

Rosário, R., Araújo, A., Padrão, P., Lopes, O., Moreira, A., Abreu, S., . . .  
Moreira, P. (2016). Impact of a school-based intervention to promote  
fruit intake: a cluster randomized controlled trial. *Public health*, 94-  
100. doi:10.1016/j.puhe.2016.03.013



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Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

## Public Health

journal homepage: [www.elsevier.com/puhe](http://www.elsevier.com/puhe)

## Original Research

# Impact of a school-based intervention to promote fruit intake: a cluster randomized controlled trial



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## ARTICLE INFO

## Article history:

Received 27 May 2015

Received in revised form

23 January 2016

Accepted 9 March 2016

Available online 18 April 2016

## Keywords:

Children

Intervention programme

Fruit for dessert

Public health

## ABSTRACT

**Objective:** There is evidence that fruit consumption among school children is below the recommended levels. This study aims to examine the effects of a dietary education intervention program me, held by teachers previously trained in nutrition, on the consumption of fruit as a dessert at lunch and dinner, among children 6–12 years old.

**Study design:** This is a randomized trial with the schools as the unit of randomisation.

**Methods:** A total of 464 children (239 female, 6–12years) from seven elementary schools participated in this cluster randomized controlled trial. Three schools were allocated to the intervention and four to the control group. For the intervention schools, we delivered professional development training to school teachers (12 sessions of 3 h each). The training provided information about nutrition, healthy eating, the importance of drinking water and healthy cooking activities. After each session, teachers were encouraged to develop classroom activities focused on the learned topics. Sociodemographic was assessed at baseline and anthropometric, dietary intake and physical activity assessments were performed at baseline and at the end of the intervention. Dietary intake was evaluated by a 24-h dietary recall and fruit consumption as a dessert was gathered at lunch and dinner.

**Results:** Intervened children reported a significant higher intake in the consumption of fruit compared to the controlled children at lunch ( $P = 0.001$ ) and at dinner ( $P = 0.012$ ), after adjusting for confounders.

**Conclusions:** Our study provides further support for the success of intervention programmes aimed at improving the consumption of fruit as a dessert in children.

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<http://dx.doi.org/10.1016/j.puhe.2016.03.013>

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## Introduction

The evidence suggests that children's consumption of fruit and vegetables is below the recommended levels.<sup>15,21</sup> It is known that human biology does not predispose children to eat the recommended amounts of fruit and vegetables and makes them especially exposed to the current food environment of foods high in refined sugars.<sup>23</sup>

Previous studies found that a western dietary pattern is characterized by the consumption of sweet desserts, which are correlated to an increase in the intake of solid fats and added sugars in children's diets.<sup>5,10,19</sup> In 2–18-year-old children, grain desserts such as cakes, cookies, doughnuts, pies, crisps, cobblers and granola bars are the top source of energy, the second major source of solid fats and third of added sugars. In addition, dairy desserts are the fourth major source of added sugars.<sup>32</sup> In Portugal, it is common to eat fruit as a dessert, at least at lunch and dinner, nevertheless total consumption of fruit is still lower than the recommended levels.<sup>20</sup> Schools in Portugal have canteens and most of the children eat there. Government recommendations provide guidelines to schools and their canteens to offer healthy food such as fruit and soup.<sup>43</sup>

There is growing evidence that childhood is an important time to establish eating behaviours. School-based intervention programmes aimed to improve students diets and reduce chronic diseases have had mixed success.<sup>2,7</sup> Some of the studies have a positive impact on fruit and vegetable consumption during the day.<sup>12,22,27,34,44</sup> However to the best of our knowledge, none of them analysed the effects of an educational programme on fruit for dessert. Until now, it is unclear the role of teachers in the delivery features of the interventions.<sup>39,41</sup> Although teachers are not able to devote as much time and energy to provide interventions as dedicated interventionists, at least theoretically, because they have responsibilities in the classroom that take precedence,<sup>41</sup> some studies consider them dedicated interventionists.<sup>39</sup> In Portugal, teachers have to attend professional development training (lifelong training) to progress in their career. There are few, if any, examples of studies that consider the programme to have impact on the progression of a teaching career. It is hypothesized that participation in this school-based intervention programme have impact on children from primary schools by increasing consumption of fruit as a dessert at lunch and dinner.

The purpose of the present study is to examine the effects of a six-month dietary education intervention programme, delivered and taught by trained teachers, on the consumption of fruit as a dessert in children aged 6–12 years.

## Methods

### Participants

During 2007/2008, seven of 80 public elementary schools from a city in 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

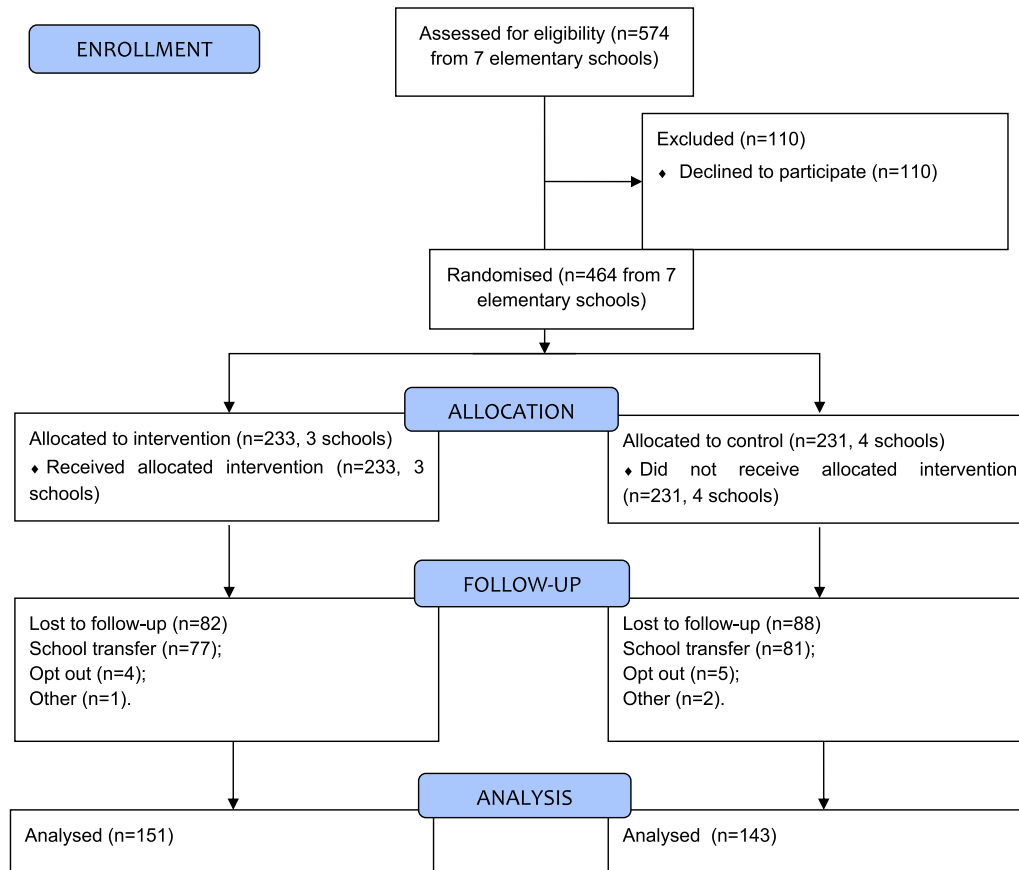
personnel for assessment and intervention. The unit of randomization was the school, and three of them were assigned into intervention, and four into the control group (Fig. 1). Previous data collection, the written consent forms signed by parents, was gathered according to the ethical standards laid down in the Helsinki Declaration. Immediately before data collection 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 [clinicaltrials.gov](http://clinicaltrials.gov), NCT01397123.

Of the 574 children who were invited to participate, 464 (239 female), aged 6–12 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 non-participation were school transfer (94.1%), parental refusal (4.1%) and absence from school (1.8%). A total of 257 parents of the children involved in the study provided data at baseline and 203 (79.0%) at postintervention, i.e. after the programme ended during the year 2009.

### Overview of the intervention

Fifteen teachers from intervention schools (15 classrooms) were invited to participate in the programme conducted between October 2008 and March 2009, and all of them agreed to be involved. This intervention programme was based on the Health Promotion Model<sup>28</sup> and the social cognitive theory,<sup>3</sup> and aimed to promote healthier active lifestyles by encouraging children to be more active and make a better food selection. The professional development training for the teachers was 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-h duration. The programme was implemented over two terms: (1) teachers' training delivered by researchers between October 2008 and March 2009; and (2) intervention delivered by the trained teachers to children between November and March 2009 and as previously described elsewhere.<sup>35,36</sup> Briefly, teachers of the intervention group had 12 sessions of three hours each with the study researchers during six months, which included contents related to health promotion and overweight and obesity prevention, concepts of food, nutrition and dietary guidelines, hydration and the importance of water, appropriate physical activity levels and strategies to reduce screen time. 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 to clarify doubts and review the materials to be used in the sessions.

The implementation of the programme occurred as planned. All the children of the intervention schools had contact with trained teachers. Teachers taught the components of the



**Fig. 1 – Flow of participants through each stage of the programme. Portugal (2007–2009).**

programme 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. There were no changes in standard care provided by teachers from control schools.

### Assessments

In each school, previously trained assessors performed anthropometric evaluation, using standardized procedures<sup>46</sup> 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. Children and outcomes assessors were blinded to group assignment. Anthropometric measurements were performed with children with light indoor clothing who were barefoot. Weight was measured in an electronic scale, with an error of  $\pm 100$  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,<sup>2</sup> (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.<sup>8,9</sup> A z-score (the number of standard deviations [SDs] 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.<sup>26</sup>

Dietary intake was gathered by a 24-h dietary recall obtained by nutritionists and/or trained interviewers, before and immediately after the intervention. These interviews captured the time, type, local, and foods and beverages at each eating occasion. Children did not have previous notification of when the recalls would occur to prevent potentially biasing reports and were asked to remember all food and beverages consumed during the previous 24-h. Portion sizes were assessed using various presentations of book images. 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. Fruit consumed as a dessert was gathered, according to whole fruit consumption after lunch and dinner (excluding fruit juice).

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<sup>38</sup> adopted by the FAO/WHO/UNU report.<sup>45</sup> BMR was determined through the Schofield equations and the subjects with EI:BMR  $\leq 0.89$  were classified as Low Energy Reporters (LERs) and excluded from analysis.<sup>16</sup>

In order to assess the level of physical activity of children, parents were asked five questions with four answer choices (four-point scale) ranging from one to four, from a questionnaire developed by Telama et al.<sup>42</sup> and previously applied to the Portuguese population.<sup>24</sup> 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 (five scores); low activity group (six–10 scores); moderately active group (11–15 scores); and vigorously active group (16–20 scores), on the basis of their reported physical activity.<sup>24,31</sup>

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: zero; one–four; five–nine; 10–12; and more than 12 years of formal education). This information was further grouped for analysis into three categories: up to nine years; 10–12 years; and more than 12 years of education.

### Statistical analyses

Data are described as mean (SD) or *n* (%) where appropriate. Student *t*-tests, Mann–Whitney *U*, Kruskal–Wallis and chi-squared tests were used to compare several variables grouped by intervention and control groups and gender. These tests were also conducted to assure comparability of fruit for dessert 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. The effect of the programme was evaluated based on changes in fruit for dessert at lunch and dinner, 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, USA).

## Results

Table 1 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<sup>2</sup>, ranging from 11.9 to 26.9 kg/m<sup>2</sup> 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 of the children were classified as sedentary or having low activity (64% for the intervention and 68.9% for the control group). Mean energy intake was not statistically significantly different ( $P = 0.257$ ) between

intervention and control groups at baseline (2091 [684] kcal/day vs 2024 [582] kcal/day respectively).

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

As we can see in Table 1 no significant differences were found on fruit for dessert consumed on lunch and dinner at baseline between intervention and control groups.

Overall, children from the intervention group reported an increase in fruit consumption at dessert whereas the control group reported a reduction in fruit as dessert for lunch. These differences were significant after controlling for confounders ( $P = 0.001$ ), Table 2. Children from both groups (control and intervention) reported an increase on fruit for dessert consumption at dinner. Intervened children had a significantly higher consumption compared to controllers and this difference was significant after controlling for confounders ( $P = 0.012$ ), Table 2. In addition, 43 children increased both consumption at lunch and dinner, 30 (70%) of which belonged to the intervention group.

## Discussion

Our study showed that a nutrition programme, delivered and taught by in-service teachers trained in nutrition is effective in improving fruit consumption as a dessert. There was a significant higher increase in fruit for dessert at lunch and dinner among intervened children compared to the controllers, after adjusting for confounders. This is noteworthy because since both environment and genetics affect dietary preferences,<sup>14</sup> effective promoting strategies that improve the consumption of healthy food as a dessert can shape preferences.<sup>23</sup> Moreover, the habits acquired early in life tend to be maintained into adulthood.<sup>4,25</sup>

Until now it has not been clearly established that the increased willingness to consume fruit observed in the school environment is mirrored in the child's eating behaviour at home. Our study adds upon other by showing that the teachers' intervention in improving children's behaviour related to fruit intake, perhaps also induced their abilities to ask parents to buy or prepare a favourite fruit and influence its readiness in the home.<sup>6,33</sup> Moreover, our data suggest that the professional development training provided teachers with the knowledge and skills needed to properly integrate health nutrition in the school curriculum. Indeed, it seems that teachers were able to adapt the topics according to the children's needs and learning abilities throughout the year. Although the results of this programme cannot be extrapolated to demonstrate lifelong changes in eating habits, it does show the ability of an education programme to impact on diet at a crucial life stage when eating habits are being established.

Previous studies identified that fruit consumption is below recommended levels among school children.<sup>21</sup> This study provides further support to improve fruit consumption at a particular time, as a dessert.<sup>11,17</sup>

It has been questioned the role of teachers as interventionists.<sup>39,41</sup> This study contributes to clarify the scant

**Table 1 – Characteristics of the sample at baseline and postintervention. Portugal 2007–2009.**

Characteristics	Baseline			Postintervention		
	Intervention n = 231	Control n = 233	P-value	Intervention n = 151	Control n = 143	P-value
Boys <sup>a</sup>	116 (49.8)	109 (47.2)		76 (50.3)	68 (47.6)	
Girls <sup>a</sup>	117 (50.2)	122 (52.8)	0.575	75 (49.7)	75 (52.4)	0.634
Age (years) <sup>b,c</sup>	8.3 (1.2)	8.2 (1.2)	0.846	9.2 (0.9)	9.1 (1.0)	0.494
BMI (kg/m <sup>2</sup> ) <sup>b,c</sup>	18.1 (2.7)	17.7 (2.8)	0.062	18.7 (2.6)	18.7 (2.7)	0.966
Energy intake (kcal/day) <sup>b,c</sup>	2091 (683.9)	2024.2 (581.8)	0.257	2388.0 (1036.5)	2475.6 (684.9)	0.049
Fruit for dessert at lunch (g) <sup>b,c</sup>	81.94 (76.0)	88.8 (91.4)	0.057	90.1 (95.8)	52.3 (67.8)	<0.0001
Fruit for dessert at dinner (g) <sup>b,c</sup>	53.4 (80.1)	27.7 (65.4)	0.077	71.2 (93.1)	48.8 (89.2)	0.044
Mother's education <sup>a</sup>						
Up to nine 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 <sup>a</sup>						
Up to nine 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 <sup>a</sup>						
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 <sup>a</sup>						
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.  
<sup>a</sup> Categorical variables; results expressed as n (%); P-value from Chi-squared test.  
<sup>b</sup> Continuous variables; results expressed as mean (SD).  
<sup>c</sup> P-value from t-test.

**Table 2 – Impact of the intervention programme on fruit consumed at lunch and dinner among children. Portugal 2007–2009.**

Measure	Baseline mean (SE) (g)	Postintervention mean (SE) (g)	Postintervention adjusted mean (SE)	Adjusted P-value
Fruit for dessert at lunch				
Control	105.5 (8.1)	52.3 (5.9)	50.9 (9.8)	0.001
Intervention	85.6 (6.6)	90.1 (8.0)	94.6 (8.6)	
Fruit for dessert at dinner				
Control	29.7 (5.8)	48.8 (7.8)	48.9 (10.9)	0.012
Intervention	45.2 (6.5)	71.2 (7.8)	85.1 (9.5)	

Adjusted for gender, age and baseline energy intake, parents' education, weight status, Physical Activity Index, underreporting (ratio of EI:BMR) and baseline measures of the dependent variable.

evidence of the effect of nutrition education-only programmes delivered by teachers, and provides support for their role in improving children's eating habits.

The present study has important strengths that should be acknowledged. We did not include fruit juice in the analysis, because the evidence for its benefits is less clear than for whole fruit, which is higher in fibre and less concentrated in sugar. In addition, dietary intake was measured with a 24 dietary recall, which is the most commonly used method in Europe and suggested by European Food Safety Authority.<sup>13</sup> A single 24 h dietary recall instead of at least two days was used, limiting the possibility to adjust for intra-individual variability and to estimate habitual intake.<sup>13</sup> 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.<sup>29</sup> Moreover, to the best of our knowledge, this is the first dietary intervention based on professional development training with impact on teachers' professional careers. This probably induced teachers to increase their motivation in the delivery of the intervention. 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 specific health promotion subjects in their academic curricula, neither are considering change in that direction.<sup>30</sup> Being aware of this need and that long-term

programmes are more effective than those of short duration,<sup>41</sup> we promoted a six-month duration professional development training with the expectation that teachers could become nutrition educators. We believe this period allowed teachers to recognize how important healthy eating and physical activity are for children's health, well being and development. Our approach was to standardize recommendations to teachers, allowing them enough flexibility to create interactive interventions and pedagogical instruments and materials to be used in children taking into consideration their educational context. This is in concordance with the 'scholarship of teaching and learning'<sup>40</sup> and contrary to previous school-based interventions that have used tight controls to ensure uniform implementation but required frequent staff training and ongoing supports.<sup>1,18,37</sup> 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 shops and homes). Furthermore, we adopt an appropriate control group against which to compare the intervention group's changes in food consumption.

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 that were not selected, due to resources constraints. In addition, from 574 children invited to participate, 110 did not agree to be included in the study. We lost to follow-up 88 children in control and 82 in the intervention group, essentially because of school transfer due to the achievement of the end of a primary degree. However, children and schools are from the same geographical area and, to the best of our knowledge, no data are available reporting significant socio-demographic and income differences between schools selected and non-selected. Furthermore, we failed to get identically equivalent groups after randomization, namely in the level of parents' education and children's height, mainly because we performed a cluster randomization at the school level instead of a simple randomization by participant, to avoid cross contamination between intervention and control groups and to improve the evidence, through the intervention programme, to all children from the same class. Nevertheless, these differences were taken into account in all of the statistical models. Also, physical activity levels were obtained upon parents' reported data creating possible recall bias, missing data and overestimation. However, this questionnaire is reliable for Portuguese children and adolescents<sup>24</sup> and we have no reason to assume that these biases would affect groups differently. Finally, we did not perform a follow-up study after a non-intervention period to clarify if children continued to eat significantly more fruit for dessert than they had done before the intervention.

## Author statements

## Acknowledgements

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 programme. Our grateful acknowledgement 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.

## Ethical approval

The Portuguese Data Protection Authority (process number 7613/2008) approved the study.

## Funding

None declared.

## Competing interests

None declared.

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