Preventive Medicine 57 (2013) 20–25

Contents lists available at SciVerse ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Impact of an intervention through teachers to prevent consumption of low nutrition, energy-dense foods and beverages: A randomized trial☆

Rafaela Rosário [a,b,*], Ana Araújo [b], Bruno Oliveira [c], Patrícia Padrão [c,d], Oscar Lopes [e], Vítor Teixeira [c,f], André Moreira [g], Renata Barros [c], Beatriz Pereira [b], Pedro Moreira [c,d,f]

[a] University of Minho, School of Nursing, Largo do Paço 4704-553 Braga, Portugal
[b] University of Minho, School of Education, Research Centre in Child Studies, Campus de Gualtar 4710-057 Braga, Portugal
[c] University of Porto, Faculty of Nutrition and Food Sciences, Rua Roberto Frias, 4200-465 Porto, Portugal
[d] University of Porto, Institute of Public Health, Rua das Taipas,135, 4050-600 Porto, Portugal
[e] Sport Medical Center of Minho (CMDM), Rua do Centro Cultural e Social de Santo Adrião, s/nª, 4715-016 Braga, Portugal
[f] University of Porto, Research Centre in Physical Activity, Health and Leisure, Rua Dr. Plácido Costa, 91, 4200-450 Porto, Portugal
[g] University of Porto, Faculty of Medicine, Al. Prof. Hernâni Monteiro 4200 - 319 Porto, Portugal

ARTICLE INFO

Available online 11 April 2013

Keywords:
LNED foods and beverages
Children
School-based intervention
Trained teachers

ABSTRACT

Objective. To examine the effects of an intervention program held by teachers previously trained in nutrition, on the consumption of low nutrient, energy-dense (LNED) foods, of children attending elementary schools.

Method. 464 children (239 female, 6 to 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 and healthy eating 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 two groups of LNED foods were defined, namely SSBs and solid LNED foods.

Results. Children from intervention group reported a reduction whereas the control group reported an increase in solid LNED foods consumption. The odds of increasing solid LNED foods consumption was 0.48, 95%CI (0.24, 0.95) in the intervention schools.

Conclusion. Our study provides further support for the success of intervention programs aimed at limiting the consumption of solid LNED foods in children.

Introduction

Healthy eating habits are essential to reduce children's risk of health problems. Epidemiological data suggests that diets rich in fruit and vegetables and poor in energy-dense foods protect against numerous conditions, including cardiovascular diseases and certain types of cancers (Oliveira et al., 2010; Tantamango et al., 2011). However, recent data shows that about one quarter of daily energy intake in US public school children are categorized as low nutrient energy-dense (LNED) foods or beverages (Briefel et al., 2009b) which may be available as a part of a school meal (Condon et al., 2009) or be easily accessible (Kant, 2003). LNED foods or beverages contain both fat and sugar, whose tastes are immediately appealing even to young children (Drewnowski and Bellisle, 2007). Examples of these foods include sugar-sweetened beverages (SSBs), salty/high-fat chips, high fat baked goods, desserts, breakfast pastries, cookies, and French fries.

Low nutrient energy-dense foods may facilitate overconsumption and excessive energy intake (Rolls, 2012) which may lead to overweight and childhood obesity (Rolls, 2012; Vernarelli et al., 2011). Furthermore, it is known that energy consumed as beverages may be especially problematic for weight gain (Houchins et al., 2012). Therefore, science-based strategies that decrease the availability of LNED foods and beverages or prevent their consumption among children are warranted.

There is evidence that habits acquired in early life might track into adulthood (Lien et al., 2001; Lytle et al., 2000; te Velde et al., 2007). Schools can play an important role in shaping the eating and physical activity behaviors of students (Anderson et al., 2005; Eisenmann et al., 2008; James et al., 2004; Khambalia et al., 2012; Rosário et al., 2012), such as improving the adequacy of nutrient intake by reducing consumption of LNED foods or beverages (Briefel et al., 2009b). In this context, some recent data point that policies which limit sale of SSBs in schools may be a promising strategy (Cradock et al., 2011).

☆ ClinicalTrials.gov Identifier: NCT01397123.

* Corresponding author at: Universidade do Minho, Escola Superior de Enfermagem, Largo do Paço 4704-553 Braga, Portugal. Fax: +351 253601319.
E-mail address: rrosario@ese.uminho.pt (R. Rosário).

0091-7435/$ – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.ypmed.2013.02.027

Until now, it is unclear the role of teachers in the delivery features of the interventions and its impact on child's LNED consumption (Sharma, 2006; Stice and Marti, 2006). Although teachers are not able to devote as much time and energy to provide interventions, at least theoretically, because they have many responsibilities in the classroom besides the implementation of the program (Stice and Marti, 2006), other studies consider them dedicated interventionists (Sharma, 2006). There are few, if any, examples of studies that consider the program to have impact on the progression of teaching career. More, few studies have examined the effects of the educational program on LNED consumption (Kant, 2003), as well as have realized teachers and children's needs.

The purpose of the present study is to examine the effects of a six months dietary education intervention program, delivered and taught by trained teachers, on consumption of LNED foods and beverages in children 6 to 12 years.

Methods

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 (Fig. 1). Prior 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 where the study was carried out, and the Portuguese Data Protection Authority (CNPD—Comissão Nacional de Proteção de Dados, process number 7613/2008) approved the study. In addition the protocol for this study was registered in the clinical trials registry clinicaltrials.gov, NCT01397123.

Of the 574 children who were invited to participate, 464 (239 female), aged 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. Children are 6–12 years because some of them have been disapproved and repeated one of the grades. 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%).

Evaluation at baseline included children from 1 to 4 grades (during 2007/2008) whereas the intervention and thus the evaluation post intervention included the same children attending the same school in the subsequent (2008/2009) school year. That means that children that finished the grade 4 at the end of 2007/2008 were not included in the intervention program, since they had to move to another school in grade 5. Nevertheless, all the statistical analyses involved only children evaluated at baseline and after the intervention, in order to prevent possible bias. Furthermore, sociodemographic, BMI, energy intake and LNED foods and beverages consumption at baseline did not vary between the children involved in the study and those who were transferred. Therefore, this did not affect the population studied.

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 post-intervention, i.e., 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 fifteen agreed to be involved. In Portugal, children from elementary schools have only one teacher who teaches a range of subjects. Teachers have the ability to work in a global perspective the process of children's living and learning and the skills to implement strategies in childhood basic education, overseen by the Minister of Education. The 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 sessions delivered to

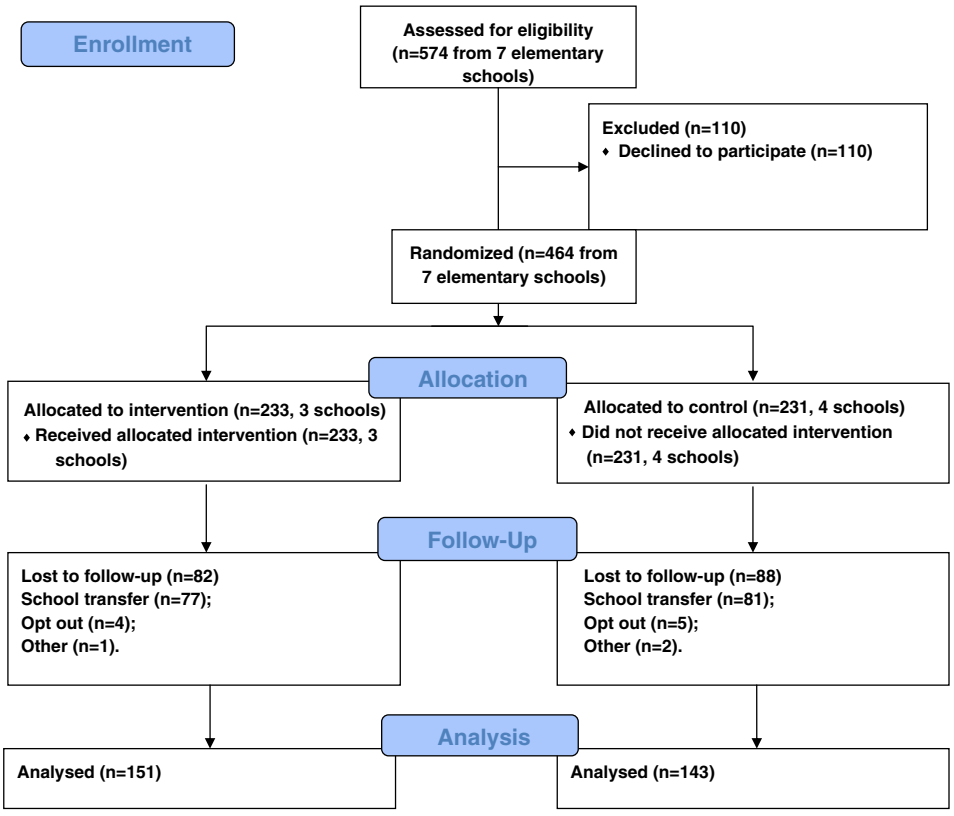

Fig. 1. Flow of participants through each stage of the program.

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 a 72 hour duration. The program was implemented over two terms: (1) teachers' training delivered by researchers during October 2008 and March 2009; and (2) intervention delivered to children by trained teachers during November 2008 and March 2009.

Teachers of the intervention group attended twelve sessions with 3 h each with the study researchers during six months, which included the following contents: session 1, health promotion and overweight and obesity prevention; sessions 2, 3, and 4, key concepts in food and nutrition and dietary guidelines (the Portuguese Food Wheel); session 5, hydration and the importance of water; sessions 6 and 7, appropriate physical activity levels and healthy eating practices; session 8, teaching and learning strategies on healthy eating in the classroom; session 9, strategies to reduce screen time; session 10, global assessment of the training program; sessions 11 and 12, healthy cooking and strategies to get children and their families involved in healthy cooking. There were no substitute teachers during the training because it was performed after the day work (from 5.30 pm to 8.30 pm).

After each session with the researchers, teachers delivered the learnt contents to their students and developed creative and engaging classroom activities about the addressed topic. All the questions that arose during the implementation of classroom activities were addressed and resolved shortly with the researchers. The autonomy of teachers in the training process was preserved and they were allowed to expand the learning strategies that were proposed by the researchers. 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 (WHO Expert Commitee, 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. BMI was computed as mass, (kg)/height^2, (m). The prevalence of underweight, normal weight, overweight and obesity was calculated according to the International Obesity Task Force (IOTF) criteria, making a correspondence between the traditional adult cut-off and specific values for children according to gender and age (Cole et al., 2000). A z-score (the number of standard deviations (sd) from the reference population) was calculated for each child using the LMS method and the calculation was determined using the LMS growth add-in for excel (Pan and Cole, 2009).

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-h. Daily routines were used as prompts (waking up, going to bed, time between classes, before or after school, etc.) to enhance recall. Portion sizes were estimated using food models, photos and other props (cups, glasses, food wrappers or containers) as an aid. Energy and nutritional intake were estimated using the nutritional analysis software Food Processor Plus (ESHA Research Inc., Salem, OR, USA), which was added with Portuguese foods and recipes.

The 24-hour dietary recall interviews captured the time, type, location, and the foods and beverages at each eating occasion. Data from the 24-hour dietary recall regarding LNED foods or beverages was analyzed according to previously studies (Briefel et al., 2009b; Kant, 2003), which considered SSBs (soda, fruit flavored sweetened beverages, "energy" and sports drinks, and sweetened iced teas) as well as solid LNED foods. These foods were classified into five mutually exclusive categories: 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 fried and similar products; and chips and salty snacks (e.g., potato chips, corn chips, and "buttered" popcorn).

In order 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 et al. (1997) and previously applied to the Portuguese population (Mota and Esculcas, 2002). Overall a maximum of 20 points could be reached. A Physical Activity Index was obtained dividing the total score of the questionnaire into four levels of activity: sedentary group [5]; low activity group [6–10]; moderately active group [11–15]; and vigorously active group [16–20], on the basis of their reported physical activity (Mota and Esculcas, 2002; Raitakari et al., 1994).

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, 10–12 years, and more than 12 years of education.

Statistical analyses

Mean and sd were used to describe continuous variables. Student's 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 LNED consumption between groups at baseline. A 0.05 level of significance was considered.

Schools were randomized according to a random number generator, with blinding to schools. To estimate the magnitude of change during the study a new dichotomous variable was computed, reproducing an increase in the consumption of solid LNED foods and SSBs. This variable was analysed by binary outcomes and adjusted for gender (boy versus girl), age, school, baseline energy intake, parents' education, weight status, Physical Activity Index 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.

In addition, the effect of the program was also evaluated based on changes in solid LNED foods and LNED beverages (both in gram weight) consumption between baseline and post intervention, comparing intervention to control schools. Normality was assessed by skewness and kurtosis coefficients. We observed that the deviation for normality appeared in variables with positive skewness. Hence, we decided to use a log transformation in the variables LNED foods and beverages, which became closed to the normal distribution. 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). Hence, solid LNED foods and LNED beverages consumption were used as dependent variable and the adjustment was made for the same variables mentioned previously.

The data analysis was performed using SPSS ®, Version 18.0 (SPSS Inc; Chicago, IL).

Results

Tables 1 and 2 show the anthropometric and socio-demographic characteristics of the participants, before and after intervention. At baseline, subjects included 239 girls and 225 boys, with an age of 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 ($p = 0.257$) between intervention and control groups at baseline [respectively, 2091 (684) kcal versus 2024 (582) kcal].

There were significant differences between groups with regard to mother ($p = 0.021$) and father ($p = 0.003$) education levels, which were higher in the intervention group. To account for these

Table 1
Characteristics of the sample at baseline and post-intervention. Portugal 2007–2009.

	Baseline			Post-intervention		
	Intervention n = 231	Control n = 233	p	Intervention n = 151	Control n = 143	p
Age (years)[a,b]	8.3 (1.2)	8.2 (1.2)	0.846	9.2 (0.9)	9.1 (1.0)	0.494
BMI (kg/m^2) [a,b]	18.1 (2.7)	17.7 (2.8)	0.062	18.7 (2.6)	18.7 (2.7)	0.966
Energy intake (kcal/day) [a,b]	2091 (683.9)	2024.2 (581.8)	0.257	2388.0 (1036.5)	2475.6 (684.9)	0.049
Solid LNED foods (g) [a,c]	129.9 (131.3)	144.5 (127.8)	0.144	138.4 (138.9)	169.0 (139.5)	0.026
LNED SSBs (g) [a,c]	110.1 (157.2)	129.9 (174.8)	0.150	227.0 (263.6)	243.3 (303.8)	0.796
Boys [d]	116 (49.8)	109 (47.2)		76 (50.3)	68 (47.6)	
Girls [d]	117 (50.2)	122 (52.8)	0.575	75 (49.7)	75 (52.4)	0.634
Mother's education [d]						
Up to 9 years	116 (58.6)	128 (69.9)		77 (59.2)	81 (69.8)	
10–12 years	52 (26.3)	36 (19.7)		32 (24.6)	26 (22.4)	
>12 years	30 (15.2)	19 (10.4)	0.021	21 (16.2)	9 (3.7)	0.050
Father's education [d]						
Up to 9 years	122 (62.9)	132 (75.9)		84 (65.6)	82 (74.5)	
10–12 years	39 (20.1)	31 (17.8)		24 (18.8)	20 (18.2)	
>12 years	33 (17.0)	11 (6.3)	0.003	20 (15.6)	8 (3.4)	0.087
Physical Activity Index [d]						
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)	0.398	10 (11.8)	5 (5.9)	0.133
IOTF [d]						
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)	0.054	10 (6.6)	13 (9.1)	0.610

IOTF (International Obesity Task Force) criteria (Cole et al., 2000).
Sample sizes correspond to all the children that involved the study and vary according to missing and new data.
[a] Continuous variables; results expressed as mean (sd).
[b] p value from t-test.
[c] p value from Mann Whitney test.
[d] Categorical variables; results expressed as n (%); p value from χ^2 test.

differences at baseline, these variables were controlled for in subsequent analyses.

Also, as we can see in Table 1 no significant differences were found on LNED foods and beverages consumption at baseline between intervention and control groups.

We analyzed the effect of the intervention in solid LNED foods and SSBs consumption, expecting that intervened children could benefit from the intervention. Overall, children from intervention group reported a reduction whereas the control group reported an increase in solid LNED foods consumption. These differences were significant after controlling for confounders (p = 0.031), Table 2. No effect was observed on SSBs.

Table 2
Impact of the intervention on sugar-sweetened beverages (SBBs) and solid low-nutrient, energy-dense (LNED) foods in children. Portugal 2007–2009.

Measure	Baseline mean (g)[a]	Post-intervention mean (g)[a]	Post-intervention adjusted mean[a, b]	(95% CI)	Adjusted p
Solid LNED foods					
Control	92.3	97.9	116.8	(92.9; 146.8)	0.031
Intervention	83.8	78.7	82.9	(67.2; 102.2)	
LNED SSBs					
Control	225.1	245.0	240.5	(183.0;316.1)	0.578
Intervention	240.1	261.3	271.6	(196.5;375.5)	

Notes: LNED items include SSBs (e.g., carbonated soft drinks, fruit-flavored juice drinks, lemonades, sweetened teas, and "energy" or "sports drinks"), chips (e.g., regular, not lower-/reduced-fat), cookies, ice cream, cake-types desserts, pastries, donuts, candy, energy bars, French fries/similar potato products, butter, sugar, mayonnaise, oil.
[a] Geometric mean.
[b] Adjusted for school, gender, age and baseline energy intake, parents' education, weight status, Physical Activity Index and baseline measures of the dependent variable.

In addition significantly fewer children from intervention schools reported an increase in solid LNED foods compared to the control group (Table 3). After controlling for confounders, the predicted odds of increasing solid LNED foods consumption was 52% lower in the intervention group (OR: 0.48, 95% CI: 0.24, 0.95; p = 0.036).

Discussion

Our study showed that a nutrition program, delivered and taught by in-service teachers trained in nutrition is effective in attenuating the increase in solid LNED foods consumption among schoolchildren. Intervened children reported a reduction while the control schools an increase in solid LNED foods consumption. This is noteworthy

Table 3
Odds ratio for solid LNED foods and SSBs consumption.

Measure	Sample, n	Increased consumption		Adjusted odds ratio (95% CI)[a]	p
		No n (%)	Yes n (%)		
Solid LNED foods					
Control	143	63 (44.1)	80 (55.9)	1.00	0.036
Intervention	151	78 (51.7)	73 (48.3)	0.48 (0.24; 0.95)	
SSBs					
Control	143	67 (46.9)	76 (53.1)	1.00	0.258
Intervention	151	76 (50.3)	75 (49.7)	1.66 (0.69;3.96)	

N = 294 (individuals with data at baseline and post-intervention. The increased consumption of solid LNED foods and SSBs was based on individuals who increased the consumption of LNED from baseline to post-intervention.
[a] Odds were adjusted for gender, age, baseline energy intake, parents' education, weight status and Physical Activity Index and baseline measures of the dependent variables.

because some studies (Briefel et al., 2009a,b; Kant, 2003) indicate that LNED foods and beverages are widely consumed by children and, therefore, interventions such as ours may contribute to, at least, prevent the intake of high-fat/high-sugar containing foods. In contrast, the intervention had no effect on SSBs probably because children are not able to distinguish natural fruit juice from other fruit drinks high in sugar or lemonades (Wind et al., 2005).

It has been questioned if teachers have enough time and energy to provide interventions as dedicated interventionists (Sharma, 2006; Stice and Marti, 2006). This study contributes to clarify the scant evidence of the effect of nutrition education-only programs delivered by teachers, and provides support for their role in improving children's eating habits. Moreover, the educational sessions provided by the researchers prior the intervention with children supported the information to be properly applied in the school's curriculum. Teachers, in turn, were able to adapt the topics in the classroom throughout the year and not just in a single moment or a specific session. Although the results of this program cannot be extrapolated to demonstrate life-long changes in eating habits, it does show the ability of an education program to impact on diet at a crucial life stage when eating habits are being formed.

Reducing easy access to energy dense foods may help to limit the opportunities of overeating and, therefore, at least in part prevent the overweight or obesity epidemic. In addition, taking into account that the food environment tends to be less healthy in higher-grade levels (Finkelstein et al., 2008), and that early food experiences influence later food preferences and dietary patterns (Skinner et al., 2002), children in the age group of this study have to be confident about their healthy food choices before they achieve higher levels. Further, the consequences of LNED consumption (Malik et al., 2006; Vartanian et al., 2007) and the likely control that parents have over child's experiences with foods, encourages the development of public health interventions involving and educating parents about the health consequences of high consumption of solid LNED foods and beverages. Furthermore, the population awareness of the dangers associated to LNED consumption should be considered a priority as stated in other studies (Hafekost et al., 2011).

Strengths and limitations

The present study has important strengths that should be acknowledge. Firstly, to the best of our knowledge this is the first work that included the program in the progression of teaching career. This probably induced teachers to increase their motivation in the delivery of the intervention. Secondly, this intervention benefits from the long-term in-service training, and the subsequent network developed between teachers, researchers and children. In Portugal, university education degrees do not have health promotion subjects in their academic curricula (Precioso, 2004), neither are considering change in that direction (Rodrigues et al., 2007). Being aware of this need and that long-term programs are more effective than those of short duration (Stice and Marti, 2006), we promoted a six-month duration training program with the expectation that teachers could become nutrition educators. We believe this period allowed the teachers to recognize how important healthy eating and physical activity are. Thirdly, 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 (Anderson et al., 2005; Hoelscher et al., 2004; Sallis et al., 2003). In addition, we believe that this approach could be disseminated to other school districts with focus on other aspects like school environment and environments beyond the school (e.g., corner stores and homes). Finally, the nature of this study may be considered powerful and robust.

However, our study also has some limitations that should be mentioned. One of the weaknesses 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 resources constraints. However, schools were from the same geographical area and, to the best of our knowledge, no data is available reporting significant socio-demographic and income differences. It is possible that our sample size was not enough to detect other significant differences than those reported. Furthermore, we failed to get identically equivalent groups after randomization, namely in the level of parents' education, mainly because we randomized by school and not by subjects, in order to avoid cross contamination between intervention and control groups. Nevertheless, these differences were taken into account in all of the statistical models. Also, physical activity levels were obtained upon self-reported data making possible recall bias and overestimation. However, the questionnaire was validated for Portuguese population (Mota and Esculcas, 2002) and we have no reason to assume that these biases would affect groups differently. Finally, although being recommended by EFSA that the dietary record method should be used when assessing children (European Food Safety Authority, 2009), we used a single 24 h dietary recall and not at least two days, limiting the possibility to adjust for intra-individual variability and to estimate habitual intake (European Food Safety Authority, 2009). Nevertheless, estimations of dietary intake of four- and eight-year-old children obtained by 24-h dietary recalls may be related to those of seven-day records from the same individuals (Persson and Carlgren, 1984). Furthermore, given that parents are reliable reporters of their children's food intake only for food eaten at home, and that most of parents now work out-of-home, we decided to use 24 h dietary recalls, as performed in other studies (Briefel et al., 2009b; Moreira et al., 2005). Furthermore, children grow over time and thus are expected to consume more energy, which was not taken into account. However, these two last limitations affected both groups of children and though are not expected to influence the results.

Conclusion

Findings from this analysis suggest that an educational program, delivered by trained teachers is effective in attenuating the intake of solid LNED foods among children. The study reported herein has some profitable directions for future research. We consider that this approach could be disseminated to other school districts. However, future directions should focus on other aspects like school environment, physical education classes or on the environment beyond the school, such as homes and stores.

Conflict of interest

The authors declare that there are no conflicts of interest.

Acknowledgments

We express our deepest appreciation to all the collaborators who assisted the development and implementation of the study, namely Célia Oliveira, Fernando Ferreira and Elisete Ferreira. Special thanks are extended to Dra. Paula Neves and Dr. Benjamim Sampaio for the assistance provided throughout this program. Our grateful acknowledgment goes to all the children and their parents for the participation in this study, school administrators and school staff for the opportunity of the implementation of the study.

This work was supported by the Fundação para a Ciência e Tecnologia (FCT), Projeto PEst-OE/SAU/UI0617/2011.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ypmed.2013.02.027.

References

Anderson, A., Porteous, L., Foster, E., et al., 2005. The impact of a school-based nutrition education intervention on dietary intake and cognitive and attitudinal variables relating to fruits and vegetables. Public Health Nutr. 8, 650–656.

Bandura, A., 1986. Social Foundations of Thought and Action: A Social Cognitive Theory. Prentice-Hall, New Jersey.

Briefel, R., Crepinsek, M., Cabili, C., Wilson, A., Gleason, P., 2009. School food environments and practices affect dietary behaviors of US public school children. Am. Diet. Assoc. 109, S91–S107.

Briefel, R., Wilson, A., Gleason, P., 2009. Consumption of low-nutrient, energy-dense foods and beverages at school, home, and other locations among school lunch participants and nonparticipants. J. Am. Diet. Assoc. 109, S79–S90.

Cole, T.J., Bellizi, M.C., Flegal, K.M., Dietz, W.H., 2000. Establishing a standard definition for child overweight and obesity worldwide: international survey. Br. Med. J. 320, 1–6.

Condon, E.M., Crepinsek, M.K., Fox, M.K., 2009. School meals: types of foods offered to and consumed by children at lunch and breakfast. J. Am. Diet. Assoc. 109, S67–S78.

Cradock, A.L., McHugh, A., Mont-Ferguson, H., et al., 2011. Effect of school district policy change on consumption of sugar-sweetened beverages among high school students, Boston, Massachusetts, 2004–2006. Prev. Chronic Dis. 8, A74.

Drewnowski, A., Bellisle, F., 2007. Liquid calories, sugar, and body weight. Am. J. Clin. Nutr. 85, 651–661.

Eisenmann, J.C., Gentile, D.A., Welk, G.J., et al., 2008. Switch: rationale, design, and implementation of a community, school, and family-based intervention to modify behaviors related to childhood obesity. BMC Public Health 8.

European Food Safety Authority, 2009. General principles for the collection of national food consumption data in the view of a pan-European dietary survey. EFSA J. 7, 1435–1486.

Finkelstein, D.M., Hill, E.L., Whitaker, R.C., 2008. School food environments and policies in US public schools. Pediatrics 122, e251–e259.

Hafekost, K., Mitrou, F., Lawrence, D., Zubrick, S.R., 2011. Sugar sweetened beverage consumption by Australian children: implications for public health strategy. BMC Public Health 11, 950.

Hoelscher, D., Feldman, H., Johnson, C., et al., 2004. School-based health education programs can be maintained over time: results from the CATCH institutionalization study. Prev. Med. 38, 594–606.

Houchins, J., Burgess, J., Campbell, W., et al., 2012. Beverage vs. solid fruits and vegetables: effects on energy intake and body weight. Obesity (Silver Spring) 20, 1844–1850.

James, J., Thomas, P., Cavan, D., Kerr, D., 2004. Preventing childhood obesity by reducing consumption of carbonated drinks: cluster randomized controlled trial. BMJ 328, 1236–1239.

Kant, A.K., 2003. Reported consumption of low-nutrient-density foods by American children and adolescents: nutritional and health correlates, NHANES III, 1988 to 1994. Arch. Pediatr. Adolesc. Med. 157, 789–796.

Khambalia, A.Z., Dickinson, S., Hardy, L.L., Gill, T., Baur, L.A., 2012. A synthesis of existing systematic reviews and meta-analyses of school-based behavioural interventions for controlling and preventing obesity. Obes. Rev. 13, 214–233.

Lien, N., Lytle, L.A., Klepp, K.I., 2001. Stability in consumption of fruit, vegetables, and sugary foods in a cohort from age 14 to age 21. Prev. Med. 33, 217–226.

Lytle, L.A., Seifert, S., Greenstein, J., McGovern, P., 2000. How do children's eating patterns and food choices change over time? Results from a cohort study. Am. J. Health Promot. 14, 222–228.

Malik, V.S., Schulze, M.B., Hu, F.B., 2006. Intake of sugar-sweetened beverages and weight gain: a systematic review. Am. J. Clin. Nutr. 84, 274–288.

Moreira, P., Padez, C., Mourao, I., Rosado, V., 2005. Dietary calcium and body mass index in Portuguese children. Eur. J. Clin. Nutr. 59, 861–867.

Mota, J., Esculcas, C., 2002. Leisure-time physical activity behavior: structured and unstructured choices according to sex, age, and level of physical activity. Int. J. Behav. Med. 9, 111–121.

Oliveira, A., Lopes, C., Rodríguez-Artalejo, F., 2010. Adherence to the Southern European Atlantic Diet and occurrence of nonfatal acute myocardial infarction. Am. J. Clin. Nutr. 92, 211–217.

Pan, H., Cole, T., 2009. lmsGrowth, a Microsoft Excel add-in to access growth references based on the LMS method (Version 2.68). http://www.healthforallchildren.co.uk/.

Pender, N.J., 1996. Health Promotion in Nursing Practice, 3rd ed. Prentice Hall, New Jersey.

Persson, L.A., Carlgren, G., 1984. Measuring children's diets: evaluation of dietary assessment techniques in. Int. J. Epidemiol. 13, 506–517.

Precioso, J., 2004. Educação para a saúde na Universidade: um estudo realizado em alunos da Universidade do Minho. Rev. Electrónica de enseñanza de las ciencias 3.

Raitakari, O.T., Porkka, K.V., Taimela, S., Telama, R., Rasanen, L., Viikari, J.S., 1994. Effects of persistent physical activity and inactivity on coronary risk factors in children and young adults. The Cardiovascular Risk in Young Finns Study. Am. J. Epidemiol. 140, 195–205.

Rodrigues, V., Carvalho, A., Gonçalves, A., Carvalho, G.S., 2007. Os professores e a educação/promoção para a saúde. In: Pereira, B., Carvalho, G.S., Pereira, V. (Eds.), Novas realidades, novas práticas. Actas do seminário Internacional de Educação Física, Lazer e Saúde. Instituto de Estudos da Criança da Universidade do Minho, Braga.

Rolls, B., 2012. Dietary strategies for weight management. Nestle Nutr. Inst. Workshop Ser. 73, 37–48.

Rosário, R., Araújo, A., Oliveira, B., et al., 2012. The impact of an intervention taught by trained teachers on childhood fruit and vegetable intake: a randomized trial. J. Obes. vol. 2012. http://dx.doi.org/10.1155/2012/342138 Article ID 342138, 8 pages. (in press).

Sallis, J., McKenzie, T., Conway, T., et al., 2003. Environmental interventions for eating and physical activity, a randomized controlled trial in middle schools. Am. J. Prev. Med. 24, 209–217.

Sharma, M., 2006. International school-based interventions for preventing obesity in children. Obes. Rev. 8, 155–167.

Skinner, J.D., Carruth, B.R., Wendy, B., Ziegler, P.J., 2002. Children's food preferences: a longitudinal analysis. J. Am. Diet. Assoc. 102, 1638–1647.

Stice, E., Marti, C.N., 2006. A meta-analytic review of obesity prevention programs for children and adolescents: the skinny on interventions that work. Psychol. Bull. 132, 667–691.

Tantamango, Y.M., Knutsen, S.F., Beeson, W.L., Fraser, G., Sabate, J., 2011. Foods and food groups associated with the incidence of colorectal polyps: the adventist health study. Nutr. Cancer 1.

te Velde, S.J., Twisk, J.W., Brug, J., 2007. Tracking of fruit and vegetable consumption from adolescence into adulthood and its longitudinal association with overweight. Br. J. Nutr. 98, 431–438.

Telama, R., Yang, X., Laakso, L., Viikari, J., 1997. Physical activity in childhood and adolescence as predictor of physical activity in young adulthood. Am. J. Prev. Med. 13, 317–323.

Vartanian, L.R., Schwartz, M.B., Brownell, K.D., 2007. Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. Am. J. Public Health 97, 667–675.

Vernarelli, J., Mitchell, D., Hartman, T., Rolls, B., 2011. Dietary energy density is associated with body weight status and vegetable intake in U.S. children. J. Nutr. 141, 2204–2210.

WHO Expert Commitee, 1995. Physical Status: The Use and Interpretation of Anthropometry. WHO, Geneva.

Wind, M., Bobelijn, K., De Bourdeaudhuij, I., Klepp, K., Brug, J., 2005. A qualitative exploration of determinants of fruit and vegetable intake among 10- and 11-year-old schoolchildren in the low countries. Ann. Nutr. Metab. 49, 228–235.