of Nutrition, because they represent a review of the nutritional recommendations and their

Table 2 - Deficient, adequate, and excessive caloric intake by sex, according to the 2005 dietary reference intakes. Pelotas, Rio Grande do Sul, 2008

Age range	Deficient n (%)	Adequate n (%)	Excessive n (%)
Male sex (n=416)			
≤6 months	24 (58.5)	7 (17.1)	10 (24.4)
7–12 months	3 (9.7)	9 (29.0)	19 (61.3)
13 a 35 months	6 (5.1)	25 (21.4)	86 (73.5)
36 months or more	66 (29.1)	102 (44.9)	59 (26.0)
Female Sex (n=381)			
≤6 months	22 (62.8)	5 (14.3)	8 (22.9)
7–12 months	7 (28.0)	4 (16.0)	14 (56.0)
13–35 months	4 (3.7)	24 (22.2)	80 (74.1)
36 months or more	42 (19.7)	101 (47.4)	70 (32.9)

Table 3 - Prevalence of adequate energy intake from macronutrients, according to percentage recommendation for age of the 2005 dietary reference intakes. Pelotas, Rio Grande do Sul, 2008

	Deficient n (%)	Adequate n (%)	Excessive n (%)
Carbohydrates			
12–47 months	39 (11.0)	321(87.4)	7 (2.0)
48 months or more	33 (11.0)	266 (89.0)	1 (0.3)
Proteins			
12–47 months	0	323 (88.0)	44 (12.0)
48 months or more	0	300 (100.0)	0
Lipids			
12–47 months	200 (54.5)	160 (43.6)	7 (2.0)
48 months or more	32 (11.0)	229 (76.3)	39 (13.0)

interpretation, besides guaranteeing more adequate analyses[8,10,11]. Thus, this study compared its results with others that used the same reference to assess dietary intake.

The semi-quantitative food frequency consumption questionnaire used in this study has the ability to estimate the usual intake of individuals and its relationship with the occurrence of diseases. It is also a practical tool, it has good reproducibility, acceptable validity, and its application has a low cost[5,12-14]. However, it does refer real consumption, which may lead to errors in estimating the frequency and the portions, and it requires memory about past habits[13].

After analyzing the obtained results, it was found that the adequacy of energy intake of children younger than 6 years assessed in the municipality of Pelotas presented a marked variation according to age. Deficient caloric intake was more frequent in boys (58.0%) and girls (63.0%) aged

Table 4 - Percentage of energy intake adequacy in boys according to demographic and socioeconomic characteristics as said by the 2005 dietary reference intakes. Pelotas, Rio Grande do Sul, 2008 (n=416)

	Deficient n (%)	Adequate n (%)	Excessive n (%)	*p*-value*
Age range (months)				<0.010
0–11	7 (37.0)	17 (23.2)	29 (40.0)	
12–23	2 (4.3)	12 (26.0)	32 (69.5)	
24–35	4 (56.3)	13 (18.3)	54 (76.0)	
36–47	15 (21.4)	37 (52.8)	18 (26.0)	
48–59	27 (34.0)	29 (36.2)	24 (32.4)	
60–71	24 (31.5)	35 (46.0)	17 (22.3)	
Years of maternal education				0.100
0–4	18 (28.5)	17 (27.0)	28 (44.4)	
5–8	49 (29.0)	61 (36.0)	59 (35.0)	
9 or more	32 (17.4)	64 (35.0)	87 (42.0)	
Family Income (MW)				0.200
<1	34 (31.1)	30 (27.5)	45 (41.2)	
1–2.99	46 (23.5)	71 (36.4)	78 (48.0)	
3–5.99	12 (16.4)	27 (37.0)	34 (46.5)	
6 or more	7 (18.4)	15 (39.4)	16 (42.1)	

*Chi-square test for heterogeneity; $p<0.05$; MW: minimum wage

Table 5 - Percentage of energy intake adequacy in girls according to demographic and socioeconomic characteristics as said by the 2005 dietary reference intakes. Pelotas, Rio Grande do Sul, 2008

	Deficient n (%)	Adequate n (%)	Excessive n (%)	*p*-value*
Age range (in months)				<0.010
0–11	29 (47.5)	9 (15.0)	23 (38.0)	
12–23	4 (63.5)	20 (31.7)	39 (62.0)	
24–35	0	4 (9.0)	41 (91.1)	
36–47	15 (21.4)	36 (51.4)	19 (27.1)	
48–59	16 (21.0)	34 (44.1)	27 (35.0)	
60–71	11 (17.0)	31 (48.0)	23 (35.3)	
Years of maternal education				0.050
0–4	13 (22,8)	18 (31.5)	26 (46.0)	
5–8	39 (27.4)	44 (31.0)	59 (41.5)	
9 or more	23 (13.0)	72 (40.0)	86 (47.5)	
Familiar Income (MW)				0.010
<1	24 (29.2)	21 (25.6)	37 (45.1)	
1 to 2.99	35 (18.2)	79 (41.1)	78 (40.6)	
3 to 5.99	11 (15.4)	18 (25.3)	42 (59.1)	
6 or more	5 (14.2)	15 (43.0)	15 (43.0)	

*Chi-square test for heterogeneity; $p<0.05$; MW: minimum wage

6 months or less. The result was similar to that found by Menezes[11], who assessed 948 children younger than 5 years in Pernambuco and observed that 49.0% of those who were 6 months or younger had a caloric intake below the EER. Due to this finding, it is essential to reinforce the importance of exclusive breastfeeding to meet the nutritional needs, once the deficient energy intake makes protein ineffective in producing tissues and uses it as an energy source, in addition to affecting children's proper growth and development[4].

In children over 6 months and under 3 years, an excessive caloric intake was observed. This result corroborates the findings of Cavalcante *et al*[15], in a study with 174 children aged between 12 and 35 months from the public health system in Viçosa, state of Minas Gerais, in which they found that the mean energy intake exceeded the recommendations in both sexes, especially among boys. This behavior is a risk factor for the continuation of this inappropriate habit in adulthood[2], because it is associated to overweight, a worrying and very common morbidity in Brazil in recent years[16-19].

Most children aged 3 years or more (44.9% of boys and 47.4% of girls) presented adequate caloric intake, a result that differs from the above-mentioned study by Menezes *et al*[11] conducted in Pernambuco, in which 55.2% of children from 48 to 60 months presented deficient caloric intake. The present result also differs from that of Castro *et al*[20], who assessed 89 children from 24-72 months in municipal nursery schools in Viçosa and verified that 75.7% presented deficient caloric intake.

An adequate diet comprises the balanced intake of carbohydrates, proteins and lipids. It is an essential condition to avoid nutritional problems and to guarantee children's growth and development[1,3].

The energy intake from macronutrients was adequate for carbohydrates and proteins in children from 1–3 years old and 4 or more, but revealed 54.5% children with deficient intake of lipids in the age group from 1–3 years. Cavalcante *et al*[15] found a similar result in children from 12–35 months, in both sexes, with an adequate intake of carbohydrates and protein, and a high proportion of children (81.5%) with energy intake from lipids below the recommended values. Also, Silva *et al*[21] observed an increasing frequency of children aged 1–3 years (64.3%) with an energy intake from lipids below the recommended values.

Adequate intake of protein in children over 1 year old goes against the growing trend of consumption of foods rich in protein by the Brazilian urban population, and some studies which observed that the dietary pattern in the 2 first years of life is predominantly dairy[22-25]. The deficiency of lipids in the age group from 1 to 3 years may compromise the intake of fatty acids considered essential to children. In the first 18 months of life and, later, until 3 years old, fatty acids are essential for physical and mental development of children[15,26].

In this study, children aged 4 years or more presented adequate intake of lipids, but the excess of this macronutrient was observed in 13.0% of them. The result is consistent with the study by Farias and Novaes[25,27], which revealed the consumption of foods rich in fat by children. This fact shows the early introduction of inadequate foods, possibly due to inadequate eating habits of the family, characterizing a risk factor for the development of overweight and obesity in this population.

In summary, it is concluded that most children under 6 years old had inadequate energy intake in the present study. Since the formation of eating habits occurs in childhood, it is necessary to encourage healthy eating practices that balance energy ingestion and distribute the consumption of macronutrients in this age group, avoiding, thus, the cultivation of wrong eating habits.

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