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Universidade do Minho
Instituto de Educação
Centro de Investigação
em Estudos da Criança (CIEC)

Professora Doutora
Maria Beatriz Ferreira Leite de Oliveira Pereira (Pereira, Beatriz)

Category: Full Professor

Institution: Universidade do Minho (UMinho)

Email: beatriz@ie.uminho.pt

Online CV: http://www.degois.pt/visualizador/curriculum.jsp?key=2030897209377539

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Health Promotion Intervention to Improve Diet Quality in Children: A Randomized Trial

Rafaela Rosário, PhD[1]
Ana Araújo, MSc[2]
Patrícia Padrão, PhD[2]
Oscar Lopes, MSc[3]
André Moreira, PhD[2]
Beatriz Pereira, PhD[1]
Pedro Moreira, PhD[2]

Objective. *This study aims to evaluate the impact of an intervention program, taught by trained teachers, on foods and nutrients components of the Diet Quality Index–International among children in Grades 1 to 4.* Method. *A total of 464 children (239 female, 6-12 years) from seven elementary Portuguese schools participated in this randomized trial. Three schools were allocated to the intervention, and four to the control group. The intervention program was based on the health promotion model and social cognitive theory. Teachers previously trained by researchers in nutrition, healthy eating, and healthy cooking implemented the intervention in the classroom from November 2008 to March 2009. Sociodemographic, anthropometric, physical activity, and dietary assessments were performed before (2007/2008) and at the end of the intervention (2009). Dietary intake was gathered by a 24-hour dietary recall and the components of Diet Quality Index–International were defined.* Results. *Children from the intervention schools reported a significantly higher adequacy in vegetable consumption (*p *= .018) and a significantly higher moderation in sodium consumption (*p *= .032) compared with the controllers.* Conclusion. *Our study provides further support for the success of intervention programs that aim to enhance children's dietary intake. Implementing similar interventions can be promising to support vegetable consumption and moderate sodium intake.*

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➤ INTRODUCTION

Dietary quality, examined as a multidimensional approach, has been appealed for researchers and has been used as a dietary guidance with focus on diet-related chronic diseases (Kant, 1996; Kim, Haines, Siega-Riz, & Popkin, 2003).

Until now, few studies have examined the effects of an educational program on food and nutritional components of diet quality (Cohen, Kraak, Choumenkovitch, Hyatt, & Economos, 2014). Therefore, effective interventions that improve the diet quality in children are needed, especially because the prevalence of some chronic diseases such as overweight and obesity is still high in schoolchildren (Olaya et al., 2015).

It is unclear what the role of teachers is in the delivery features of the interventions and its impact on children's dietary patterns (Sharma, 2006; Stice & Marti, 2006). Although teachers are not able to devote as much time and energy to provide interventions, at

[1]*University of Minho, Braga, Portugal*
[2]*University of Porto, Porto, Portugal*
[3]*Erdal Association, Guimarães, Portugal*

Authors' Note: *The authors declare that there are no conflicts of interest. ClinicalTrials.gov Identifier: NCT01397123. Address correspondence to Rafaela Rosário, PhD, Universidade do Minho, Escola Superior de Enfermagem, Largo do Paço 4704-553 Braga, Portugal; e-mail address: rrosario@ese.uminho.pt.*

least theoretically, because they have many responsibilities in the classroom beside the implementation of the program (Stice & Marti, 2006), other studies consider them dedicated interventionists (Sharma, 2006). Nevertheless, teachers have been identified as core agents in the dissemination of schools health promotion (Jourdan, Samdal, Diagne, & Carvalho, 2008).

The purpose of this research was to evaluate the impact of an intervention program, taught by trained teachers, on foods and nutrients components of the Diet Quality Index–International (DQI-I) among children in Grades 1 to 4.

➤ BACKGROUND/LITERATURE REVIEW

Measuring an overall diet is a preferred alternative to a single nutrient or food as a measure of diet quality because people do not consume nutrients or single foods; they consume several foods with different substances. Previous studies showed that beside energy balance, diet quality was independently associated to children's weight status (Jennings, Welch, van Sluijs, Griffin, & Cassidy, 2011).

Consuming a healthy diet reduces the risk of several chronic diseases such as overweight and diabetes (Fardet & Boirie, 2014). However, children's consumption of vegetables is below recommended amounts (Evans, Christian, Cleghorn, Greenwood, & Cade, 2012; Rosário et al., 2012). Previous research focused on increasing the portion size of vegetables most liked, instead of increasing the variety of vegetables (Mathias et al., 2012). The available evidence of interventions with focus on schools to improve healthy eating habits has found mixed success (Khambalia, Dickinson, Hardy, Gill, & Baur, 2012). Schoolchildren are independently influenced by outside sources, such as the schoolteachers, with whom they spend most of the day, and that affect their eating patterns (Birch, Savage, & Ventura, 2007).

Schools are not primarily concerned with the improvement of children's health (Jourdan et al., 2008). Health promotion practices must be in accordance with teachers' perception of their mission and the constraints of school setting (Jourdan et al., 2008), taking into account their autonomy (Shulman, 2000). In Portugal, university education degrees do not have health promotion subjects in their academic curricula (Precioso, 2004). Therefore, teachers' continuing education and training is an approach to improve the knowledge and skills to deliver effective health promotion practices, such as those related to lifestyles. Teachers' trainings can influence their knowledge and perceptions about the importance of teaching health (Barr et al., 2014). However, providing knowledge about health is not enough to lead to a healthier behavior change; health programs should include several techniques linked to communication and decision making (Myers-Clack & Christopher, 2001). We hypothesized that children from primary schools who had a program based on lifestyles promotion had better outcomes on the foods and nutrients components of a DQI-I.

➤ MATERIALS AND METHOD

Participants

During 2007-2008, seven out of eighty public elementary public schools from a city from the north of Portugal were selected by a simple random sample and invited to participate in this study. The number of schools involved was according to constraints of personnel for assessment and intervention. The unit of randomization was the school, and three of them were assigned into intervention and four into control group (Figure 1). Prior to data collection, parents provided written informed consent, according with the ethical standards laid down in the Declaration of Helsinki, and children gave oral assent. Also, both the schools and the Portuguese Data Protection Authority (Comissão Nacional de Proteção de Dados, Process No. 7613/2008) approved the study. In addition the protocol for this study was registered in the clinicaltrials.gov, NCT01397123.

Of the 574 children who were invited to participate, 464 (239 female), 6 to 12 years old, agreed and returned (80.8%) the written consent forms filled by their parents. From these, 233 (50.2%) were allocated to the intervention group and 231 (49.8%) to the control group. Follow-up assessment was available for 63.4% of the children, 143 (61.9%) in the control and 151 (64.8%) in the intervention groups. Attrition rates did not differ between intervention and control group (35.2% and 38.1%, respectively). Major reasons for nonparticipation were school transfer (94.1%), parental refusal (4.1%), and absence from school (1.8%). Children and outcomes assessors were blinded to group assignment. A total of 257 parents of the children involved in the study provided data at baseline and 203 (79.0%) at postintervention, that is, after the program ended during the year 2009.

Overview of the Intervention

Teachers from intervention schools were invited to participate in the program conducted between October 2008 and March 2009, and 15 agreed to be involved.

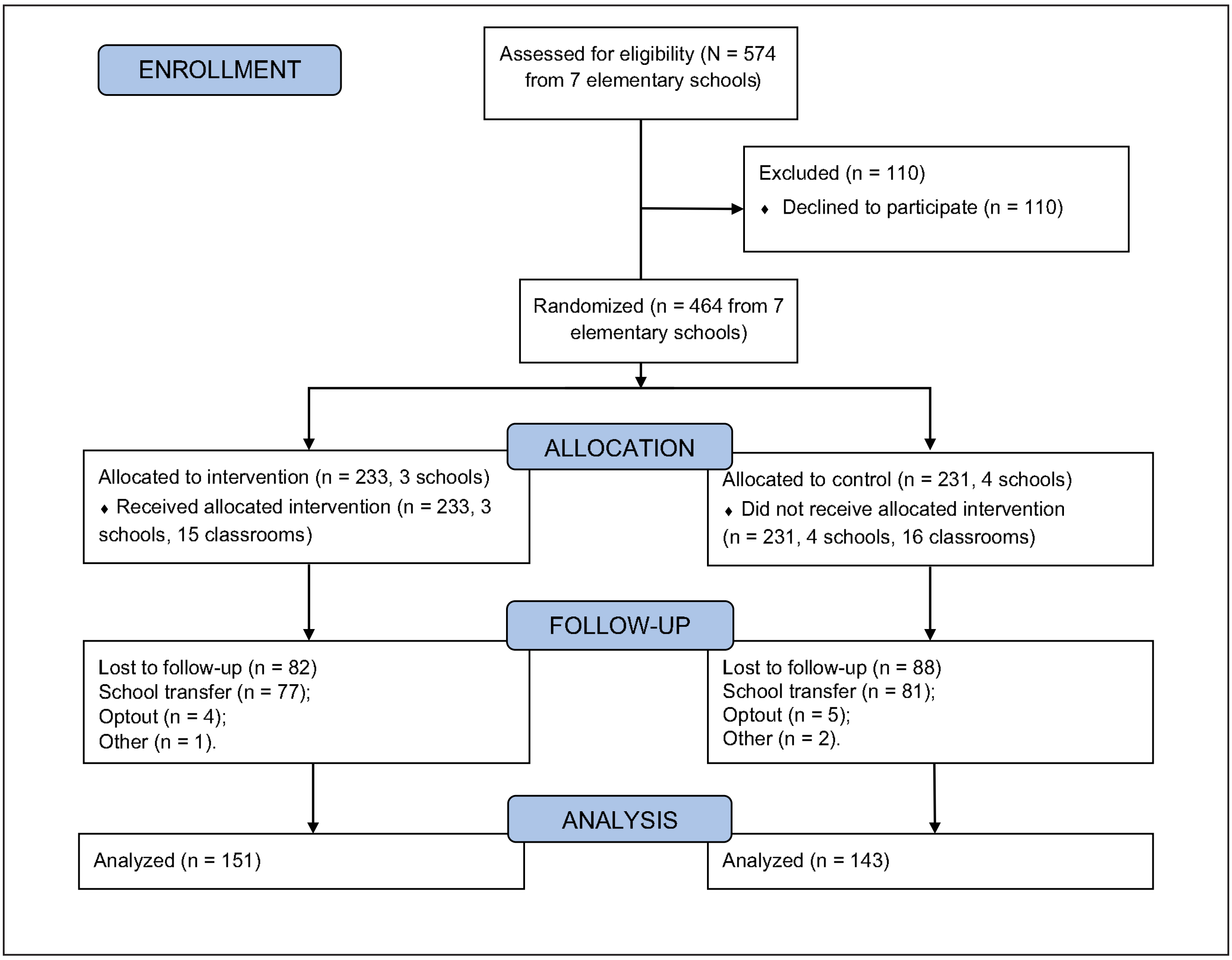

FIGURE 1 **Flow of Participants Through Each Stage of the Program: Portugal (2007-2009)**

Not only teachers but also school heads were involved in the training course. This intervention program was based on the health promotion model (Pender, 1996) and the social cognitive theory (Bandura, 1986), and aimed to promote healthier active lifestyles by encouraging children to be more active and make a better food selection. The main strategy was to embed health promotion regarding healthier lifestyles into the school development process. The health promotion model is aware that the health-promoting behavior is a result of self-characteristics and cognitive factors combined with competing demands and preferences as well as a commitment to a plan of action (Pender, 1996). Likewise, this program was responsive to the influences of children's behavior and, like Pender (1996) followed a positive vision of health. The social cognitive theory enhanced cognitive and behavioral skills by enabling children to make changes in their own behavior and helping them make new choices effectively (Bandura, 1986). In addition the concept of self-efficacy was very important in the promotion of healthier lifestyles. The sessions delivered to teachers were approved by the Minister of Education, Scientific-Pedagogic Council for In-Service Training (Conselho Científico Pedagógico da Formação Contínua, Ministério da Educação) in the form of "training workshop" with 72 hours duration. The program was implemented over two terms: (1) teachers' training delivered by researchers during October 2008 and March 2009 (36 hours) and (2) intervention delivered to children by trained teachers during November and March 2009 (36 hours). Being aware that long-term programs are more effective than those of short duration (Sharma, 2006; Stice & Marti, 2006), the training program was developed for 6 months duration.

Teachers of the intervention group had 12 sessions of 3 hours each with the study researchers during 6 months (see Table 1). The training workshop consisted of two phases: (1) an attendance phase at the beginning, in which the participants took part in a workshop, which provided them basic information on health promotion in schools and was intended to enable them to start the health promotion process in their schools, and (2) an implementation phase, in which the participants were supported in their first attempts of implementation and received further information via contact with the researchers. The attendance phase, streamlined by the researchers, included the following contents: health promotion and overweight and obesity prevention (Session 1); concepts of food, nutrition, and dietary guidelines for children and families (Sessions 2-4); hydration and the importance of water (Session 5); strategies to encourage fruit and vegetable consumption and to reduce low-nutrition, energy-dense foods (Sessions 6-8); appropriate physical activity levels and strategies to reduce screen time (Sessions 9 and 10); and healthy cooking activities (Sessions 11 and 12). After each session, teachers delivered the learnt contents and developed creative and engaging classroom activities about the addressed topic. Individual meetings with teachers occurred just before the beginning of the intervention in order to clarify doubts and review the materials to be used in the sessions.

The implementation of the program occurred as planned. All the children of the intervention schools had contact with trained teachers. Teachers taught the components of the program as prescribed, and the researchers were always available to answer any question. Teachers reported they were enthusiastic about the training, and had a total attendance in the sessions with the researchers.

Assessments

In each school, previously trained persons performed anthropometric evaluation, using standardized procedures (World Health Organization, 1995) before the intervention, from February to June of the school year 2007-2008, as well as after the intervention from April to June of 2009. Anthropometric measurements were performed in children with light indoor clothing and barefooted. Weight was measured in an electronic scale, with an error of ±100 g (Seca, Model 703, Germany), and height was measured using a stadiometer, with the head in the Frankfort plane. Body mass index (BMI) was computed as mass (kg)/height^2 (m^2). Weight status was defined according to the International Obesity Task Force criteria (Cole, Bellizi, Flegal, & Dietz, 2000).

Dietary intake was gathered by a 24-hour dietary recall obtained by nutritionists and/or trained interviewers, before and immediately after the intervention. Children did not have prior notification of when the recalls would occur in order to prevent potentially biasing reports and were asked to remember all food and beverages consumed during the previous 24 hours. Energy and nutritional intakes were estimated using the nutritional analysis software Food Processor Plus (ESHA Research Inc., Salem, OR), which was added with Portuguese foods and recipes.

To evaluate the mean population bias in reported energy intake, at baseline and after intervention, the ratio energy intake (EI):basal metabolic rate (BMR) was computed for each subject, according to gender- and age-specific equation adopted by the World Health Organization, Food and Agriculture Organization, & United Nations University (2004) report. BMR was determined through the Schofield equations and the subjects with EI:BMR ≤ 0.89 were classified as low energy reporters and excluded from analysis (Goldberg et al., 1991).

To assess the level of physical activity of children, parents were asked five questions with four answer choices (4-point scale) ranging from 1 to 4, from a questionnaire developed by Telama, Yang, Laakso, and Viikari (1997) and previously applied to the Portuguese population (Mota & Esculcas, 2002).

Social, demographic, and family characteristics were assessed by questionnaire. The survey sent to parents contained questions about gender and age of the children, education of the parents (recorded in five categories: 0, 1-4, 5-9, 10-12, and more than 12 years of formal education). This information was further grouped for analysis into three categories: up to 9 years, 10 to 12 years, and more than 12 years of education.

Diet Quality Index

The DQI-I comprised four components that describe a high-quality diet (variety, adequacy, moderation, and overall balance). Variety included the overall food group variety and within-group variety for protein source. Overall variety was maximum when at least one serving of food per day from each of the five groups (meat/poultry/fish/egg, dairy/beans, grains, fruits, and vegetables) was consumed. The score for the variety of protein sources (meat, poultry, fish, dairy, pulses, and eggs) was based on intakes of more than half the serving size per

TABLE 1
Sessions and Description of the Attendance Phase During the Intervention Program

Session Title	*Description*
1. Incorporating characteristics of health promotion	This session focused on health promotion and overweight and obesity prevention. It focused on lifestyle determinants of health and obesity—definitions and descriptions of the problem, risk factors, and health problems.
2. Incorporating key concepts	This session provided an overview of food and nutrition concepts.
3. Development of appropriate guidelines: meeting children's needs	This session documented the dietary guidelines (the Portuguese Food Wheel) and healthy eating advice for children, covering the five main food groups. Participants explored resources and guidelines related to food and nutrition needs for children.
4. Working with the families	A variety of interventions to help children and their families to consume healthy foods and plan well-balanced meals and snacks were explored. Participants also analyzed models of family-centered care.
5. Linking best practice to practice: incorporating characteristics of effective interventions in nutrition and food consumption in the classroom	This session provided a broad of approaches to teach children about the importance of water, and teaching strategies to replace consumption of sugar-sweetened beverages with water. Participants in this session engaged in activities to support the implementation of the program.
6 and 7. Linking best practice to practice: incorporating characteristics of effective interventions in physical activity, nutrition, and food consumption in the classroom	This session provided a broad of appropriate physical activity levels and healthy eating behaviors such as increasing fruit and vegetable intake and decreasing energy-dense, micronutrient-poor foods. Participants in this session engaged in activities to support the implementation of the program.
8. Health behavior change	This session focused on teaching strategies, health promotion model, and social cognitive theory to be used in the classroom. The participants engaged in techniques of decision-making, refusal skills, and communication.
9. Linking best practice to practice: incorporating characteristics of effective interventions in reducing sedentary behavior in the classroom	A variety of strategies to reduce sedentary behavior such as screen exposure time were analyzed. Participants in this session engaged in activities to support the implementation of the program.
10. Assessment of the training program	Global assessment of the training program was carried out.
11 and 12. Working with the families	This session provided healthy cooking and strategies to get children and families involved in healthy cooking.

day. Serving was considered one cup equivalent and was estimated calculating the grams of intake of each food and applying common serving sizes.

Adequacy comprised the vegetable group, fruit, grain, fiber, protein, iron, calcium, and vitamin C. The scores of the eight components in the category were assigned on the basis of the percentage attainment of the recommended intakes on a continuous scale, which ranges from 0 points (0%) to 5 points (100%).

Moderation included the total fat, saturated fat, cholesterol, sodium, and empty-calorie foods categorized into tiers. Empty-calorie foods in this study was obtained from higher fat baked goods, including desserts such as cakes, cookies, and brownies; candy (all types) and sweetened gum; dairy-based desserts (e.g., ice cream); French fries and similar products; and chips and salty snacks (e.g., potato chips, corn chips, and "buttered" popcorn). Each group ranged from 0 to 6 points.

Finally, overall balance of diet included the proportionality of energy source of the macronutrient and fatty acid (Kim et al., 2003).

The score for each component was the sum of scores for each group in that component. The total DQI-I score (range 0-100 points) was the sum of scores of the four components (Kim et al., 2003).

Statistical Analyses

Data are presented according to mean (*SD*) or *n* (%) where appropriate. Student *t* tests, Mann–Whitney *U*, Kruskall–Wallis and chi-square tests were used to compare several variables grouped by intervention and control groups and gender. These tests were also conducted to assure comparability of food and nutrients components between groups at baseline. A .05 level of significance was considered.

Schools were randomized according to a random number generator, with blinding to schools. The effect of the program was evaluated based on changes in adequacy and moderation components from DQI-I, comparing intervention to control schools. The tests examining these differences were developed using generalized linear models and took into account the nested nature of the data (children were nested within schools). The adjustment was made for gender (boy vs. girl), age, school, baseline energy intake, parents' education, weight status, Physical Activity Index, underreporting (ratio of EI:BMR), and baseline measures of the dependent variable. Baseline values were used as covariates to control of any differences between participants on these variables prior to the intervention.

The data analysis was performed using SPSS, Version 21.0 (SPSS Inc., Chicago, IL).

➤ RESULTS

Table 2 shows the anthropometric and sociodemographic characteristics of the participants, before and after the intervention. At baseline, subjects included 239 (51.5%) girls, with 8.3 (1.2) years. As there were no differences between genders, data from boys and girls are shown combined.

The average BMI was 17.9 (3.4) kg/m^2, ranging from 11.9 to 26.9 kg/m^2 and mean BMI *z* score was 0.8 (1.1). Overall, 23.3% of the children were classified as overweight and 9.5% as obese. The large majority (91.6%) of the children were classified as sedentary or having low activity. Mean energy intake was not statically significantly different (p = .257) between intervention and control groups at baseline: 2,091 (684) kcal versus 2,024 (582) kcal, respectively.

There were significant differences between groups with regard to mothers' (p = .021) and fathers' (p = .003) education levels, which were higher in the intervention group. To account for these differences at baseline, these variables were controlled for in subsequent analyses. In addition, there were significant differences regarding final score of DQI-I and moderation, as well as calcium intake, energy from fat, saturated fat, and empty-calorie foods between intervention and control group (Table 3). Further analyses were developed with the components that were not significant at the baseline.

We analyzed the effect of the intervention on food and nutrient components, expecting that intervened children could benefit from the intervention program. Intervened children reported a significant higher adequacy in vegetable group compared with the controllers after adjusting for confounders (p = .018; Table 4). Regarding moderation, intervened children reported a significantly moderation on sodium component compared with the control group after adjusting for confounders (p = .032; Table 4). No effect was observed on the other components of DQI-I.

➤ DISCUSSION

Our study showed that an intervention program, delivered and taught by teachers trained in nutrition, is effective in vegetables adequacy and sodium moderation intake among schoolchildren. The vegetable group adequacy was significantly higher in the intervention group compared with the control, after adjusting for confounders. In addition, the sodium moderation was significantly higher for intervened children compared to the controllers. This is particularly meaningful because previous school-based interventions had a minimal impact on vegetables intake (Evans et al., 2012).

It is well known that a reduction in sodium intake has been associated with a fall in blood pressure (He & MacGregor, 2006). Previous studies also identified a positive correlation between salt intake and fluid consumption but considered salt a predictor of sugar-sweetened beverages intake (Grimes, Riddell, Campbell, & Nowson, 2013). Therefore adequacy in vegetable consumption and moderation of sodium intake may help, at least in part, prevent chronic diseases.

It was observed a significant difference regarding calcium consumption. However, the consumption of calcium in both groups met the daily recommended allowances. The inadequacy of calcium intake (with a consumption higher than the recommended levels) was significantly higher in control group after the intervention (χ^2 = 10.788, p = .001; data not shown).

The lack of more differences between groups could have resulted in a modest benefit among recipients of the program; however, it is well known that the nutritional improvement of cumulative small dietary changes should not be underestimated (Paineau et al., 2010). Beside the effect on vegetables adequacy, no effect was observed on fruit consumption, which underscores the need to improve the intervention program toward, for example, an exposition of school-

TABLE 2
Characteristics of the Sample at Baseline and Postintervention

	Baseline			*Postintervention*		
Characteristic	*Intervention,* n = *231*	*Control,* n = *233*	p	*Intervention,* n = *151*	*Control,* n = *143*	p
Boys, *n* (%)[a]	116 (49.8)	109 (47.2)		76 (50.3)	68 (47.6)	
Girls, *n* (%)[a]	117 (50.2)	122 (52.8)	.575	75 (49.7)	75 (52.4)	.634
Age (years)[b]	8.3 (1.2)	8.2 (1.2)	.846	9.2 (0.9)	9.1 (1.0)	.494
Mother's education in years, *n* (%)[b]						
≤9	116 (58.6)	128 (69.9)		77 (59.2)	81 (69.8)	
10-12	52 (26.3)	36 (19.7)		32 (24.6)	26 (22.4)	
>12	30 (15.2)	19 (10.4)	.021	21 (16.2)	9 (3.7)	.050
Father's education in years, *n* (%)[b]						
≤9	122 (62.9)	132 (75.9)		84 (65.6)	82 (74.5)	
10-12	39 (20.1)	31 (17.8)		24 (18.8)	20 (18.2)	
>12	33 (17.0)	11 (6.3)	.003	20 (15.6)	8 (3.4)	.087
Physical Activity Index, *n* (%)[b]						
Sedentary	23 (14.0)	21 (15.6)		5 (5.9)	6 (7.1)	
Low activity	82 (50.0)	72 (53.3)		40 (47.1)	48 (56.5)	
Moderately active	49 (29.9)	35 (25.9)		30 (35.3)	26 (30.6)	
Vigorously active	10 (6.1)	7 (5.2)	.398	10 (11.8)	5 (5.9)	.133
International Obesity Task Force, *n* (%)[b]						
Underweight	7 (1.5)	10 (2.1)		2 (0.7)	0 (0.0)	
Normal	138 (29.7)	157 (33.8)		95 (62.9)	90 (62.9)	
Overweight	67 (14.4)	41 (8.8)		44 (29.1)	40 (28.0)	
Obesity	21 (4.5)	23 (5.0)	.054	10 (6.6)	13 (9.1)	.610

NOTE; Sample sizes correspond to all the children that involved the study and vary according to missing and new data.
[a]Results from χ^2 test. [b]Results from Mann–Whitney test.

teachers to fruit consumption (Perikkou, Gavrieli, Kougioufa, Tzirkali, & Yannakoulia, 2013). Taking into account that early food experiences influence later food preferences and dietary patterns (Birch et al., 2007), children in the age-group of this study should be confident about their healthy food choices before they achieve higher levels.

The present study has important strengths that should be acknowledged. First, to the best of our knowledge, this is the first work that included the intervention program in the progression of a teaching career. This probably motivated teachers to increase their interest in the delivery of the intervention. Many teachers often feel they work in a vacuum because they teach a complex subject such as healthy lifestyles. This intervention program offered an opportunity for teachers realize they are not alone. Second, this intervention benefits from the long-term in-service training, and the subsequent network developed between teachers, researchers, and children. We believe the period of the intervention program allowed the teachers to recognize how important healthy eating and physical activity are. Our approach was to standardize recommendations to teachers, allowing them enough flexibility to create interactive interventions and pedagogic instruments to be used with children. This is contrary to previous school-based interventions that have used tight controls to ensure uniform implementation but required frequent staff training and ongoing supports (Hoelscher et al., 2004). Underreporting among participants is common in nutritional studies (Fisher, Johnson, Lindquist, Birch, & Goran, 2000) and by using it as a

TABLE 3
DQI-I Scores and Components According to Groups of Schools at Baseline

Component	*Score Ranges (Points)*	*DQI-I Score Between Groups*		p
		Control	*Intervention*	
N		231	233	
DQI-I score	0-100	43.4 (8.3)	45.4 (7.8)	.017
Variety score	0-20	12.9 (3.7)	13.4 (3.2)	.393
Adequacy score	0-40	17.8 (3.2)	18.1 (3.0)	.566
Moderation score	0-30	10.9 (4.1)	12.2 (3.8)	.001
Overall balance score	0-10	1.1 (1.9)	1.5 (2.1)	.057
DQI components				
Vegetable	0-5	0.31 (0.59)	0.34 (0.45)	.537
Fruit	0-5	2.56 (1.87)	2.47 (1.73)	.623
Grain	0-5	3.14 (0.88)	3.12 (0.97)	.843
Fiber	0-5	3.03 (1.14)	3.07 (1.03)	.807
Protein	0-5	4.95 (0.23)	4.99 (0.06)	.058
Iron	0-5	1.40 (0.67)	1.46 (0.72)	.315
Calcium	0-5	2.04 (0.90)	2.19 (0.84)	.044
Vitamin C	0-5	0.45 (0.42)	0.48 (0.36)	.103
Total fat	0-6	1.31 (1.56)	1.79 (1.60)	.001
Saturated fat	0-6	2.56 (1.91)	3.10 (1.79)	.003
Cholesterol	0-6	3.16 (1.55)	3.12 (1.54)	.638
Sodium	0-6	3.33 (1.59)	3.43 (1.47)	.525
Empty-calorie foods	0-6	0.57 (1.21)	0.76 (1.21)	.028

NOTE: DQI-I = Diet Quality Index–International. Values expressed as *M* (*SD*). *p* value from *t* test or Mann–Whitney.

TABLE 4
Estimated Difference in Dietary Intakes Based on DQI-I at Postintervention

Component	*Control*, N = *134*[a]	*Intervention*, N = *143*[a]	*Adjusted Difference* (SE)[b]	*Adjusted* p[b]
Adequacy				
Vegetable group	0.46 (0.54)	0.64 (0.89)	−0.27 (0.12)	.018
Fruit group	2.59 (1.72)	2.40 (1.70)	−0.14 (0.12)	.474
Grain group	3.24 (0.88)	2.89 (0.98)	0.27 (0.20)	.177
Dietary fiber	3.11 (1.01)	3.03 (1.05)	0.03 (0.15)	.851
Energy from protein	4.97 (0.22)	4.98 (0.15)	0.01 (0.03)	.841
Iron	1.67 (0.79)	1.70 (0.86)	−0.07 (0.11)	.523
Vitamin C	0.52 (0.35)	0.56 (0.57)	−0.07 (0.08)	.396
Moderation				
Cholesterol	3.25 (1.74)	3.02 (1.77)	0.29 (0.26)	.268
Sodium	2.86 (1.74)	2.98 (1.74)	−0.55 (0.26)	.032

NOTE: DQI-I = Diet Quality Index–International.
[a]Values expressed as *M* (*SD*). [b]Adjusted for school, gender, age, baseline energy intake, parents' education, weight status, Physical Activity Index, underreporting (ratio of ratio energy intake:basal metabolic rate), and baseline measures of the dependent variable.

covariate we were able to control the latent effect of misreporting on any reported association.

There are some limitations that should be mentioned. Measurement error is a problem in dietary intake; however, previous studies used 24-hour dietary recalls to assess children's diets and validated for energy intake using doubly labeled water (Burrows, Martin, & Collins, 2010). Furthermore, because sodium was assessed by using the 24-hour dietary recall method, reported salt intake does not include salt added at the table or during cooking. Nevertheless sodium intake in this study far exceeds nutritional recommendations (World Health Organization, 2003) and is in line with previous studies (Grimes et al., 2013). It is possible that our sample size was not enough to detect other significant differences than those reported. We failed to get identically equivalent groups after randomization, namely, in the level of parents' education, children's height, DQI-I score, moderation score, calcium intake, total fat, and saturated fat as well as empty-calorie foods, mainly because we randomized by school and not by subjects, in order to avoid cross-contamination between intervention and control groups. Parents' education and height were taken in account in all the statistical models, and the analysis was further developed according to the components of the index (food and nutrient intake) that were not significantly different at baseline. Another weakness is that we have not explored whether there were differences among the schools selected for the study and those who were not selected, due to resource constraints. However, schools were from the same geographical area, and to the best of our knowledge, no data are available reporting significant sociodemographic and income differences. Also, physical activity levels were obtained on self-reported data, making possible recall bias and overestimation. However, the questionnaire was validated for Portuguese adolescents (Mota & Esculcas, 2002) and we have no reason to assume that these biases would affect groups differently.

➤ CONCLUSION

Findings from this analysis suggest that an educational program, delivered by trained teachers, is effective in vegetables adequacy and sodium moderation intake among schoolchildren. The study reported herein has some profitable directions for future research. We consider that this approach could be experienced in other primary schools and settings, in order to ensure that all teachers are capable of providing youth with food and nutrition information. However, future directions should focus on other aspects like identifying, the types of foods consumed at home, school, and other locations with their impact in dietary quality. In addition, these findings underscore the need to enhance policies and educational programs to encourage healthier food choices among children and families.

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