



Original/Otros

Consumption of ready-to-eat cereal is inversely associated with body mass index in 6-13 years old Chilean schoolchildren

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Abstract

Background and aims: childhood obesity in Chile is a serious problem with the prevalence continuing to increase over the last decade, despite all governmental efforts to diminish it. Studies indicate that the consumption of certain foods may help to control body weight. The objective of this study was to evaluate the relationship between ready-to-eat cereals (RTEC), body mass index and nutritional intake of macronutrients and micronutrients in school children from Santiago, Chile.

Methods and results: the study included 1 477 children aged 6-13 years who were evaluated by trained nutritionists. Weight, height and waist circumference were measured and a 24-hour recall questionnaire was administered in which the hours spent watching TV were also recorded. Overall, 32% of boys and 28 % of girls were overweight but the difference between them was not significant. All children, regardless of sex, showed a significant inverse relationship between amounts of RTEC consumed and body mass index (BMI). Those girls that consumed higher amount of RTEC had a reduced waist circumference than those that had a lower intake. A high consumption of RTEC in all children was related to a higher intake of calories, proteins, carbohydrates, calcium and zinc and to a lower intake of calories from fat. RTEC consumption was also associated with lower risk of being overweight/obese.

Conclusion: this study identifies RTEC intake as a potential indicator of a healthy diet. Controlled interventions are necessary to isolate the effect of RTEC consumption from other participating factors.

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EL CONSUMO DE CEREALES LISTOS PARA COMER ESTÁ INVERSAMENTE ASOCIADO CON EL ÍNDICE DE MASA CORPORAL EN ESCOLARES CHILENOS DE 6 A 13 AÑOS

Resumen

Introducción y objetivos: la obesidad infantil en Chile es un problema serio de salud, con una prevalencia que ha ido en aumento durante las últimas décadas, a pesar de todos los esfuerzos gubernamentales por combatirla. Algunos estudios indican que el consumo de ciertos alimentos puede ayudar en el control del peso corporal. El objetivo de este estudio fue evaluar la relación entre los cereales listos para comer (CLC), el índice de masa corporal y la ingesta de macro y micronutrientes en escolares de Santiago de Chile.

Métodos y resultados: el estudio incluyó 1.477 niños con edades entre los 6-13 años que fueron evaluados por nutricionistas entrenados. Se midieron peso, talla y circunferencia de la cintura, además se aplicó una encuesta alimentaria por recordatorio de 24 horas y se preguntó por el número de horas que veían TV. Del total, el 32% de los niños y el 28% de las niñas presentaron exceso de peso, diferencia que no fue significativa. Todos los niños, independientemente del género, mostraron una asociación inversa significativa entre el consumo de CLC y el índice de masa corporal. Aquellas niñas que consumían mayores cantidades de CLC tenían menor circunferencia de cintura que aquellas que consumían menos. Un mayor consumo de CLC en todos los niños estuvo relacionado con mayor ingesta de calorías, proteínas, carbohidratos, calcio y zinc, además de con un menor consumo de calorías provenientes de las grasas. El consumo de CLC también estuvo asociado con menor riesgo de ser obeso o padecer sobrepeso.

Conclusión: este estudio muestra que la ingesta de CLC es un indicador potencial de una dieta saludable. Son necesarias intervenciones más controladas para evaluar el efecto aislado de los CLC en comparación con otros factores.

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Palabras clave: Cereales listos para comer. Índice de masa corporal. Ingesta de alimentos. Escolares.

Introduction

The prevalence of childhood obesity in Chile has increased 4-fold over the past two decades reaching epidemic proportions¹⁻². Currently, it is estimated that almost a quarter of Chilean children entering grammar school are obese². This is very pertinent given the established association between childhood obesity and obesity in later adulthood which in turn increases the risk of other chronic diseases such as diabetes, hypertension, and dyslipidemia³. Obesity is a complex multifactorial disease where genetic and environmental factors such as excessive food intake and lack of physical activity are key elements in its development⁴.

A substantial amount of studies relate breakfast consumption to a decreased risk of obesity in children, adolescents and adults⁵, and an association has been found between breakfast consumption and nutritional status. A systematic review involving 59,000 children and adolescent in Europe showed that breakfast consumption has a protective effect against becoming overweight or obese⁶.

Breakfast intake has been considered as a “protection” against snack consumption. The recent study by Van Lippevelde et al in 6374 child-parent pairs from 8 European countries showed that out of 11 family variables, 3 were related to breakfast consumption: the frequency of this meal was inversely related to BMI z-score, while permissiveness concerning skipping breakfast and negotiating about breakfast were positively related to BMI z-score⁷.

Consumption of ready-to-eat cereals (RTEC), especially those with whole wheat, has been associated with a better diet quality and nutritional profile, lower body mass index (BMI) and a reduced presence of diabetes risk factors like altered fasting glycaemia and high blood cholesterol⁸. Studies have shown that children who eat RTEC have a better diet than those that do not, and an inverse relationship has been reported between frequency of consumption of RTEC at breakfast and body mass index (BMI)⁹. Albertson et al studied 603 American 4-12 years old children showing a statistically significant inverse correlation between RTEC consumption and BMI. Those children in the highest tertile of breakfast consumption had a lower fat intake and a better intake of micronutrients compared to those that consumed less or didn't consume¹⁰. Similar results were reported by Kostı et al in a sample of 2,008 12-17 years old Greek children showing that cereal consumption was associated with a 33% lower probability of being overweight and obese adjusted for age, sex and physical activity¹¹.

In Latin America, a prospective study in 147 Mexican children 6y-12 years old lasting 12 weeks showed that a decrease in body weight was related to intake of 33g of RTEC only when accompanied by nutrition education¹². In Argentina, Hirschler et al studied 330 students between 6 and 12 years old from low socio-

economic class finding a negative association between obesity/overweight in children and eating breakfast, independent of physical activity¹³.

There is limited information on RTEC consumption of Chilean children and its relationship to nutrient intake and BMI; therefore the aim of this study was to relate intake of RTEC to these indicators.

Methods

Study Population

The study included 1,678 children aged 6-13 years old recruited from 7 schools of different socioeconomic level (SEL) in Santiago, Chile. Two hundred and one children had missing or incomplete dietary information, reducing the sample size to 1,477 children. Exclusion criteria were the presence of a gastrointestinal disease or any condition that could alter food intake. Schools were classified according to the School Vulnerability Index (SVI) calculated by the Chilean National Organization for School Help and Fellowships (JUNAEB), which measures the SEL of each school as an institution according to their attending population. Informed consent was obtained from parents or guardians of the children in accordance with the Declaration of Helsinki. The Ethics Committee of the Faculty of Medicine approved the study protocol. Data collection took place between April 2010 and November 2011 by trained nutritionists.

Dietary Assessment

Food and beverage intake data were collected by a single 24 hour recall administered by trained nutritionists using a standardized protocol. The older children (aged ≥ 8 yrs) were interviewed in the school while the parent or guardian of the younger children completed the 24 hour recall in their home (72% response). Utensils representing standard household measures such as cups, spoons and bowls were used during the interview to facilitate the estimation of portion size. To ensure correct classification of RTECs, pictures of common RTECs available in the market were shown to children during the interview.

Food intake was analyzed using the program Food Processor 7.9 (ESHA Research, Oregon, USA) which uses the food composition tables from various sources including the USDA Standard Reference database and it has been previously validated for Chilean foods¹⁴.

Anthropometry

Weight was measured with the child wearing light clothing without shoes on an Omron scale model HBF-400 (Omron, Kyoto, Japan) (precision 100 g,

range 0.1-130 kg). Height was measured using a portable scale (Seca, model 214, Hanover, MD) to the nearest 0.1 cm with the subject's head oriented in the Frankfurt plane¹⁵. Waist circumference was measured with an inextensible tape on the upper lateral border of the right ilium in the mid-axillary line at the end of an exhalation¹⁶, three measurements were Averaged and >90th percentile as a cut-off value was used¹⁷. All measurements were performed in the school by trained nutritionists before the dietary interview.

Weight classification was determined by the BMI (weight in kg/height² in m) comparing it with the CDC/NCHS 2000 tables¹⁷. Cut off points were those recommended by the Expert Committee on Child Obesity from USA (underweight BMI < 10; normal BMI ≥ 10- p <85; overweight BMI p ≥ 85- p <95; obese BMI p ≥ 95).

In order to establish pubertal development, a self-administered observation was requested to each child who, in private, observed standardized pictures showing different Tanner stages of pubescent development. This information was used to adjust BMI according to their biological health, a methodology validated and used in other studies¹⁸.

Physical Activity

Physical activity was estimated by proxy asking the children the number of hours that the child spent watching TV.

Statistical analysis

Continuous variables are presented as mean and standard deviation, while categorical variables are pre-

sented as absolute and relative frequencies. Student t test for independent samples was used to compare anthropometric means between boys and girls. The population was categorized into 4 groups according to the amount of RTEC consumed: 0 g/d (non-consumers), 1-29 g/d (1 portion or less), 30-59 g/d (1 to 2 portions), and ≥60g/d g (2 or more portions) Portion size was established based on the manufacturer size portion guidelines. Mean anthropometric measurements, food and nutrient intakes were compared across the consumption groups using ANOVA test and Bonferroni or Tamahne post-hoc tests were performed to evaluate pair differences.

Excess weight and obesity prevalence was computed in each cereal consumption group. P value for trend was used to assess associations. Logistic regression was used to examine the extent to which RTEC consumption was associated with the risk of overweight and obesity crude odds ratios (OR) and its 95% confidence interval (CI) were obtained to estimate the relative risk of overweight and obesity. To correct for possible confounding variables including gender, age, pubertal maturation and physical activity, adjusted ORs and the 95% CI were also computed.

All p values were two-tailed, and a value of p<0.05 was considered to be statistically significant. Data processing and statistical analyses were conducted with SPSS statistical software version 17.0.

Results

No significant differences were observed on the average age, weight, height, BMI or waist circumference between boys and girls (Table I). Overall, 35% of the sample consumed RTEC with no substantial difference between boys and girls. Figure 1 shows the changes

Table I
Characteristics of the study population. 2009-2010, Santiago, Chile³⁹

	<i>Males</i> (n=787)	<i>Females</i> (n=690)	<i>Total</i> (n=1477)	<i>p value</i>
Age 10-12 years (%)	60.7	59.1	60.0	0.530
Low SEL (%)	50.2	47.7	49.0	0.336
Weight (kg)	39.47 (11.6)	39.42 (12.0)	39.45 (11.8)	0.938
Height (cm)	142.27 (13.4)	141.99 (12.5)	142.14 (13.0)	0.684
BMI (kg/m ²)	19.12 (3.2)	19.17 (3.5)	19.14 (3.4)	0.767
z-BMI	0.57 (0.94)	0.48 (0.91)	0.53 (0.92)	0.056
Waist circumference (cm)	69.32 (9.6)	70.20 (10.4)	69.73 (10.0)	0.091
Overweight (%)	19.6	16.8	18.3	0.171
Obese (%)	12.5	10.9	11.7	0.345
RTEC consumers %	35.2	35.7	35.4	0.855

SEL: socioeconomic level; BMI: body mass index; RTEC: ready to eat cereal

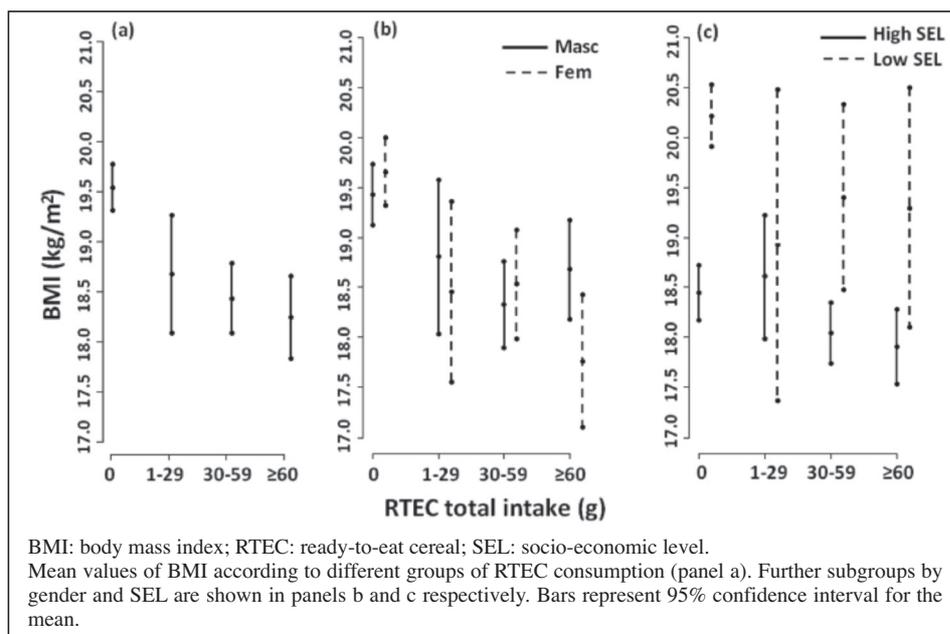


Fig. 1.—Changes in BMI with the total intake of RTEC. 2009-2010, Santiago, Chile.

in BMI according to RTEC total intake. There was an inverse relationship between BMI and RTEC consumption at breakfast in the whole group ($p < 0.001$). No difference was observed in boys and girls in RTEC consumption and BMI ($p = 0.333$). Children from the high SEL group showed lower values of BMI than low SEL and the inverse relationship was significant only in the high SEL group ($p < 0.001$).

Table II shows socio-demographic and anthropometric characteristics and nutrient intake according to children's RTEC intake. All categories of RTEC consumers had a significantly lower mean BMI than non-consumers and those who consumed ≥ 30 g/d of RTEC also had a significantly lower waist circumference. The differences in zBMI, are maintained only for those who consumed more than 1 serving of RTEC. In general, RTEC consumption was associated with a higher quality diet, characterized by an increased mean intake of fruits, vegetables, dairy products and whole wheat bread and a lower of consumption of white bread and sugar. Furthermore, RTEC consumers tended to have significantly higher mean intakes of protein, carbohydrate, vitamin A, B6, C and D, iron, calcium and zinc compared to non-consumers. Sodium intake was significantly higher in RTEC consumers than in non-consumers; however, this was only significant in those who consumed 2 portions or more (≥ 60 g/d) of RTEC.

Multiple logistic regression analysis showed that the risk of being obese or overweight was reduced as RTEC intake increased by 1 or more portions per day (Table III). When up to 1 portion (30g) of RTEC is consumed, overweight/obesity is diminished by 7% compared to non-eaters. Eating 1 to 2 portions and more than 2 portions /day reduced the risk of overweight in 53% and 58% respectively compared to those

who did not eat at all, adjusted for age, sex, pubertal state and physical inactivity per week (Table III). Likewise, prevalence of obesity decreased by 12%, 67% and 77%, respectively, using the same levels of intake described above for overweight.

On average, 64 % of children spent less than 2 hours/day watching TV while 35.5% watched between 2-4 hours. Boys played more videogames and spent more hours in front of a computer than girls. While 28% of children of high SEL spent more than 2 hours watching TV, 50% of children from low SEL did the same (data not shown).

Discussion

The prevalence of overweight and obesity in Chile has consistently increased in the last decades despite all the governmental efforts to diminish it. It is particularly worrisome the high prevalence of obesity in children and young adults which is a predictor of a high morbidity in adult life¹⁹. The efforts to combat overweight and obesity have concentrated in improving eating habits or increasing physical activity of children²⁰. Although some positive results have been seen in the short and medium term, there is still no adequate long term intervention strategy to reduce weight in children, a scenario prevalent in most developing countries and in the developed world²¹.

More recently, studies have been focused on the association between the intakes of certain foods with the prevalence of obesity. In a detailed meta-analysis the authors concluded that regular consumption of breakfast RTEC results in a lower BMI and a decreased likelihood of being overweight in children and adolescents²².

Table II
Anthropometry and mean daily nutrient intakes across RTEC consumption groups. 2009-2010, Santiago, Chile

	RTEC consumption (g/d)					P value
	0 (n=954)	1-29 (n=91)	30-59 (n=277)	≥60 (n=155)	Total (n=1477)	
<i>Socio-demographic</i>						
Age; mean (SD)	10.5 (2.1)	10.1 (2.1)	10.4 (1.8)	10.6 (1.9)	10.5 (2.0)	0.151
Gender Male (%)	64.8	7.1	17.8	10.3		0.333
Gender Female (%)	64.3	5.1	19.9	10.7		
High SEL (%)	48.5	9.6	26.3	15.7		
Low SEL (%)	81.4	2.6	10.9	5.1		<0.001 ^{a,b,c}
Physical inactivity (<2 hrs per day in front of a screen) (%)	53.6	61.5	58.1	58.1		
Physical inactivity (2-4 per day hrs in front of a screen) (%)	35.4	33.0	35.4	33.5		
Physical inactivity (>4 hrs per day in front of a screen) (%)	11.0	5.5	6.5	8.4		0.326
<i>Anthropometry</i>						
Weight (kg); mean (SD)	40.2 (12.2)	38.1 (10.8)	38.0 (11.2)	38.3 (10.0)	39.4 (11.8)	0.010 ^b
Height (cm); mean (SD)	142.0 (13.0)	141.4 (13.7)	142.1 (12.8)	143.6 (12.8)	142.1 (13.0)	0.469
BMI (kg/m ²); mean (SD)	19.5 (3.6)	18.7 (2.9)	18.4 (3.0)	18.2 (2.6)	19.1 (3.4)	<0.001 ^{a,b,c}
z-BMI; mean (SD)	0.61 (0.95)	0.49 (0.90)	0.35 (0.87)	0.28 (0.84)	0.53 (0.93)	<0.001 ^{b,c}
Waist circumference (cm); mean (SD)	70.8 (10.4)	68.4 (8.9)	67.9 (9.2)	67.4 (8.0)	69.7 (10.0)	<0.001 ^{b,c}
<i>Nutrient intakes</i>						
Energy (kcal); mean (SD)	1963 (691)	2001 (598)	2021 (602)	2267 (631)	2008 (669)	<0.001 ^{c,e,f}
Proteins (g); mean (SD)	71.7 (30.7)	85.7 (30.1)	77.3 (28.7)	84.8 (26.5)	75 (30.2)	<0.001 ^{a,b,c}
P% (%); mean (SD)	14.7 (3.9)	17.4 (4.4)	15.4 (3.7)	15.1 (3.5)	15.1 (3.9)	<0.001 ^{a,b,d,e}
Carbohydrates (g); mean (SD)	290.0 (108.9)	287.1 (101)	303.5 (93.2)	346.2 (100.9)	298.2 (106.1)	<0.001 ^{c,e,f}
CHO% (%); mean (SD)	59.2 (8.0)	56.9 (8.1)	60.2 (7.2)	61.2 (7.6)	59.4 (7.9)	<0.001 ^{a,c,d,e}
Sugar (g); mean (SD)	21.1 (24.6)	13.1 (23.7)	14.8 (19.9)	13.5 (15.8)	18.6 (23.2)	<0.001 ^{a,b,c}
Fats (g); mean (SD)	58.9 (26.7)	58.5 (20.8)	56.8 (23.5)	61.8 (29.2)	58.8 (26.1)	0,299
F% (%); mean (SD)	26.9 (6.9)	26.6 (6.0)	25 (5.9)	24.3 (6.8)	26.2 (6.7)	<0.001 ^{b,c,e}
Soluble fiber (g); mean (SD)	5.7 (3.5)	4.9 (2.8)	5.3 (2.9)	5.1 (2.8)	5.5 (3.3)	0.026
Insoluble fiber (g); mean (SD)	11.2 (8.6)	9.6 (6.1)	9.9 (7.3)	9.4 (6.9)	10.7 (8.1)	0.008 ^c
Polyunsaturated fat (g); mean (SD)	13.1 (7.2)	11.6 (5.1)	11.9 (6.2)	12.4 (6.6)	12.7 (6.9)	0.026 ^b
Vitamin A (RE); mean (SD)	725 (672)	835 (665)	818 (633)	955 (1695)	773 (836)	0.008 ^c
Vitamin B6 (mg); mean (SD)	1.3 (0.7)	1.6 (0.7)	1.4 (0.6)	1.5 (0.7)	1.4 (0.7)	<0.001 ^{a,c}
Vitamin C (mg); mean (SD)	62.6 (61.3)	79 (74.8)	76.5 (71.0)	73.5 (55.5)	67.4 (63.8)	0.002 ^b
Vitamin D (ug); mean (SD)	4.4 (3.5)	5.4 (3.7)	5.5 (4.6)	5.6 (3.7)	4.8 (3.8)	<0.001 ^{b,c}
Calcium (mg); mean (SD)	807 (429)	1088 (429)	979 (405)	1106 (411)	888 (438)	<0.001 ^{a,b,c}
Iron (mg); mean (SD)	13.6 (6.4)	13.8 (6.4)	13.2 (5.3)	15.4 (6.8)	13.7 (6.3)	0.005 ^{c,f}
Sodium (mg); mean (SD)	1760 (921)	1964 (809)	1874 (833)	2332 (921)	1854 (915)	<0.001 ^{c,e,f}
Zinc (mg); mean (SD)	8.7 (4.2)	10.5 (4.1)	9.3 (4.1)	10.0 (3.9)	9 (4.2)	<0.001 ^{a,c}

Post hoc correction. a: 0 g different from 1-29 g; b: 0 g different from 30-59 g; c: 0 g different from 60 or more g; d: 1-29 g different from 30-59 g; e: 1-29 g different from 60 or more g; f: 30-59 g different from 60 or more g.

Table III
Prevalence of excess weight/obesity by RTEC consumption groups. 2009-2010, Santiago, Chile

RTEC consumption (g/d)	n	Excess weight (%)*	Obesity (%)*
0	954	34.6	14.7
		OR (95% CI)	1
		Adjusted OR (95 CI)**	1
1-29	91	33.0	13.2
		OR (95% CI)	0.93 (0.59-1.47)
		Adjusted OR (95 CI)**	1.24 (0.70-2.20)
30-59	277	19.9	5.4
		OR (95% CI)	0.47 (0.34-0.65)
		Adjusted OR (95 CI)**	0.61 (0.42-0.90)
≥60	155	18.1	3.9
		OR (95% CI)	0.42 (0.27-0.64)
		Adjusted OR (95% CI)**	0.53 (0.32-0.89)
Total	1477	30.0	11.7

* p value for trend <0,001.

** OR adjusted by gender, pubertal maturation (tanner), Physical inactivity (hours per days in front of a screen), age and socioeconomic level. RTEC: ready to eat cereal; OR: Odds Ratio; CI: confidence interval.

RTEC have been particularly studied since they are easy to prepare, tasteful, most of them are low in fat, some are whole grain and most are also fortified with vitamins and minerals. Their consumption is related to a healthier diet in children, which correlates with our finding that those children that consumed a higher amount of RTEC had a healthier diet²³. RTEC are not frequently consumed in Chile; the results reported here show that only approximately 35% of the children consumed RTEC cereals at breakfast, mainly in the better-to-do groups, although there is also some level of consumption in poorer children. Gradually the higher socioeconomic groups have been incorporating this food item in their diet, reaching levels similar to the intake in the USA and some countries in Europe²³. In our population we observed an inverse relationship between RTEC consumption and BMI in both boys and girls and we showed a higher prevalence of overweight in those children that did not eat RTEC (those that did vs. those that did not, 26% vs. 36% in boys and 17% vs. 33% in girls, respectively). Although in our study there were no changes in fat consumption or white bread intake together with an increase in sodium, the diet of RTEC was healthier than non-eaters.

These results are similar to the results found in other countries^{10, 23}, which have shown that RTEC consumption is related to a better dietary pattern and a higher level of physical activity than those who did not consume them.

One hypothesis that can be put forward is that those children that consume RTEC have a better lifestyle

and overall diet than those who did not. In the present study the consumption of RTEC was associated with a higher intake of dairy products, white meats (poultry and pork), fruits and vegetables and other cereals, a reduced intake of added sugar and less hours watching TV, a pattern that is protective of excess weight in children and adults²⁴. In our group the intake of milk in children that consumed RTE cereals was about 200 ml higher than those who did not. This association has been extensively discussed in the literature describing an inverse relationship between consumption of dairy foods and BMI²⁵.

Waist circumference, a cardiovascular risk factor, was also diminished in the RTEC, probably also related to a better lifestyle²⁶. Our study showed that girls consuming RTEC had a higher energy intake than those who did not, although they showed a reduced prevalence of overweight and obesity, probably related to the higher intake of dairy products and a reduced intake of sugar. McNulty et al reported a similar finding in 1,015 Irish boys and girls²⁷.

Fat intake expressed as percentage of calories showed an inverse relationship with consumption of RTEC in agreement with other studies (9) (data not shown). Fiber consumption did not show any relationship with RTEC intake, suggesting that the RTEC consumed were not particularly high in fiber, which is in agreement with the report by Ruxton et al in 136 schoolchildren²⁸.

The intake of zinc, iron, phosphorus, sodium, vitamins A, B₁, B₂, B₃, pyridoxine, B₁₂ C and D, were also high in RTEC consumers which can be explained

by the fortification of RTEC with these nutrients, as reported by Gibson in 1,688 4-18 y old British children²⁹.

The adequacy of energy intake and selected macro and micronutrients in children that consumed RTEC was above 100% except for fiber and calcium, which did not reach the recommendations for the age group. This data coincides with other populations studied³⁰.

The present study shows the effect of RTEC in a population where their consumption is low. Limitations of this study are the cross sectional nature and the possibility of under/over reporting. However, special care was taken to confirm their reporting of intake. The use of a proxy to physical activity (hours watching TV) is another limitation. This was done in order to avoid doing a lengthy questionnaire due to time constraints. Nevertheless, based on their answers it seems to correlate well with physical activity.

In conclusion, this study identifies RTEC intake as a potential indicator of a healthy diet. Since we know that breakfast intake is related to a decreased BMI, a score can be constructed in order to assess the importance of the different foods described as protectors against a high BMI. On the other hand, it is essential to conduct prospective controlled interventions that will allow isolating the effect of RTEC consumption from other factors that may permit to establish feeding strategies for children.

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